

# Southern Division of the American Fisheries Society

## 2005 Spring Meeting, Virginia Beach, Virginia

### Meeting Abstracts

#### Oral Presentations

##### *Asian Carp Symposium*

###### **Origin and Perspectives of the National Triploid Grass Carp Inspection and Certification Program**

*Vincent A. Mudrak\* U.S. Fish and Wildlife Service, Warm Springs, GA 31830*

Asian grass carp (*Ctenopharyngodon idella*) were introduced into the United States in 1963 by the U.S. Fish and Wildlife Service (USFWS). The goal was to find a biological alternative to the use of chemicals as a control measure for invasive aquatic plants. Most scientists and managers of the 1960s focused on the positive aspects of the introduction. But the original premise, that grass carp life history requirements would preclude reproduction in open waters of the United States, proved false, and grass carp became established in some rivers. In order to control the proliferation of grass carp, studies led to the development of triploid grass carp, which contained three sets of chromosomes, and which were determined to be reproductively non-functional. Additionally, during the 1980s, the USFWS worked with the aquaculture industry and instituted a process to inspect grass carp for ploidy. The USFWS agreed to certify grass carp that were destined to go to states that would only accept grass carp that were certified as non-diploid by the U.S. Fish and Wildlife Service. Then in the early 1990s, because of budgetary shortfalls and changing priorities, the USFWS considered the withdrawal from active participation in the inspection and certification process. But state managers desiring the continued use of triploid grass carp sought help, and in 1995, the 104th Congress responded by passing a law that authorized the USFWS to collect fees to administer a certification program. The resultant USFWS program embraced quality assurance standards for inspectors and producers, and is presently known as The National Triploid Grass Carp Inspection and Certification Program.

Keywords: Asian, Carp, triploid, government,

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###### **Dietary overlap of Asian carp and native filter feeding fishes in the Upper Mississippi River System**

*Chick, J.H., Sampson, S.J., and Pegg, M.A. Illinois Natural History Survey*

Bighead and silver carp became established in the Mississippi River during the 1980's, and have been spreading through the drainage basin since that time. Data from the Long Term Resource Monitoring Program suggests that these species became established in the Upper Mississippi River System in the early 1990's. Both species are filter feeders, consuming zooplankton and phytoplankton, and therefore have the potential to compete with native filter-feeding fishes including paddlefish, bigmouth buffalo, and gizzard shad. We collected dietary samples from the two Asian carp species and the three native filter-feeding fishes during the late spring of 2002 and 2003. We sampled fish and zooplankton in backwater lakes because all five species are known to congregate in these habitats during the spring, allowing for dietary comparisons from fish feeding in similar locations. Dietary overlap was greatest among bighead carp, silver carp, and gizzard shad. Rotifers dominated the diet of all three of these species, whereas bigmouth buffalo and paddlefish primarily consumed larger zooplankton (e.g., copepods and cladocerans). Our results suggest that of the native filter-feeding fishes in the Upper Mississippi River system, bighead and silver carp have the greatest potential for negative interactions with gizzard shad.

Keywords: Asian carp, dietary overlap, filter-feeding fishes, zooplankton

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## **The U.S. Asian Carp Industry: Economic Value And Importance**

*Engle\*, C.R. and N.M. Stone. Aquaculture/Fisheries Center, University of Arkansas at Pine Bluff*

The top four finfish species cultured worldwide, in terms of volume of production, are Asian carps. This group of fish has been introduced into many different countries and constitutes an important source of food for many people across the globe. Grass carp (*Ctenopharyngodon idellus*) were introduced into the U.S. in 1963, bighead (*Hypophthalmichthys nobilis*) and silver (*Hypophthalmichthys molitrix*) carp in the 1970s and black carp (*Mylopharyngodon piceus*) were introduced somewhat later, in the 1980s. The U.S. Fish and Wildlife Service, the Arkansas Game and Fish Commission, Auburn University, and the Illinois Natural History Survey were among the pioneers that conducted research on culturing Chinese carps and promoted their culture on private fish farms. As investigators sought solutions for two critical issues of that era, clean water and the food supply for a growing world population, early research focused on using the carps in polyculture to treat wastewater and to turn agricultural wastes into animal protein. In spite of their 30-year history in the U.S., a great deal of controversy has emerged over the presence of these fish species in U.S. waters. The controversy has extended to attempts to prevent the interstate shipment of various Asian carps as fish farmers transport fish from their farms to Asian grocery stores for live sales. Asian carp are commercially traded in the U.S. on a significant scale. Farmers have a substantial investment in broodstock and in the infrastructure to produce, haul, and sell carp. Restrictions on production and sale of Asian caps will affect large numbers of small businesses. The economic impact of destroying this industry will represent millions of dollars of economic losses. Bighead carp are commonly co-cultured in catfish ponds and with other fish species in the U.S. Budgets have shown that bighead carp generate an additional \$192/acre. Sales of bighead carp have enabled catfish farms to survive times of low prices by providing an alternative crop to sell to diversify farm revenue. Bighead are hauled from fish farms to New York, Chicago and other major cities. Based on informal polls in Arkansas and Mississippi, farm-gate sales in 2003 were estimated at \$5.36 - \$6.5 million/yr with an additional revenue of \$6.09 - \$21.7 million/yr through the supply chain. Moreover, closures of catfish farms that did not have the risk reduction benefits of bigheads, would have incurred losses of \$22 million, for a total economic impact of \$135 million/yr. This would equate to losses of 1,026 jobs in the Delta regions of the two states. Grass carp are used in many states throughout the U.S. for aquatic weed control. It has been estimated that use of grass carp for weed control costs about \$45-\$125/acre while other means will cost from \$100 - \$26,200/acre to control aquatic weeds. Survey data show that 42% of catfish farms stocked grass carp in foodfish ponds. Black carp are used to control snails in fish ponds. A recent study estimated the economic effect of restricted access to black carp on hybrid striped bass farms. The effects stem from the higher mortality of fingerlings and reduced marketability of bass foodfish. Net farm revenues decreased by 58% to 100% with the greatest decreases on the smaller farms.

Keywords: Bighead carp industry, grass carp industry, black carp, economics

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## **National Standards for Triploid Grass Carp Inspection and Certification Program**

*Heil\*, N.P., and Hickson\*, B.H. U.S. Fish and Wildlife Service (USFWS) Warm Springs, GA*

The U.S. Fish and Wildlife Service (USFWS) offers a triploid grass carp inspection service for natural resource agencies in the United States and in other countries, to help States and others protect their aquatic habitats. The inspection program is to provide assurance to these agencies, and others concerned about protecting aquatic resources, that shipments of grass carp alleged to be all triploid, do not, within the confidence limits of the inspection program, contain diploids. A set of standards have been developed to provide quality assurance which the USFWS will use to provide consistency and fairness in dealing with different circumstances encountered in the implementation of a National Triploid Grass Carp Inspection and Certification Program. The critical elements of the Program are described in four categories: (1) Standards for USFWS Inspectors; (2) Standards for Grass Carp Producers; (3) Checklist for Inspectors and Producers; and (4) Standards for Collection and Fees. The standards are available at web address: <http://warmsprings.fws.gov/FishHealth/index.html>.

Keywords: Grass, Carp, Triploid, Standards, USFWS, Certification

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## **Development of a National Asian Carp Management Plan**

*Conover\*, Greg C.*

The Aquatic Nuisance Species Task Force requested the U.S. Fish and Wildlife Service organize an Asian Carp Work Group and lead the development of a national management and control plan for bighead, black, grass, and silver carp. Representatives from federal, state, and Canadian natural resources management agencies, Native American tribes, industry professionals, universities, and non-governmental organizations are working together to draft the plan. Broad and diverse representation of stakeholders on the Work Group is intended to bring multiple interests together to collaborate on effective methods of prevention and control to protect native ecosystems from potential impacts of these species. The Work Group has developed goals and objectives for the plan and is beginning to draft the plan. This comprehensive plan will include a variety of control strategies and specific actions to be taken by federal, state, and local agencies, and by the private sector to limit the further spread, prevent additional introductions, and reduce the impacts of existing populations of Asian carps in the wild. Once drafted, the Working Group will lead efforts to solicit public comments and refine the draft management plan as necessary. The final management plan will then be submitted to the Task Force for implementation approval.

Keywords: Asian carp management

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## **Telemetry and habitat characterization of bighead and silver carp in the lower Missouri River**

*Chapman\*, D.C.*

Telemetry and depth temperature archival tags were used to determine habitat selection and behavior of bighead (*Hypophthalmichthys nobilis*) and silver carp (*H. molitrix*) in the Missouri River from fall 2002 – summer 2004. A variety of habitat characterization techniques were used to characterize the habitats selected by the fish, including water quality measurements, bathymetry, substrate classification, acoustic imaging, and acoustic Doppler current mapping. Both species were active during cold-water periods. Both species mostly occupied the midwater zone in coldwater periods, but bighead carp sometimes came to the surface, especially at night. Fish generally used deep water with low velocity. More than 90% of fish locations, all months, were over 3 m deep. Many fish moved upstream during high water events during the warm months. Movements of over 150 miles within a season, both upstream and downstream, were recorded. Silver carp tended to move longer distances than bighead carp. Bighead carp used tributaries more than silver carp. Among Missouri River sites, chlorophyll concentrations at silver carp locations were higher than at bighead carp locations or the main channel of the river. Turbidity at bighead carp locations was lower than that of the main channel.

Keywords: Asian bighead silver carp habitat telemetry turbidity chlorophyll behavior

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## **Morphometrics for the determination of sex and hybridization in *Hypophthalmichthys* species**

*Chapman, D.C. USGS Columbia Environmental Research Center, Columbia, MO.*

Bighead carp (*Hypophthalmichthys nobilis*) and silver carp (*H. molitrix*) apparently hybridize readily in the wild in the United States. Five percent of *Hypophthalmichthys* captured in the Missouri River in the summer of 2005 were nominal hybrids. Hybrids can be difficult to identify because they can closely resemble either of the parent species, and because the hybrids are fertile and backcrosses may exist. Incorrect identification hybrids can compromise research findings. Various authors have had success in identification of the sex of *Hypophthalmichthys* using the ridges on the pectoral fins, but other researchers have found that those secondary sexual characteristics are not always adequate, especially during periods when

the fish are not sexually active. We measured several morphometric parameters on a large number of fish to determine which parameters would be most useful in determining hybridization and the sex of *Hypophthalmichthys*. Genetic analysis was used to verify the hybridization in a subset of samples.

Keywords: Asian bighead silver carp hybrid gender sex morphometrics

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### **Quality Assurances Within Triploid Grass Carp Industry**

*Freeze, M. Keo Fish Farm, Keo, AR*

Quality control within the triploid grass carp industry is assured not only by the USFWS but also by the triploid grass carp industry itself. Failing a USFWS inspection is not only a major embarrassment; it creates economic problems for the farm that fails if customers are waiting or in route to pick up scheduled fish. Besides the progressive USFWS fine, each fish in a failed certification must be individually retested before another certification can be rescheduled. Normally fish shipments are tightly scheduled and such an event can wreck havoc with such schedules.

The triploid grass carp industry also polices the illegal transportation of grass carp. An unscrupulous individual that is shipping diploids into a triploid state is taking dollars away from legitimate farms and such incidents are quickly reported by the industry to appropriate officials. The shipment of any grass carp into states that currently prohibit all grass carp is also reported as such activity serves as an impediment to the eventual legalization of sterile triploid grass carp in that state. Many private individuals that want to illegally import grass carp into such states are discouraged after legitimate farms explain state laws and the Lacey Act to these misguided people.

Keywords: grass carp quality assurance

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### **Asian Carp Impacts**

*Jerry L. Rasmussen, MICRA, P.O. Box 774, Bettendorf, IA 52722*

The invasion and spread of Asian carp (silver and bighead) into many mainstream rivers and tributaries of the Mississippi River Basin has occurred at an alarming magnitude and rate. The biological impacts of these large (100+ lb.), prolific invaders on native fish species and their habitats has not been well documented scientifically, but observation and experience with other carp invasions raises significant concerns for the long term. More than 100 years after the introduction of the European or common carp this species remains the number one most troublesome fish species to fish and wildlife managers in the Basin. The bighead and silver carp have quickly achieved second and third place on this most troublesome list, followed by yet another Asian carp species, the black carp. The black carp was introduced to control snails in fish culture ponds, and has recently found its way into the wild where biologists are gravely concerned for the welfare of the Basin's endangered snail and mussel species that could fall prey to the invasive black carp. This paper explores the biological, physical, emotional and economic impacts of the Asian carp invasion on fish and aquatic organisms, fishing, recreation, and fish and wildlife management in the United States.

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## **Defining a Catch and Release Research and Education Model Symposium**

### **Hooking Mortality of Deep and Shallow Hooked Striped Bass Under Different Environmental Conditions In Chesapeake Bay**

*Lukacovic\*, Rudolph. Maryland Fisheries Service, Annapolis, MD*

Catch-and-release fishing for striped bass along the Atlantic coast has grown substantially as have concerns about release mortality. Physical injury and stress are the two major causes of death of released fish. Anatomical location of the hook wound is the single most important factor, but temperature, salinity, and fish size are also risk factors. Trials comparing hook styles were run during 1999's fishing season. Standard J-hooks were used the first day of each trial and non-offset circle hooks were used the second. Striped bass were caught by chumming and were kept in holding pens for three days. Striped bass caught on J-hooks were deep-hooked 17.2% of the time throughout the season but were deep-hooked only 3.4% with circle hooks. Mortality rate of striped bass deep-hooked with J-hooks was 53.1% and 23.5% with circle hooks. Mortality of shallow-hooked fish was 3.5%. Shallow-hooking mortality when air temperatures were low was 0.8%, but was 17.2% when air temperatures ranged above 35C. Combining deep-hooking rates with deep-hooking mortality for each style of hook indicates a reduction in mortality from 9.1% to 0.8% using circle hooks.

Keywords: striped bass circle hooks catch-and-release mortality deep-hooking

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### **The National Symposium on Catch and Release in Marine Recreational Fisheries: Progress and Issues Since 2001**

*Lucy\*, J. A. VA Institute of Marine Science, College of William and Mary, Gloucester Pt., VA*

The National Symposium on Catch and Release (CR) in Marine Recreational Fisheries was held December 1999. Participants developed "Action Agendas" for research and education priorities. However, since 2001 effort in North America shows little coordinated effort. For example, there have been diverse studies on snook, red drum, spotted sea trout, striped bass, white and blue marlin, reef fish venting, white seabass (CA), salmon, trout, sunfish, walleye, live weigh-in tournaments and physiological-behavioral impacts of CR. Overviews of research effort include meta-analysis of circle hook research and a review of angling mortality studies pertaining to no-take reserves. Neither are educational efforts coordinated, the Catch and Release Association for FL Fishing Guides, "Tips for Saltwater CR (from Federation of Fly Fishers), fishing ethics and circle hook materials (Sea Grant Programs and Boat U.S.), "Released Salmon—Do They Survive? (video, Canada), and circle hook outreach (largely targeting billfish tournaments). Starting in 2001, Australia developed a national research and education program, "The National Strategy for the Survival of Released Line Caught Fish." This program offers a model for consideration by the US. Highlights of CR research and education projects on both continents will be discussed, along with suggestions for better coordinating research and education productivity.

Keywords: catch and release, research, education, North America, Australia

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### **Evaluating the physiological and physical consequences of capture on post-release survivorship in large pelagic fishes**

*Skomal, G.B.\* Massachusetts Marine Fisheries, Oak Bluffs, MA*

Sharks, tunas, and billfishes are exploited by extensive recreational and commercial fisheries throughout the world. Quotas, minimum sizes, and bag limits imposed by state, federal, and international management bodies result in the mandated release of a high, yet poorly quantified, number of large pelagic fishes annually. Evaluating post-release survivorship in these fishes is difficult because standard methods are simply not applicable to large oceanic animals. Post-release mortality in fish is directly related to the acute and chronic effects of physiological stress and physical trauma. Exhaustive exercise and time out of water cause physiological stress, which can be quantified in large pelagic fishes through the sampling of blood and muscle biochemistry. Fishing gear and handling cause physical trauma, which is manifested as external and internal tissue and organ damage. Gross examination and histopathological sampling of tunas, sharks, and billfishes can be used to assess physical trauma and to infer post-release survivorship. Moreover, these methods have shown that hook retention can cause chronic

systemic disease that may lead to delayed mortality. Conventional, ultrasonic, and satellite tagging can be used to assess recovery and post-release survivorship in large pelagic fishes exposed to the physiological stress and physical trauma associated with capture.

Keywords: sharks, tunas, billfishes, physiological stress, physical trauma, post-release survivorship

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### **Post-release mortality of blue marlin and white marlin caught in the western North Atlantic recreational and commercial fisheries**

*Graves\*, J.E., Kerstetter, D.W, and Horodysky, A.Z. Virginia Institute of Marine Science, College of William and Mary*

Atlantic blue marlin and white marlin are caught in directed recreational fisheries and are taken incidentally in pelagic longline fisheries that target tunas and swordfish. Both species of marlin are seriously overfished. Currently, most blue marlin and white marlin caught by recreational anglers are released alive, and U.S. commercial fishermen are required to release all billfish whether they are dead or alive. Recently, member nations of the International Commission for the Conservation of Atlantic Tunas (ICCAT) adopted a binding management measure requiring the release of all live blue marlin and white marlin taken in longline and purse seine operations. In order for these measures to reduce overall fishing mortality, fish must have a reasonable chance of survival following release. We employed short duration (5 - 10 day) pop-up satellite archival tag technology to evaluate survival of white and blue marlin released from recreational and pelagic longline fisheries. Our results indicate that release of live animals will substantially reduce fishing mortality of both species in both fisheries. Furthermore, the use of circle hooks appears to significantly reduce white marlin mortality in the recreational fishery.

Keywords: blue marlin white marlin post-release mortality

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### **Measuring short-term catch and release mortality of tarpon in Boca Grande Pass, FL through the use of ultrasonic tagging techniques**

*Guindon\*, K.Y., C.R. Powell, and L.R.R. Barbieri. Florida Fish and Wildlife Conservation Commission, Florida Fish and Wildlife Research Institute, St. Petersburg, FL 33701*

The number of tarpon tags (permits) sold and used each year in Florida has been used to estimate annual tarpon fishing mortality due to harvest; however, determining annual fishing mortality using tags sold is unrealistic for a predominantly catch-and-release fishery. The objective of this study is to obtain current estimates of catch-and-release mortality rates for tarpon in Boca Grande Pass using ultrasonic telemetry. Tarpon landed on fishing charters were tagged with ultrasonic transmitters and tracked for up to 6 hours immediately following release. Of the 41 tagged tarpon, four were unconfirmed mortalities inferred from movement patterns and three were visually confirmed mortalities, all caused by shark attacks. The catch-and-release mortality rate evaluated for this study is 17.1% (7 out of 41). Statistical comparison showed no significant difference between jig- and live-bait fishing methods on catch-and-release mortality rates in Boca Grande Pass. No association between tackle used, hook placement, or fight time and tarpon catch-and-release mortality could be detected; however, the condition of the fish at time of release may affect survival. Tagging studies can be a valuable tool for estimating post-release mortality of game fish, especially for large species that might be difficult to maintain in floating pens or tanks.

Keywords: Tarpon tagging catch-and-release

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## **Effect of Hook Removal on Recapture Rates on 27 Species of Angler-caught Australian Fishes**

*Wilde\*, G. R., and W. Sawynok. Texas Tech University, Lubbock, TX, and Infofish Services, 142 Venables St., North Rockhampton, QLD, Australia*

We used data from a cooperative angler tagging program to assess the potential benefit of leaving hooks in fish captured and released by anglers. We assembled 248,010 records for 27 species of Australian fishes. Hooks were left in only 1.1% of released fish and the overall recapture rate was 8.8%. We used relative risk, the probability of an event (recapture) in a treatment group (those with hooks not removed) divided by the probability of an event in a control group (those with the hook removed), to assess the potential effects of leaving hooks in released fish. Relative risk ranged from 0.30 to 7.6, but did not differ significantly from 1.0 in any species. Thus, there was no evidence that hook removal affected recapture probability. Pooling results across all species yielded an overall relative risk of 1.18 (95% confidence interval, 1.02 to 1.36), which suggests that the recapture rate of fish in which hooks were not removed prior to release was marginally greater than that for fish released without hooks. Our results indicate there is no substantial benefit, nor adverse affect, of hook removal on recapture rates, which can be considered as a surrogate measure of survival of released fish.

Keywords: catch-and-release, hook removal, survival

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## **Conceptual Models for Studying the Survival of Fishes Caught and Released by Anglers**

*Wilde\*, G. R. Texas Tech University, Lubbock, TX*

A large, and growing, number of studies have examined factors that influence the survival of captured and released fishes. An important limitation of this body of literature is the lack of conceptual, or other models, that allow results of individual studies to be placed into a broader perspective. In this paper I (1) demonstrate the utility of simple conceptual models that describe survival of angler-caught and released fishes using largemouth bass as an example, and (2) provide a general framework for synthesizing results of diverse studies. Finally, I argue for development, validation, and application of quantitative models for predicting survival and show how these models might be quickly constructed.

Keywords: catch-and-release, conceptual models, survival

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## **Conceptual Model for Reduction in Growth Performance of Fishes Caught and Released by Anglers**

*Pope \*, K. L., and Wilde, G. R. Texas Tech University, Lubbock, TX*

Many studies have examined factors that influence the survival of fishes caught and released by anglers. These studies document varying amounts of mortality, which indicates that in some instances, the act of catching and releasing fishes is stressful. Thus, in instances where fish are stressed, but not mortally wounded, we expect to observe sub-lethal effects, such as a reduction in growth rate. In this presentation, we will (1) present results that compared growth rates for caught-and-released and un-caught largemouth bass *Micropterus salmoides* and rainbow trout *Oncorhynchus mykiss*, and (2) discuss a conceptual model of growth for fishes caught and released by anglers.

Keywords: angling growth model

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## **Contributed Papers Session**

### **Environmental Assessment**

#### **The 316(b) Regulation: Fisheries Biologist Right to Work Law**

*Heitman, J. F. \*, AMERICAN AQUATICS, INC.*

In July 2004 EPA finalized an updated regulation (CWA Section 316(b)) that deals with power plants with cooling water intake structures that have a design capacity of at least 50 MGD. The regulation sets performance criteria for impingement and entrainment of aquatic organisms of 60-80% and 70-90%, respectively, from a calculated baseline flow. Of particular interest to fisheries workers is that there is extensive work associated with larval fish, adult fish and fish restoration associated with this new regulation. Not since the 316 (a & b) work of the 1970's has there been an environmental regulation that so directly impacts fisheries workers. In this presentation I will review and discuss opportunities for workers and agencies pertaining to the 316(b) regulation.

Keywords: CWA 316(b) Fisheries Biologists environmental regulations

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#### **Assessing the Ecological Recovery of the Pigeon River Using Benthic Invertebrate Surveys (B-IBI) in Cocke County, TN and Haywood County, NC (1987-2005)**

*Wilson, MJ \*, JL Wilson and JA Coombs. University of Tennessee, Knoxville, TN.*

The Pigeon River Restoration Project (PRRP) is an ongoing project to help restore the ecological integrity of the Pigeon River as is feasible while maintaining economic growth along the river. The benthic invertebrate assessment is just one aspect of a larger restoration project. Historical Benthic Index of Integrity (B-IBI) data is available for both the Tennessee and North Carolina portions of the Pigeon River. Current B-IBI samples for 2004 were collected in March and August. Additional samples will be taken in March and July of 2005. This assessment will include the creation of a database with a comprehensive species list of all aquatic invertebrates collected on the river. Improvements in the fauna are expected due to the reduction of emissions and the upgrade of equipment at Blue Ridge Paper Products mill in Canton, North Carolina. We have witnessed improvements in the fish communities, with multiple species re-colonizing the Pigeon River from its tributaries. There should be a corresponding improvement in benthic communities. I will try to assess this ecological recovery in the benthic invertebrate assemblage to aid the ongoing habitat assessment and restoration efforts on the Pigeon River. \* I would also be interested in presenting a poster if there is not available space for my presentation. Thank you!  
Melinda

Keywords: Benthic Invertebrate Assemblage Riverine Habitat Assessment Assess Ecological Recovery of River Pigeon River Restoration Project Cocke County, Tennessee Haywood County, North Carolina

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#### **Lake bed accretion and patterns of sedimentation affect lake morphometrics and fish communities in Lake Texoma, Oklahoma**

*Lyday\*, C. L., Patton, T. M., and Morel, J. Department of Biological Sciences, Southeastern Oklahoma State University, Durant, OK.*

Lake Texoma is a 36,000 ha reservoir located in northern Texas and southern Oklahoma. It was completed in 1944, and upper reaches are now experiencing significant sedimentation and accretion, resulting in isolation of coves and a reduction of reservoir surface area. In this study, we are determining (1) the amount of reservoir surface area lost to accretion, (2) morphometric changes in areas of high sedimentation, and (3) the impacts of these processes on fish community structure. We are using GIS technology to address changes in surface area, standard limnological measurements to address morphometrics, and experimental gill nets and electrofishing to characterize the fish community. Preliminary analyses

indicate that a substantial area of the reservoir has experienced accretion above the water level, shoreline development has increased, and numerous areas of the lake have lost connectivity to the main body of water. With these changes, the fish community has become fragmented, and more representative of a riverine-like community; it is likely that the relative abundance of game fish has become reduced, while the relative abundance of non-game fish has increased. These changes will likely impact the quality of the sport fishery and the local economy in this area.

Keywords: sedimentation accretion shoreline development fragmentation isolation

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### **Assessing Macroinvertebrate Communities in Streams Impaired by Fecal Coliform in the Vicinity of Lake Anna, Virginia.**

*Cramer\*, R. L., and C. Gowan. Environmental Studies Program, Randolph-Macon College, Ashland, VA*

Citizen monitoring programs are used throughout Virginia to detect impaired aquatic ecosystems. However, one major source of contamination, fecal coliform, cannot be measured easily by citizens. About 7,726 km of the state's rivers currently fail to meet water quality standards for fecal coliform bacteria, a result livestock, leaky sewage systems, wildlife, and pets. A simple method allowing citizens to detect fecal coliform would aid professionals in their efforts to protect Virginia rivers. The goal of this study was to determine if macroinvertebrates, already commonly used by citizen monitors, could also be used as indicators of fecal coliform. Six impaired and five unimpaired streams in the vicinity of Lake Anna were sampled using methods developed for use by citizens. Stream health scores for impaired streams were significantly lower (average = 16.5 on a scale of 0-24) than scores for unimpaired ones (average = 19.8). Streams impaired by fecal coliform had significantly more tolerant organisms and more non-insects. For impaired streams, stream health scores were negatively correlated with the percentage of time Virginia Department of Environmental Quality water samples exceeded water quality standards. This research suggests that macroinvertebrate monitoring may offer a way for citizens to detect fecal coliform impairment.

Keywords: fecal coliform stream health citizen monitoring

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## Reservoir Management

### Striped Bass Eggs: The White Perch's Caviar?

*Harris\*, J.L., and Ney, J., Virginia Polytechnic Institute and State University, Blacksburg, VA*

White perch (*Morone americana*) were introduced into Kerr Reservoir, Virginia in the late 1980's and have subsequently become very abundant. There is concern that the perch are affecting recruitment of sportfishes, especially the self-sustaining striped bass (*Morone saxatilis*), by eating their eggs and larvae. To address ovivory, white perch of all sizes were collected in 2004 from the Roanoke River, the major spawning tributary of striped bass in Kerr Reservoir, and their stomach contents were examined for sportfish eggs and larvae. Perch collection took place in early May at multiple locations on the Roanoke River coinciding with the peak striped bass spawn. First-year results showed that white perch ate primarily chironomids and ephemeropterans, but egg predation did occur. Much of the predation was on white perch eggs (as high as 7.2 % by weight), but striped bass eggs (never above 2 % by weight) did appear in the perch's diets at certain locations. Larval striped bass were not found in white perch diets. To determine if white perch egg predation affects striped bass recruitment, the fraction of eggs consumed must be determined.

Keywords: White Perch Striped Bass Kerr Reservoir

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### Environmental and Genetic Influences to Hatching Timing of Florida and Intergrade Largemouth Bass

*Rogers, M.W., and Allen, M. S. University of Florida, Department of Fisheries and Aquatic Sciences Porak, W. Florida Fish and Wildlife Conservation Commission*

We evaluated the relative contribution of genetic versus environmental factors to the timing of largemouth bass reproduction. Florida strain broodstock from Lake Okeechobee, FL and intergrade broodstock from Lake Seminole, FL were allowed to spawn in experimental ponds located in central Florida (i.e., keeping environmental conditions similar prior to spawning). We compared pond results to observed hatching distributions at Lakes Okeechobee and Seminole during the same year. First hatching and median hatch dates were earlier for Florida-strain fish (prior to February 13th in all ponds, median hatch date February 28th) than for intergrade largemouth bass (all after February 24th, median hatch date March 11th) in experimental ponds. Water temperatures at median hatch date were generally similar for Florida and intergrade fish (14-19° C). Florida largemouth bass had longer hatching duration than intergrade fish in experimental ponds (16-72 days and 7-11 days, respectively). Similar to our pond results, age-0 fish at Lake Okeechobee exhibited earlier hatching, earlier median hatch date, and longer hatching duration than fish at Lake Seminole, and water temperatures at median hatch date were similar. Our results suggest that intergrade largemouth bass genetics may facilitate punctuated spawning, thus maximizing the growing season for the majority of offspring.

Keywords: largemouth bass, hatching timing, hatching duration

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### Temporal and spatial variability in trace element signatures of juvenile striped bass otoliths

*Schaffler\*, J.J., and Winkelman, D.L. Oklahoma State University, Stillwater, OK*

The elemental composition of fish otoliths represents a permanent record of the environmental conditions an individual has experienced as trace elements, incorporated into the growing surface of the otolith, reflects the physical and chemical characteristics of the ambient water. We tested the utility of trace element signatures in otoliths as natural tags of the river of origin of juvenile striped bass collected from the Red and Washita River arms of Lake Texoma. We were able to detect 17 elements in otoliths of juvenile striped bass during all three years. All otoliths were standardized to 40% Calcium. Phosphorus was the strongest predictor of river of origin in during 2002; however, phosphorus is biologically unstable. Strontium ( $Sr_{88}$ ) was the next strongest predictor. During 2002, our classification rate was 83%. During 2003, Lanthanum,

Copper, and Strontium were all useful in predicting the river of origin. During 2003, our classification rate was 84%. During 2004, Rubidium, Neodymium, Phosphorus, Vanadium, and Strontium ( $Sr_{86}$ ) were all useful in predicting the river of origin. During 2004, our classification rate was 88%.

Keywords: striped bass otolith trace element analysis

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### **First-year Contribution to the Year Class and Growth of Largemouth Bass Stocked at 50 mm and 100 mm into the Arkansas River**

*Heitman\*, E., Racey, C., and Lochmann, S. University of Arkansas at Pine Bluff.*

Few evaluations of largemouth bass stockings have been conducted in rivers. Oxytetracycline-marked largemouth bass *Micropterus salmoides*, averaging 50 or 100 mm TL, were stocked into backwater areas of pool 4 of the Arkansas River in the summer of 2003 at densities of 309 and 62 fish/ha, respectively. Contributions to the year class of 50-mm (13.2%) and 100-mm (13.8%) stocked largemouth bass were not significantly different in fall 2003. Stocking contributions of 50-mm (17.6%) and 100-mm (17.2%) largemouth bass were also not significantly different in spring 2004. Contributions were not significantly different between seasons. Mean (SD) total lengths for 50-mm stocked, 100-mm stocked, and wild fish were 164 (38), 172 (39), and 162 (43) mm, respectively, in fall 2003, and 187 (37), 185 (43), and 179 (44) mm, respectively in spring 2004. There were no significant differences among mean lengths for stocked or wild fish in either season. Stocking five times as many 50-mm as 100-mm largemouth bass yielded similar contributions. Largemouth bass stocked into the Arkansas River had one-year stocking contributions similar to largemouth bass stocked into reservoirs and lakes.

Keywords: largemouth bass, supplemental stocking, rivers, contribution

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### **Exploitation of Nile Tilapia in a Closed System, Public Fishing Reservoir in Northern Arkansas**

*Henry\*, S.D. and Barkley, S.W. Arkansas Game and Fish Commission (AG&FC), Jonesboro, AR. Johnson, R.L. Department of Biological Sciences, Arkansas State University, State University. AR.*

Nile tilapia, *Oreochromis niloticus*, have been stocked as a forage species annually since 2001 in Lake Hogue of Northeast Arkansas, a 101 ha., closed system public fishing reservoir. A mail-in tag study was implemented in 2003 to determine total estimated harvest, contribution of tilapia to the lakes sportfish fishery and impact of angler harvest on tilapia reproduction. Estimates of harvest were corrected for tag loss, tag-induced mortality and non-reporting of tags by anglers. Angler hours were compared for anglers targeting and not targeting tilapia. Sportsmen harvested an estimated 82% of the stocked tilapia using traditional fishing methods and with dip-nets. Anglers primarily targeting Nile tilapia fished significantly longer than individuals who incidentally caught tilapia while fishing for other species. Analysis of the economic impacts of stocking Nile tilapia demonstrated a cost/benefit ratio of 0.38. Harvest of Nile tilapia did not apparently interfere with the management goal of serving as a forage species for gamefishes. Tag return data strongly suggested that anglers harvested Nile tilapia over the traditional panfish species (e.g., bluegill, redear sunfish) at mid-day during the hot summer months, when fishing pressure had been traditionally low.

Keywords: Exploitation Nile tilapia Reward tag study Estimated 82% harvest

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### **Contribution of Stocked Fingerling Walleyes in Lake James**

*Besler\*, D.A. North Carolina Wildlife Resources Commission*

Approximately 30,000 walleye *Sander vitreus* fingerlings were marked with oxytetracycline hydrochloride (OTC) and stocked in Lake James in May 2000–2002 to measure the contribution of stocked fingerlings to the sport fishery. Gillnetting

was conducted during October–November in 2001–2003. Total catch of age-1 walleyes varied between years (range, 51–94). The percent of marked age-1 walleyes was consistently low and ranged from 2.1–3.7%. The proportionate contribution reported for all years was substantially below the criteria used to determine stocking success. It is recommended that fingerling walleye should not be stocked in Lake James.

Keywords: Walleye OTC Stocking

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### **Using an Angler Mail Survey to Assist in Evaluating a Slot-length Limit on a Texas Reservoir**

*Bonds\*, C.C., and Magnelia, S.J. Texas Parks and Wildlife Department, San Marcos, TX*

Changes in largemouth bass population were evaluated in Georgetown Reservoir, Texas, following the implementation of a 356- to 457-mm slot length limit in 1993. The largemouth bass population was surveyed by electrofishing semi-annually from 1988 through 2004. An angler creel survey, followed by a mail survey, was conducted in 2004 to gather angler catch statistics and opinions concerning support for this length limit. Size structure, electrofishing catch per effort, and angler catch rates for largemouth bass greater than 356 mm increased moderately, but only after six years post regulation change. Evidenced by survey responses, most angler opinions were neutral concerning improvements in fishing quality (50%; N = 40) and support for the slot length limit (33%; N = 24). More tenured bass anglers (i.e., fished Georgetown Reservoir > 10 years) agreed (28%; N = 7) than disagreed (12%; N = 3) fishing for largemouth bass improved after the slot. More respondents disagreed (47%; N = 20) than agreed (28%; N = 12) when asked if they would support rescinding the slot length limit in favor of a 356 mm minimum length limit if fisheries data showed improvement in the largemouth bass population. Because fisheries and angler opinion data were largely neutral, we believe allowing a minority constituent component to share in the decision to retain the slot length limit positively influenced our agency's credibility among Georgetown Reservoir anglers.

Keywords: largemouth bass management mail survey slot length limit

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### **Changes in Walleye Recruitment and Growth Following a Blueback Herring Invasion**

*Wheeler\*, A.P., C.S. Loftis, D. L. Yow. North Carolina Wildlife Resources Commission*

Blueback herring *Alosa aestivalis* were first collected from Hiwassee reservoir in 1998. Their recent appearance has raised concerns due to negative impacts of a similar species, alewife *A. pseudoharengus*, on walleye *Sander vitreus* recruitment in Tennessee reservoirs. We began monitoring the Hiwassee Reservoir walleye population with annual bottom-set gillnet surveys in the fall of 2000, and aged all walleye collected using sagittal otoliths. The successive annual surveys allowed us to track recruitment, mortality, and growth of walleye year classes since the blueback herring invasion. In addition, we used catch curves to back-calculate pre-blueback estimates of walleye recruitment. Due to low catch rates of recent year classes and sampling variability, estimates of annual mortality rates could only be calculated for the 1996-1998 cohorts and ranged from 32-43%. Total length at age has increased for each consecutive year class. Walleye recruitment declined and then

nearly ceased following the blueback herring invasion. The 1996 cohort was approximately four times larger than the 1997-1999 cohorts, and recruitment has essentially failed since 2000. In response to recruitment failure, we began stocking OTC marked fingerling walleye in Hiwassee Reservoir in 2004.

Keywords: Walleye Recruitment Blueback Herring Invasion

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## **Increases in voluntary release rate of largemouth bass of legally-harvestable size from Texas creel surveys over 1985-1999**

*Taylor, J.B, and Myers, R.A. Texas Parks and Wildlife*

Concurrent with a large increase of popular interest in bass angling over the past few decades, anecdotal evidence indicates a strong catch and release ethic has also become more prevalent among largemouth bass (LMB) anglers. However, documentation of long-term changes in LMB voluntary release rates is lacking. Texas Parks and Wildlife conducted annual creels on five reservoirs managed with minimum-length limits for LMB (Canyon, Conroe, Palestine, Sam Rayburn ,and Toledo Bend) and two managed with protected slot limits (Lake Fork and Monticello) over varying time spans of 12-15 years from 1985-99. Voluntary release rates of LMB in legally-harvestable sizes increased significantly over time in each of the seven reservoirs, with correlation coefficients ranging from 0.62-0.96. Analysis of covariance indicated the slope of the relationship between voluntary release rate and time for Lake Fork to be significantly lower than for the other six reservoirs, and Lake Fork also had the highest voluntary release rates observed. Lake Fork has had a reputation as an exceptional fishery for trophy bass since the mid-80s, and anglers there have consistently demonstrated a high propensity to voluntarily release LMB of harvestable size. By 1999, voluntary release rates ranged from 52-98% in creels from all reservoirs examined.

Keywords: largemouth bass voluntary release creel

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## **Otolith Ageing techniques for an invasive population of white perch *Morone americana* in an Oklahoma reservoir**

*Kurt E. Kuklinski\*, Oklahoma Department of Wildlife Conservation (ODWC), Norman, OK*

White perch (*Morone americana*) entered Oklahoma via the Arkansas River system and were first discovered in Kaw Reservoir in 2000. In order to determine the age structure of the invasive population, 161 white perch have been aged using annulus counts on the saggital otoliths. Whole view otolith ageing was effective for age-0 and age-1+ white perch as confirmed by sectioned view ageing (97.9% and 97.1% respectively). Whole view otolith ageing of age-2+ and older white perch was not accurate, with only 13.5% confirmed by sectioned view for age-2+ and just 25% confirmed by sectioned view for age-3+ fish. The age structure of the Kaw white perch population consists of mainly age-0 and age-1+ white perch, with few fish older than age-2+ in fall samples. Both adult and age-0 white perch were found in Keystone Reservoir, downstream of Kaw Reservoir, in fall 2004 gillnet samples.

Keywords: white perch, non-native species, age and growth, otolith

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## **Relation between fish assemblages and native and non-native aquatic plants at Lake Izabal, Guatemala**

*Christian Barrientos\* and Mike S. Allen Department of Fisheries and Aquatic Sciences, University of Florida, 7922 Northwest 71st Street, Gainesville, Florida 32653, USA.*

We compared the abundance and community composition of fishes among five species of aquatic plants at Lake Izabal, Guatemala. Lake Izabal is the largest lake in Guatemala, Central America, and was recently invaded by a non-native aquatic weed *Hydrilla verticillata*. Fish were sampled with block nets (0.01 ha) using rotenone in June-July of 2004. Hydrilla had higher aquatic plant biomass than eel grass *Vallisneria americana* and bulrush *Scirpus spp.* of the same coverage area. Total fish biomass was positively related to plant biomass across all plant types. Fishes of the family Cichlidae were the most abundant in species richness and showed the highest biomass across all habitats sampled. The most common fish collected fish in all habitats and areas with no plants was the silverside *Atherinella spp.* Mojarra *Vieja maculicauda* support the

primary fisheries in the lake, and we found that areas with high hydrilla coverage contained high densities and biomass of this species. Hydrilla in littoral areas of Lake Izabal is suitable habitat for fishes, containing high species richness, density, and biomass compared to other plant species present.

Keywords: Aquatic plants native Hydrilla Fish habitat Cichlidae Guatemala Izabal

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### **Variability In Egg Characteristics Among Female White Bass *Morone chrysops* And The Relationship Between Egg Volume And Yolk-Sac Fry Length Of Sunshine Bass**

*Lochmann\*, S.E., Racey, C.R., Goodwin, K.J., and Green, C.C. Aquaculture/Fisheries Center, UAPB, Pine Bluff, AR.*

Domesticated white bass *Morone chrysops* make possible selective breeding programs to produce sunshine bass. Besides fast growth or favorable feed conversion, selection could be based on favorable egg or fry characteristics. Eggs from 12 white bass, used to produce sunshine bass fry, were individually photographed and incubated. Average egg volume ranged from 0.316 to 0.422 mm<sup>3</sup> and varied significantly among females ( $P < 0.0001$ ). Hatch rates ranged from 49% to 96%, but there was no relationship between hatch rate and egg volume. Total lipids varied from 4.03% to 6.17%. There was no relationship between egg volume and percent total lipids. The yolk-sac fry hatched from these eggs were also photographed within 3 h of hatching. Standard lengths of yolk-sac fry were less variable than egg volumes ( $CV = 6.3\%$ ) and ranged from 2.35 to 3.62 mm. Average standard length ranged from 2.89 to 3.08 mm and also varied among females ( $P < 0.0001$ ). Specific female and time to hatch explained 60% of the variability in yolk-sac fry SL. Some females had egg and fry characteristics more suitable to increasing survival and fingerling production. Selection for these characteristics in brood stock white bass females could lead to improved production of sunshine bass fingerlings.

Keywords: sunshine bass, egg volume, fry length

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### **The demographics of retirement among state agency fisheries personnel: challenges and opportunities presented by retiring Baby Boomers.**

*McMullin, S.L. Department of Fisheries and Wildlife Sciences, Virginia Tech*

Aging of the Baby Boomer generation has created concern among public agency administrators and policy makers that significant institutional memory and leadership ability may be lost as Baby Boomers approach retirement age. For fisheries personnel in state fish and wildlife agencies, that concern is amplified by the fact that many people were hired during the "Environmental Decade" of the 1970s and those employees now have 25 to 30 years of service. I conducted a nationwide, Internet-based survey of state fish and wildlife agency personnel to quantify the demographics of retirement and professional development needs. Twenty-five percent of fisheries professionals nationwide plan to retire by 2010 and 43% plan to retire by 2015. Forty-six percent of fisheries professionals in leadership positions plan to retire by 2010 and 77% will retire by 2015. This large turnover of fisheries professionals will challenge agencies to replace the institutional memory that will go with retiring personnel. It also offers an opportunity for agencies to address the lack of diversity in their work forces.

Keywords: Retirement, fisheries professionals, diversity

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## **Investigation of the Effect of Size-Selective Fishing on Growth Rates in Wisconsin Bluegill Populations**

*Leonard,\*D.M., and J.J. Ney*

Both commercial and sport fishing are biased toward harvest of large specimens. Intense size-selective harvest that removes fast-growing specimens can cause genetic stunting in the population, as has occurred in marine commercial fisheries. Can sportfish harvest be both sufficiently intense and selective to depress growth potential? We addressed this question for bluegill sunfish populations in northern Wisconsin lakes, where harvest-oriented bluegill fisheries are subject to restrictive bag limits, by comparing growth in spatial and temporal data sets. Bluegills were 10-15% longer at ages 5-9 in a lightly-fished lake versus an adjacent lake with public access. Length at age 3 declined 15-45% in 10 of 15 heavily fished lakes between 1970 and 2000. These growth dynamics provide initial support for the genetic stunting hypothesis for Wisconsin bluegill populations. More such comparisons plus controlled experiments are required for confirmation.

Keywords: size-selective fishing; genetic stunting; growth rate; bluegill sunfish

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## **The Evolution of Competitive Bass Fishing**

*Gene Gilliland\*, Oklahoma Fishery Research Lab, Oklahoma Dept. of Wildlife Conservation, Norman, OK*

Competitive bass fishing began with amateur anglers testing their skills against their fishing buddies. Seemingly limitless quantities of fish were available from our waters. Fishery managers felt that little harm could come to these renewable resources. Early tournaments were catch-weigh-and-fillet. Then in the mid-1970s, fishery managers, tournament organizers and competitors began to embrace the concept of catch-and-release. As tournament fishing evolved into an increasingly complex sport complete with professional anglers, corporate sponsors and prime-time television coverage, so too did the care given tournament-caught bass. Using a time-line approach, I describe changes in equipment and fish-care techniques over the past 30 years which have dramatically improved the survival of bass released following tournaments, and areas needing further research and refinement. Note to Program Chair: This can be an oral presentation or a poster, whichever best fits your program.

Keywords: competitive bass tournament mortality fish-care

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## **Effects of Livewell Conditions and Largemouth Bass Virus on Mortality of Largemouth Bass Caught in Summer Tournaments**

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This study evaluates the effect of improved livewell conditions on mortality and the interaction of tournament stress and largemouth bass virus (LMBV) for largemouth bass *Micropterus salmoides* caught in 12 summer tournaments. Improving livewell conditions by cooling water about 2-5°C, adding uniodized salt (NaCl), and continuous aeration reduced initial mortality of largemouth bass from 7% to 3%. However, post-release mortality of fish held for 5 d in net pens or raceways was not reduced by the improved livewell conditions and averaged 76% for all tournament fish. The percentage of angler-caught fish infected with LMBV at the end of tournaments (14%) was significantly higher than population levels (7%). The percentage of tournament-caught fish infected with LMBV increased after capture and during the post-tournament retention period, but was significantly lower for fish from livewells with improved conditions (63%) compared to fish from control livewells (70%). Many of the fish also had bacterial diseases during the post-tournament period, so the effect of LMBV on mortality could not be determined. However, the higher mortality of both tournament and reference fish in our study

compared to previous tournaments on lakes presumed free of LMBV suggests that this newly discovered pathogen influences measurement of post-tournament mortality.

Keywords: Largemouth bass, tournament mortality, livewell conditions, largemouth bass virus

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### **Smallmouth bass tournament mortality on middle Tennessee reservoirs**

*Kaintz\*, M.A., and Bettoli, P.W. Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, Cookeville, TN (MAK); U.S. Geological Survey/Biological Resources Division, Tennessee Cooperative Fishery Research Unit, Cookeville, TN (PWB)*

Few tournament mortality studies have distinguished mortality rates among black bass species; however, recent studies have found that black bass species respond differently to tournament angling. In particular, smallmouth bass are thought to be more susceptible to tournament mortality than largemouth bass. In addition, when initial mortality rates are low there is a common misconception among anglers and organizers that total tournament mortality is also low. Providing information on delayed mortality will allow for a more accurate assessment of the impact of tournament fishing on smallmouth bass. This study was designed to measure initial mortality resulting from tournaments on Center Hill and Percy Priest reservoirs in middle Tennessee and measure delayed mortality of smallmouth bass on Dale Hollow Reservoir under simulated tournament conditions. Smallmouth bass captured with conventional hook-and-line tackle were held and monitored in a large net pen or externally tagged with an ultrasonic tag and float assembly and released immediately after a simulated weigh-in. Initial mortality of all three black bass species on Center Hill and Percy Priest reservoirs ranged from 0-16% and 0-23%, respectively. Delayed mortality of smallmouth bass at Dale Hollow Reservoir ranged from 0-27% at water temperatures ranging from 9-27 °C.

Keywords: smallmouth bass, tournament, mortality

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## **Instream Flow**

### **An Analysis of Fish Abundance and Flow Patterns in the North Anna River, Virginia**

*Fowler, D. L., Virginia Department of Game & Inland Fisheries, Richmond, VA*

In order to evaluate whether additional flow reductions in the North Anna River downstream from Lake Anna would have a measurable impact on resident fish, an analysis of historical flow patterns and fish abundance in this river was undertaken. Historical electrofishing data (1981-2002) collected by Dominion Virginia Power were compared with river flow data. At least 55 fish species were collected in the North Anna River during the study period. The abundance of numerous species appeared to be influenced by river flows. Flow during spawning and early life history stages was directly correlated with the abundance of eight species during subsequent years, whereas it was inversely correlated with that of two others. Numerous other significant relationships are discussed. Results suggest that reductions in flow during spawning and early life stages, and during dry periods that generally occur from July-October, will have a negative effect on the abundance of numerous fish species found in the North Anna River. The recent reduction in the minimum release requirement at the Lake Anna Dam from 40 to 20 cfs may have already had such effects.

Keywords: fish abundance spawning flow river

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### **Fish habitat use and community structure in regulated and unregulated reaches of a large southeastern warmwater stream.**

*Shea\*, C., and Peterson, J.T., US Geological Survey, Georgia Cooperative Fish & Wildlife Unit, Warnell School of Forest Resources, University of Georgia, Athens, GA*

River regulation and development are the foremost problems threatening fishes and other aquatic biota in the Southeastern US. Dams-- primarily constructed for power generation and water use-- have impounded more than half of the mainstem rivers in the Southeast, destroying and fragmenting critical riverine habitat. Dam operation also can influence both habitat availability and environmental stability in downstream areas. Minimum stream flow regulations are often used to protect the former. However, previous studies have shown that the flow regime can influence fish community structure and that species interactions can influence habitat use. We evaluated the fish community structure and habitat use at unregulated and hydropower regulated reaches of the Flint River in southwest GA. Daily discharge downstream of the regulated reach varied by as much as 35% of the maximum daily flow within a 24-hour period. We examined overall and seasonal species richness among and between study sites. We found significant differences in fish community structure between sites with more species occurring in the unregulated reach. Habitat use patterns at the unregulated and regulated sites also differed for small-bodied species and juvenile fishes representing various genera. These differences were presumably related to the effects of hydropower regulation on the species pool and its effect on species interactions and habitat use patterns.

Keywords: Flow regulation Fish habitat use Fish community structure

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### **Long-Term Impacts of Bridge and Culvert Construction on Fish Communities within West Tennessee**

*Melville\*, M.J., and Combs, D.*

Currently there are close to 17,000 bridges and culverts constructed throughout Tennessee, and many are in need of repair. Bridges and culverts have many potential negative impacts on streams, including increased sedimentation, stream bank erosion, channelization, and changes in stream chemistry. The effects of bridge and culvert construction were studied on 48 streams in west Tennessee. Two 100-m stream reaches above and two 100-m reaches below were sampled at each bridge or culvert. Each of the four reaches had a 50-m buffer zone separating the reach. Instream habitat, woody debris, water quality parameters, and riparian zones were measured for each of the four reaches. Streams were sampled once by single pass

techniques using a backpack electrofishing unit. Fish diversity, abundance, and richness were then compared upstream and downstream from the bridge or culvert. Based on preliminary analysis, fish communities did not appear to be negatively impacted in this study.

Keywords: bridges culverts fish communities

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### **Influence of seasonally discontinuous surface flow on stream fishes of the Interior Highlands**

*Girondo\*, N.M., and Gagen, C.J. Arkansas Tech University, Russellville, AR.*

Relationships between discontinuity of surface streamflow and the fish communities within the Interior Highlands of Arkansas were investigated during 2004. Fish were sampled and marked during June while surface flow was continuous in nine streams draining ~2800 ha watersheds distributed among three ecoregions. Fish were sampled again during August when streams were drying and in October when continuous flow had resumed. Stream dryness was not observed for the Ouachita Mountains, but dry reaches were measured for the remaining six streams (ranging from 0 to 83 % of a 2 km study section). Species richness was similar among ecoregions. Fish densities in the Boston Mountains (driest streams) and Ozark Highlands were lower in October after surface flow resumed; whereas densities of fish in the Ouachita Mountains (no dry reaches) increased with each sample. Documented fish movement was greater in the Ouachita Mountains (mean = 188 m) than the Ozark Highlands (mean = 152 m) or Boston Mountains (mean = 135 m) ( $x^2 = 40.7$ ,  $p = 0.03$ ). Recapture rates were higher in the Ouachita Mountains (6.2%) than the Boston Mountains (1.8%). Thus, dry reaches during the growing season were associated with increased mortality and decreased movement without substantial effects on species richness. We argue that habitat assessments in these types of ecoregions should include measures of stream dryness.

Keywords: stream flow dryness drying discontinuity community movement

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## **Paddlefish Biology**

### **Assessment of Overfishing in a Commercial Paddlefish Fishery**

*Scholten\*, G.B. Tennessee Wildlife Resources Agency, Nashville, TN Bettoli, P.W. Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, Cookeville, TN*

Paddlefish *Polyodon spathula* were collected from Kentucky Lake, KY-TN, in 2003-2004 to assess population characteristics and the likelihood of commercial overfishing. Size and age structure have been reduced and annual mortality has trebled since the most recent study in 1991. Thirty-seven percent of fish collected in 1991 were older than the maximum age we observed (age 11) and annual mortality for age 7 and older paddlefish in 2003 was high ( $A = 68\%$ ). Estimates of total annual mortality were negatively related to river discharge in the years preceding each estimate. The number of paddlefish harvested since 1999 was also negatively related to river discharge during the fishing season because gill nets cannot be easily deployed when discharge exceeds  $\sim 850 \text{ m}^3/\text{sec}$ . Large females spawn annually because all females longer than 1,034 mm eye to fork length (EFL) were gravid. No mature females were protected by the current 864 mm minimum EFL limit. Simulation modeling indicated growth overfishing was likely occurring and spawning potential ratios were below minimum levels suggested for freshwater fish populations. Recruitment overfishing probably occurs during droughts; however, variations in rainfall and river discharges have prevented the population from being exploited at unsustainable rates over long periods.

Keywords: Paddlefish overfishing

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### **Bycatch Mortality and Gillnet Size Selectivity in a Paddlefish Fishery**

*Bettoli\*, P.W. Tennessee Cooperative Fishery Research Unit, Tennessee Technological University, Cookeville, TN Scholten, George, B. Tennessee Wildlife Resource Agency, Nashville, TN*

Paddlefish *Polyodon spathula* in Kentucky Lake, KY/TN, were sampled using experimental gillnets and the ability of mesh size restrictions to increase spawning escapements was investigated. Factors influencing bycatch mortality were also described. Following the standards of commercial gear used in that fishery, nets were tied-down or "hobbled" (128 x 3.6 m nets were hobbled to 2.4 m; 91 x 9.1 m nets were hobbled to 7.6 m). Mean lengths of captured fish were similar among most meshes and bycatch rates of sublegal fish ( $< 864 \text{ mm}$  eye-fork length) did not vary with mesh size. The range of fish girth:mesh perimeter ratios for paddlefish captured in each mesh was broad. It is unclear whether the lack of size selectivity was due to the fact that gillnets were hobbled, the unique morphology of paddlefish, or a combination of those two factors. Netting material, water temperature, and soak time were all significant predictors in a logistic regression model of initial mortality. Fish died at a higher rate in monofilament nets and observed mortality exceeded 70% at water temperatures  $> 20 \text{ C}$ ; most ( $> 85\%$ ) paddlefish were alive when nets were retrieved in cold ( $< 14 \text{ C}$ ) water.

Keywords: Paddlefish gillnets mesh selectivity bycatch mortality

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### **Zooplankton density and taxonomic composition in the Tennessee-Tombigbee Waterway: Implications for paddlefish restoration**

*OKeefe, D. M., OKeefe, J. C., and Jackson, D. C.*

The paddlefish is a long-lived planktivorous species which has declined in many areas of former abundance. In the Tennessee-Tombigbee Waterway and its tributaries, paddlefish have disappeared from upstream impoundments and persisted in the most downstream impoundment: Demopolis Lake, Alabama. Reintroduction of paddlefish into an upstream impoundment (Columbus Lake, Mississippi) began with the translocation of eight radio-tagged adult paddlefish from Demopolis Lake during May, 2004. Zooplankton samples were taken from tailrace areas and radio-tagged paddlefish locations weekly during summer in Demopolis and Columbus lakes. Density, abundance, and taxonomic composition of zooplankton in the two lakes were compared to evaluate the quality of Columbus Lake food resources relative to a similar

area that is known to support a high density of paddlefish. Three introduced zooplankters were identified in samples: *Daphnia lumholtzi*, *Leptodora kindtii*, and *Mysis relicta*. *D. lumholtzi* has larger helmet and tail spines than native cladocerans and may be less vulnerable to larval paddlefish predation. The other two species are large predators which may reduce zooplankton biomass or alter species composition. An introduced planktivorous fish, bighead carp, was also recorded during sampling. Changes in zooplankton community structure should be monitored to evaluate effects of exotics and implications for paddlefish.

Keywords: zooplankton paddlefish Tombigbee

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### **Population characteristics and commercial exploitation of paddlefish in the Arkansas River**

*Quinn,\* J.W., Limbird, R.L., and F.J. Leone. Arkansas Game and Fish Commission*

We studied population characteristics of paddlefish in the Ozark Pool of the Arkansas River during a commercial fishing moratorium, and we documented harvest during a special 5-day commercial fishing season with a check station. We used large-mesh gill nets (5- and 6-inch bar mesh) to sample paddlefish during the winter months for two consecutive years. Fish captured were measured for eye-to-fork length and marked with individually numbered jaw tags. Median growth of fish recaptured after 1 year at large was 20 mm. Mark-recapture estimators suggest the adult population of paddlefish susceptible to gill nets was 5,000 fish. The Cormack-Jolly-Seber model estimated apparent survival as 1 during the commercial fishing moratorium. High survival of adult paddlefish was supported by a concurrent telemetry study. Commercial fishermen harvested 1072 paddlefish during a 5-day special season held during February 2004. Exploitation of fish greater than the 914-mm minimum length limit was 16%, and 70% of the harvest was gravid females.

Keywords: paddlefish

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## Sampling Techniques

### Standardized Sampling in Lentic Systems: A Florida Perspective.

*Bonvechio\**, K. I. Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, Eustis, FL

Standardized sampling protocols are gaining widespread consideration among fishery biologists at the state agency level. Florida contains over a million acres of fresh water and is home to a diversity of inland systems including natural lakes, impoundments, rivers, and canals. The Florida Fish and Wildlife Conservation Commission (FWC) is developing standardized sampling protocols for all inland waters in an effort to improve the statistical value of data collected, to construct a statewide database, and to encourage data sharing within FWC and among other state and federal agencies. We consulted published literature and obtained standardized sampling protocols from state agencies throughout the Southeast. Over half of the surveyed agencies had formal standardized sampling protocols, and three were currently under construction. The objectives, sampling designs, and methods varied widely among these agencies, but most were organized by gear type. We discuss these differences in reference to standards being proposed for Florida's lentic systems and offer justifications and considerations that ultimately led to the formation of these standards.

Keywords: standardized sampling

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### Evaluation of seining and hoop netting for collecting fishes in Oklahomas large prairie rivers

*Utrup, N.J.\**, Oklahoma Cooperative Fish and Wildlife Research Unit, and Department of Zoology, Oklahoma State University, Stillwater, OK. *Fisher, W.L.*, U.S. Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit, and Department of Zoology, Oklahoma State University, Stillwater

Our objective was to evaluate seining and hoop netting for detecting fish species in large prairie rivers in the central and western part of Oklahoma. To evaluate these gear types, we first determined the types and proportion of habitats that needed to be sampled, the amount of effort needed at a site, and the effectiveness of each gear type at detecting fish species. Three habitat types: shallow water (< 0.75 m), deep water (> 0.75 m), and backwater (< 0.01 m/s) were visually identified on aerial photos, and samples were allocated to each type. Sampling efficiency evaluations showed that seining detected, on average, 54.2% of the available species in shallow water habitats and 57.7% in backwater habitats. Hoop net efficiency evaluations in deep water habitats revealed that small hoop nets detected significantly more fish than large hoop nets and large hoop nets detected significantly larger fish than small hoop nets; however, there was no significant difference in the number of species detected between the two. For all species; catch per unit effort for the seine was 2.16 species per seine haul, 0.78 species per net for the small hoop net, and 0.80 species per net for the large hoop net.

Keywords: river seine hoopnet Oklahoma sampling

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### Evaluation of shoreline seining and mini-fyke nets in floodplain lakes

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Mini-fyke nets (MFN) were compared with shoreline seining (SS) to assess their relative abilities to describe littoral fish assemblages in 14 White River, AR floodplain lakes. Lakes ranged in size from 1 ha to 48 ha. Lakes greater than 2.4 ha were sampled using three MFN, while those smaller than 2.4 ha were sampled using two MFN. MFN were set for a 24-hour period. SS effort depended on the amount of open shoreline with a minimum of one seine haul and a maximum of 30 seine hauls conducted per lake. MFN were deployable in all of the 14 sample lakes; whereas SS could only be used in 10 lakes due to woody vegetation. MFN collected more fish (3148) than SS (777). Overall, MFN species richness was 42 with 18 unique

species. SS species richness was 25 with one unique species. In lakes sampled using both gears, Cyprinidae (42%), Centrarchidae (31%), and Clupeidae (9%) were most commonly caught in MFN whereas Poeciliidae (43%), Centrarchidae (30%), Cyprinidae (12%) were most commonly caught in SS. MFN were more efficient at sampling littoral fish assemblages than SS, required less manpower, and were fishable in all lakes.

Keywords: mini-fyke net shoreline seining floodplain lake

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### **Utility of Absolute Abundance Estimates in Largemouth bass, *Micropterus salmoides*, Management**

*Michaelson\*, D.P. and DiCenzo, V.J. Virginia Department of Game and Inland Fisheries (VDGIF), Farmville, VA.*

Population estimates used to expand our knowledge about largemouth bass populations in small reservoirs (<1000 acres) of south-central Virginia included the Petersen and Schnabel mark-recapture techniques and the Leslie depletion method. Objectives of this work were to develop a qualitative hierarchy for bass lakes based on population densities, use population estimates to determine electrofishing efficiency, and to use correlation and regression analysis to develop equations to estimate population size from catch-per-unit-effort (CPUE) estimates. Categories of population size broke out as high (> 36 bass/acre), medium (16-35 bass/acre) and low (< 15 bass/acre). Electrofishing efficiency (percent of largemouth bass actually sampled) ranged from 11-48% and averaged 29%. Correlation analysis revealed that CPUE and absolute abundance estimates were highly correlated for the total population ( $r = 0.83$ ) as well as for preferred size (>380 mm) bass ( $r=0.90$ ). The Leslie depletion technique worked best on larger reservoirs with adequate numbers of definable coves where one cove per day could be depleted. The Petersen and Schnabel techniques were well suited when the entire shoreline could be sampled daily. Absolute abundance estimates have shown great utility in a basic understanding of bass population dynamics, population models for regulation review, and in dealing with constituents.

Keywords: Largemouth bass, absolute abundance

## Conservation Biology

### Predictive Habitat Models For Conservation Of The Federally Threatened Blackside Dace *Phoxinus Cumberlandensis*

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The U.S. Fish and Wildlife Service listed the cyprinid *Phoxinus cumberlandensis* (blackside dace) as a threatened species in 1987. Identification of environmental attributes which affect the distribution of this fish may assist natural resource managers in the preservation and recovery of the species. Field-collected and map-produced habitat variables were gathered at 72 stream sites at a 200-meter-long reach scale and at 92 streams at a headwaters-to-mouth stream scale. Spearman correlation analyses at the reach scale showed significant ( $p < 0.05$ ) correlations between the presence of blackside dace and water temperature (-), turbidity (-), conductivity (-), variation in average maximum water depth (+) and several other fish species (+ and -). Logistic regression models were constructed to relate the probability of the presence of blackside dace to water temperature, conductivity, and link magnitude at the reach scale. An additional logistic regression model was constructed relating dace presence to gradient at the stream scale. These models indicate that dace are more likely to be present in streams which have a gradient between one and six percent and in reaches with a link magnitude between three and six, a conductivity below 240  $\mu\text{s}$ , and a summer temperature between 15° and 19° C.

Keywords: habitat model logistic regression blackside dace endangered species

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### Characterizing habitats and threats for species of conservation concern

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As a part of the Comprehensive Wildlife Conservation Strategy required by all states, Virginia is developing habitat maps for all species identified as species of critical conservation need (SCCN). Habitats have been characterized using an attributed hydrography. The reaches known to contain the SCCN were pulled out and compared for patterns in the habitat attributes. For example, the habitat characterization used for the Roanoke logperch, (*Percina rex*), was small streams to small rivers with very low or low gradient and, in the Roanoke drainage, a reach elevation range between 175 and 500 m. These data were used to highlight reaches as potential Roanoke logperch habitats. After characterizing SCCN habitats, we assessed habitat quality and specific threats to the species. This was done using GIS analyses and expert meetings. The percentage of habitat in waters rated as “impaired” by the Virginia Department of Environmental Quality and the amount of habitat in disturbed land use were determined. The experts identified habitat loss and sediment load alteration from agriculture and urban land use as two of the factors affecting Roanoke logperch. The experts provided additional information on the scope and severity of all threats and the conservation actions needed for all species.

Keywords: conservation threats habitat

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### Assumptions, evolution, and application of conceptual models of Roanoke logperch population dynamics

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Conceptual models of fish dynamics are built upon theory, empirical evidence, and expert judgment, all of which have embedded assumptions. Expert judgment is especially prominent in models for rare species, for which data are often lacking. Herein we draw from our monitoring of endangered Roanoke logperch to illustrate the assumptions, evolution, and application of conceptual models of fish population dynamics. The original, implicit model of logperch dynamics, based largely on expert judgment, assumed stable abundance, deterministic regulation, and a strong connection between abundance and habitat availability. Based on this model, flood-control construction on the Roanoke River was expected to reduce logperch abundance by decreasing availability of silt-free habitat, and this population reduction was assumed detectable. Subsequent data collection and analyses revealed high, stochastic variation in pre-construction abundance, and weak

relationships between abundance and habitat. This new knowledge led to refinement of our conceptual model and modification of monitoring and construction procedures. Based on our experiences, we suggest that scientists need to 1) explicate conceptual models and uncertainties, 2) seek opportunities to test key assumptions, 3) expect models to change as more data become available, and 4) work closely with managers to incorporate new knowledge into actions and policies.

Keywords: conceptual model population dynamics assumptions uncertainty expert judgment

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#### **Pigeon River Re-introduction Efforts Update: 2004**

*Coombs\*, J.A., and Wilson, J.L. University of Tennessee, Department of Forestry, Wildlife and Fisheries Burr, J.E. Tennessee Department of Environment and Conservation, Office of Water Pollution Control*

Since its inception in 2001, the Pigeon River Recovery Project has re-introduced 12 fish species totaling 8,257 individuals as well as substantial numbers of snails and mussels. During the past three years, fish have been collected from tributaries to the Pigeon River, reference streams within the French Broad basin, and from the upper reaches of the Pigeon River itself. Visible implant fluorescent elastomer (VIE) was employed to tag darter species only. In 2004, re-introductions of four targeted species began in the North Carolina reach: saffron shiner (*Notropis rubricroceus*), mirror shiner (*N. spectrunculus*), telescope shiner (*N. telescopus*), and silver shiner (*N. photogenis*). Limited snorkeling surveys in the Tennessee reach located surviving mussels, thousands of common snails, and the first sighting of a blueside darter (*Etheostoma jessiae*). Tagged and untagged gilt darters were also observed at the re-introduction site and further downstream. September brought back-to-back 100-year floods from two hurricanes that inundated western North Carolina and eastern Tennessee, cutting the field season short and, raising concerns for the survival of the recently transplanted shiners. An attempt to propagate the tangerine darter (*Percina aurantiaca*) at Conservation Fisheries, Inc., began this year with the goal of re-introducing it into North Carolina and Tennessee.

Keywords: Re-introduction Pigeon River Visible implant fluorescent elastomer (VIE) Non-game fish species Gilt Darter Snails Mussels Tennessee North Carolina

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#### **The Digital Atlas of Oklahoma Fishes: Development of an Internet-based Geographic Information System to Manage Museum Databases**

*Freund\*, J.G., and Fisher, W.L., Oklahoma Cooperative Fish and Wildlife Research Unit and Oklahoma State University, Stillwater, OK. Echelle, A.A., Oklahoma State University, Stillwater, OK. Brooks, M., Hargrave, C., and Marsh-Matthews, E., Sam Noble Oklahoma Museum of Natural History and Department of Zoology, University of Oklahoma, Norman, OK.*

Historic fish records and museum collections are useful research tools that are important in examining and understanding changes in fish distribution and assemblage structure. However, museum records are seldom readily available to researchers and educators. The Digital Atlas of Oklahoma Fishes (DAOF) combines museum records from the Sam Noble Museum of Natural History at the University of Oklahoma (OU) and the Oklahoma State University (OSU) Vertebrate Collection into a searchable online geographic information system (GIS). The DAOF is a cooperative effort between OU and OSU with support from the Oklahoma Department of Wildlife Conservation. The project consists of three components: (1) an interactive text and map query of historic fish records, (2) a centralized resource for educators and researchers providing information about the aquatic resources and fishes of Oklahoma, and (3) a centralized geodatabase that allows for online data entry and editing by museum personnel. The goals of the project are to increase the accessibility of museum fish records, provide a resource for educators and researchers information regarding Oklahoma's aquatic resources, and simplify and centralize the management of Oklahoma's museum databases. To meet these goals, the DAOF will utilize online database (Microsoft SQL Server) and GIS (ArcIMS) technology. Currently this technology is underutilized but shows great promise as a research, educational, and database management instrument.

Keywords: GIS Internet Museum database historical records

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## Shad

### Abundance and Potential Effects of Predators on Seaward Migrating Juvenile *Alosa* spp. in the St. Johns River, Florida

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We assessed seasonal shifts in abundance of juvenile American shad *Alosa sapidissima*, hickory shad *A. mediocris*, and blueback herring *A. aestivalis* relative to predator diets in the St. Johns River, Florida during 2004. Our sampling area near Palatka, Florida, is used as a summer staging area for juvenile *Alosa* spp. Prey abundance was assessed using catch rates from surface trawls. Predator diets were collected using electrofishing, and stomach contents were removed from predators sampled using acrylic tubes. We also used trawl catches to estimate seasonal prey availability. Threadfin shad *Dorosoma petenense* was the most abundant prey species throughout the year. Atlantic croaker *Micropogonias undulates* were most abundant during spring, and Atlantic menhaden *Brevoortia smithi* became abundant during the fall samples. Diet contents of predators shifted with trends in prey availability based on the trawl catches. However, *Alosa* spp. were relatively rare in samples of prey availability and predator diets through the study period. Thus, juvenile *Alosa* spp. were not an important prey item for predators even during months when they were present, likely due to their low abundance relative to other prey groups.

Keywords: *Alosa* Juvenile Predator Diet Trawl

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### American shad (*Alosa sapidissima*) usage of the Wateree River, SC

Coughlan, D.J., Barwick, D.H., Baker, B.K., Rash, W.M., Duke Power Company, Huntersville, NC, and Garner, A.B., Doby, W.R., GeoSyntec, Atlanta, GA.

Use of the Wateree River, SC, (230 km from the Atlantic Ocean) by spawning American shad was evaluated during spring 2004. Two locations in the coastal plain and three locations in the Piedmont of the 124-km long river were electrofished biweekly from March through June. Catch rates (fish/hr) of American shad in the Wateree River were highest from April 13 through May 25. Catch rates were highest in coastal plain locations with a predominantly sand substrate and lowest upstream in the Piedmont where gravel, cobble, and rock substrate were most abundant. Yearling American shad, spawned in 2003, were also encountered in large numbers. Yearling shad appeared to utilize the river at the same time as adults although they migrated through the coastal plain and into the Piedmont, where they were observed actively feeding in the tailrace of the Wateree Dam. Adult American shad were able to use downstream fish passage structures, navigate through Lakes Moultrie and Marion, and make limited use of the coastal plain reach of the Wateree River. Yearling American shad appeared to migrate with the adults and various life-history aspects of these fish are under investigation.

Keywords: American shad, spawning, adults, yearlings, anadromous, Wateree River, substrate

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### The Upstream Movement of *Anguilla rostrata* at the Millville Dam Eel Ladder

Hildebrand\*, H.L. and Welsh\*, Stuart. WVU Cooperative Fish and Wildlife Research Unit, Morgantown, WV

Stock assessments depict declines in American eel (*Anguilla rostrata*) populations, however, we know little about abundances and migrations of yellow-phase American eels in upper watersheds, or the impact of dams on upstream migration. Fish ladders on dams provide a relatively low cost solution to upstream passage of eels, and provide managers with counts of upstream migrants. We counted, weighed, and measured eels at the Millville Dam eel ladder, lower Shenandoah River (upper Potomac River watershed) during fall 2003, spring 2004, and summer 2004. Models with season and environmental covariates (lunar phase, river flow, water temperature, and local precipitation) were fit to the time series of daily count data. A total of 3548 eels (range 200 to 690 mm TL) passed the Millville ladder during our study period. Length-frequency

distributions of eels were similar among seasons. Higher daily counts of eels occurred with spikes in river flow, and during dark periods on or near the new moon. Large numbers of eels during fall and summer provide baseline data for future assessments, and indicate that upstream migration is not restricted to spring.

Keywords: Eel Movement Ladder

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## Trout

### **The biotic integrity of native brook trout watersheds in Virginia**

*Hudy\*, M., USDA Forest Service; T.M. Thieling, USDA Forest Service, James Madison University, and L.O. Mohn, Virginia Department of Game and Inland Fisheries*

The long term integrity of native brook trout in Virginia is threatened by the many physical, chemical and biological watershed level changes over the last hundred years. Evaluations of the biotic integrity of watersheds over wide regions are needed to guide decision makers, managers and publics in setting priorities for watershed level restoration, inventory and monitoring programs. Our objective was to 1) classify brook trout (*Salvelinus fontinalis*) population status (never occurred, extirpated, present, depressed, severely depressed, strong-large population, strong-small population) by watershed in Virginia, and 2) evaluate watershed level metrics (physical, chemical and biological) at the 6th code watershed level to determine the current range of land use conditions for each population classification category. At the watershed level brook trout populations in Virginia are severely reduced from historic levels.

Keywords: brook trout, risk assessment, biological integrity

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### **Physico-chemical Parameters Regulating Brook Trout (*Salvelinus fontinalis*) Reproductive Potential and Juvenile Recruitment in an Appalachian Watershed**

*Liller\*, Z.W., and Petty, J.T. West Virginia University Division of Forestry, Department of Wildlife and Fisheries*

The Shavers Fork is a 5th order, high elevation watershed located in the Allegheny Plateau region of eastern West Virginia. Previous studies have indicated that significant levels of brook trout reproduction in this system are restricted to extremely small (i.e., < 3 km<sup>2</sup> basin area) tributaries. Consequently, larger mainstem habitats are dependent on small tributaries for sources of recruits to the adult population. The objective of our current study was to identify key factors determining brook trout reproductive success and juvenile recruitment potential in small tributaries of the Upper Shavers Fork watershed. Brook trout population size and age structure, water quality, and physical habitat were sampled within 25 small basin area (<3 km<sup>2</sup>) tributaries distributed throughout the watershed. Spatial variation in juvenile abundance was influenced by both physical and chemical characteristics. We determined that the most important streams to juvenile brook trout recruitment in this watershed range in size from 0.1 – 3 km<sup>2</sup>, possess alkalinities exceeding 10 mg/L, have canopy cover less than 50%, and possess gradients less than 5%. Results from this study will be incorporated into a comprehensive assessment of the importance of small basin area tributaries to the watershed scale dynamics and productivity of Appalachian brook trout populations.

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### **Temporal trends in energy storage, consumption, and growth in a population of central Appalachian brook trout.**

*Utz\*, R.M., and Hartman, K.J. West Virginia University, Morgantown, West Virginia*

Fish store energy in dynamic patterns depending on food availability and environmental conditions. A recent development of biological impedance analysis (BIA) provides protein and lipid estimates without fish destruction. Using BIA, we monitored energy storage in a natural population of brook trout *Salvelinus fontinalis* approximately once every month through multiple seasons in attempt to identify periods of stress, growth, and energetic gain. Dietary analyses and mark-recapture allowed comparisons to be made between growth, consumption, and energy storage. Lipid storage was strongly correlated with fish size. Multiple significant differences in lipid storage were observed between seasons. Fish emerging from winter conditions in March contained the lowest levels of lipids (3.36 ± .314%) while fish in June had the highest levels of lipid (5.99 ± .153%). Energy storage appears strongly correlated with food availability, as high rates of consumption occurred during months of high lipid storage. Growth rates were highest during months of maximum energy storage. The pattern observed for

this population is likely representative of brook trout populations in central West Virginia. The monitoring of energy storage in this fashion may help predict recruitment and survivorship. Furthermore, these findings may help predict the effects of climate change on Appalachian brook trout.

Keywords: brook trout, energy, growth, consumption, feeding, seasonality

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### **Habitat Use by Brook Trout in a Large Appalachian River Mainstem**

*Fulton\*, J.B., and Petty, J.T. West Virginia University, Morgantown, WV*

Brook trout (*Salvalinus fontinalis*) populations in upper Shavers Fork, a high elevation river in eastern West Virginia, have declined considerably over the past century, in part due to loss of quality habitat. In order to design an appropriate habitat restoration plan for the river, it is necessary to identify preferred habitat types. We divided the upper Shavers Fork mainstem into three regions (upper, middle, and lower) based on stream channel width and discharge. We then produced continuous maps of hydraulic channel units (e.g., pools, riffles, and pool-riffle complexes) throughout the river continuum. Electrofishing was used to collect fish from a sub-sample of available HCU's in spring and summer. Brook trout densities varied significantly among the different channel unit types. In spring, brook trout were over-represented in intermediate gradient riffles and under-represented in low gradient habitats such as glides, low gradient riffles, and pools. In summer, increasing water temperatures triggered a movement to deeper water habitats. Large adults were concentrated in bluff pools, whereas small adults preferentially used riffle run complexes. Total brook trout density declined in each successive downstream region, corresponding to a downstream shift from intermediate to low gradient habitat types. Our findings indicate that a broad range of habitat types are used by brook trout in the upper Shavers Fork, and habitat preferences may vary considerably between populations inhabiting small tributaries and the Shavers Fork Mainstem.

Keywords: brook trout habitat

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### **Evaluation of a predictive model for upstream fish passage through culverts**

*J. Seth Coffman and Mark Hudy*

Fish diversity in the United States has been declining due in part to pollution, invasive species, and continual habitat degradation and fragmentation. Recent studies have shown that culverts at road crossings can fragment habitat acting as barriers to the upstream movement of fishes preventing essential spawning migrations, and inhibiting recolonization of streams after natural or anthropogenic disturbances. With over 50,000 road crossings on eastern National Forest lands, these crossings represent a serious threat to the viability of native fish fauna. Currently, there are few predictive models or software available that address fish passage through culverts, and those that are have not been validated with field experiments. We developed 3 models for fishes common to the Mid-Atlantic Highlands region of the United States that predict whether a culvert is impassable or passable to upstream movement based on measured culvert characteristics and fish swimming and leaping ability. We validated these models using a mark recapture movement study of individuals from the Salmonidae, Cyprinidae, Cottidae, and Percidae families at 26 stream crossings in the Mid-Atlantic Highlands region during the summer and fall of 2004. The validated predictive models and results of this study will provide fisheries biologists with a tool for evaluating, prioritizing, and implementing fish passage projects in addition to increasing our knowledge of fish movement in small streams.

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## **Watershed-scale thermal regimes and the distribution of brook trout (*Salvelinus fontinalis*) and smallmouth bass (*Micropterus dolomieu*) in the Cheat River watershed, WV**

*Martin\*, R.M., and Petty, J.T. West Virginia University (WVU), Morgantown, WV*

We examined relationships between landscape physiographic factors and summer stream temperatures in the Cheat River watershed, WV and developed statistical models to characterize thermal patterns at the stream segment and watershed scales. We also examined the influence of modeled thermal regimes on the distribution of smallmouth bass (*Micropterus dolomieu*) and brook trout (*Salvelinus fontinalis*) in this system. We found that the composition and spatial arrangement of coldwater, coolwater, and warmwater segments among watersheds was highly variable in the basin, even among watersheds of similar area. Also, both brook trout and smallmouth bass distributions in the Cheat River watershed were significantly related to modeled summer water temperature; however, there was an unusually high degree of sympatry between these two species, which may be related to the thermal geography of the basin. Finally, brook trout distributions in the Cheat watershed may be related to both local and regional thermal conditions, because the presence of brook trout in warmwater streams was significantly related to the regional density of coldwater tributaries. In conclusion, these results may provide further evidence that stream fish communities are influenced simultaneously by local conditions and regional processes.

Keywords: Brook Trout, Smallmouth bass, Landscape Model, Thermal Regime, GIS

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## **Mortality and Mark Efficacy of Brown Trout and Rainbow Trout marked with OxyMarine® and Calcein**

*Brittle\*, E.M. and Bettoli, P.W. Tennessee Technological University, Cookeville, TN*

*Abstract* – Mortality and marking efficacy were compared between hatchery reared rainbow trout *Oncorhynchus mykiss* and brown trout *Salmo trutta* immersed in a 600 mg/L oxytetracycline hydrochloride (OTC) solution or a 1% calcein solution using an osmotic induction procedure. Some fish were subsequently immersed 7-d later to produce a second mark. Brown trout and rainbow trout were initially marked at approximately 60-d posthatch with mean total length of 33 and 31 mm, respectively. External marks in caudal and pectoral fin rays and internal marks on sagittal otoliths were viewed under an epifluorescent light source at 40X and 100X magnification. Brown trout marked with OTC suffered high 30-d mortality ( $\bar{x}$  = 94%, range 81 -100%). Brown trout marked with calcein experienced a mean 30-d mortality of 24% (range 4 - 100%). Rainbow trout suffered lower mark-induced 30-d mortality when treated with OTC ( $\bar{x}$  = 21%, range 6-47%) and calcein ( $\bar{x}$  = 22%, range 6-63%). Marks scored in a blind test were evident for single and double marked otoliths of fish treated with OTC (93 and 98%). Fin rays from both species immersed once in calcein showed high mark efficacy (81 and 95% for brown and rainbow trout, respectively). Calcein double marks were not discernable from single marks for brown and rainbow trout (47 and 58%, respectively). We demonstrated that calcein marked brown trout and OTC and calcein marked rainbow trout can be applicable for population studies involving release of fingerling fish intended for recapture.

Keywords: salmonids marking oxytetracycline calcein brown trout rainbow trout

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## **Aches, pains, conflicts, and do-overs. Arkansas finally creates a state trout management plan in 2004.**

*Bowman\*, D.W., and M. Jones. Arkansas Game and Fish Commission*

Trout were introduced to some north Arkansas spring-creeks approximately 100 years ago. But trout fisheries in “The Natural State” increased dramatically from 1948 through 1965 as four Flood Control Act dams were built in the upper White River System. Three of the four resulting cold-tailwater rivers have produced world record brown trout and trout fisheries throughout Arkansas have become extremely popular. Through all of this, the Arkansas Game and Fish Commission had never successfully created a statewide trout management plan. A new effort began to create such a plan in 2001, and by January 2004, the Commission approved the plan. The Arkansas Trout Management Plan (ATMP) is a strategic plan using adaptive management ideas, and is basically a plan to plan. The ATMP has three goals that follow the basic components of a

fishery (people, biota, and habitat) and a fourth goal to create a specific management plan for each, individual trout water bringing together information from the three components, for that particular fishery.

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### **Managing brook trout in an urbanizing environment**

*Morgan II\*, R. P., Wiley, D.J., Kline, M.J., University of Maryland Center for Environmental Science, Appalachian Laboratory, 301 Braddock Road, Frostburg, MD. Holt, J. D., Maryland Department of the Environment, Technical and Regulatory Services Administration, 2800 Washington Boulevard, Baltimore, MD. Stranko, S. S., Kazyak, P.F., Maryland Department of Natural Resources, Tawes State Office Building, 580 Taylor Avenue, Annapolis, MD.*

Urbanization effects, from an increasing human population, threaten all mid-Atlantic trout populations. Currently, Maryland is experiencing acute anthropogenic problems that are particularly severe in the Northern Piedmont ecoregion, an area of significant precolonial native brook trout populations, but now containing only remnant and highly fragmented populations. These relic populations are highly vulnerable to urbanization stresses, and many may become extinct in the near future. Employing primarily Maryland Biological Stream Survey (MBSS) data, we determined urbanization effects on Maryland brook trout streams, focusing principally on the Northern Piedmont ecoregion. Combining GIS with the MBSS data set, landscape-based urban characteristics, including watershed impervious surface, road density, roads near streams, forest fragmentation, and others were examined to determine effects on stream community structure. We also investigated brook trout population fragmentation, exotic species effects, and stream connectivity. Impervious surface greater than 0.3% in a watershed effectively eliminated brook trout populations, with urbanization, road density and roads near streams severely affecting stream community structure. Effective brook trout management plans need to be developed to specifically address urbanization effects in the Northern Piedmont ecoregion.

Keywords: brook trout urbanization

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### **Use of otolith microstructure for determining recruitment of naturally produced Chinook salmon (*Oncorhynchus tshawytscha*) to the Salmon River, NY.**

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The Chinook salmon (*Oncorhynchus tshawytscha*) is an important component of the Lake Ontario sport fishery providing millions of dollars to local communities. Changes in habitat quality, specifically flow levels associated with Federal Energy Regulatory Commission reauthorization protocols, since the mid 1990s in the Salmon River, NY, may have led to increased natural reproduction in the system. Based on known-origin YOY Chinook salmon from hatchery and wild sources we established a baseline for separating these two groups using otolith microstructure. A protocol was developed for determining hatchery or wild origin of adult spawners based on the daily growth characteristics in the vicinity of 300  $\mu\text{m}$  from the otolith core. Variation in the wild proportion of returning spawners by year class provides insights into the recruitment variability of wild origin fish. While some year classes appear to contain up to 25% fish of wild origin this appears to be the maximum for recent years. Our analysis indicates little evidence for an increase in natural production due to water flow changes, but that a substantial proportion of the Salmon River stock (10-15%) is of wild origin.

Keywords: Chinook salmon, *Oncorhynchus tshawytscha*, Lake Ontario, recruitment, otolith microstructure,

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## Warmwater Streams

### Larval fish and zooplankton abundances in oxbow lakes of the Lower White River, AR

Racey\*, C.L., and S.E. Lochmann. University of Arkansas at Pine Bluff, Pine Bluff, AR

The White River National Wildlife Refuge (NWR) is a 160,000 acre bottomland hardwood forest with more than 350 oxbow lakes and 90 miles of the White River. The White River supports a highly diverse fish community with nearly 100 different species. Fish populations within individual oxbow lakes have not been well researched. Similarly, the interactions between fish spawning and natural zooplankton abundances have not been examined. We sampled larval fish during the spring using bilateral plankton tows with 0.5 m x 2 m townets in six oxbow lakes to estimate larval fish abundances. We also used a Wisconsin plankton sampler to estimate spring zooplankton abundances in the same oxbow lakes. All samples were conducted weekly for all lakes. Clupeids were highly abundant throughout the spring in all lakes, while crappie abundances generally increased over time. A variety of other fish appeared in varying abundances throughout the spring. Cladocerans and adult copepods were virtually nonexistent in oxbow lakes, while rotifers increased in abundance as the spring progressed. Copepod nauplii were found in low abundances throughout the spring in all lakes. Oxbow lakes in the White River NWR are important for fish spawning and nursery habitat.

Keywords: river oxbow lake larval fish

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### Differential movement of stream cyprinids in urban and rural watersheds

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Fish movement studies generally show differences among species and within populations. Urbanized watersheds display poor stream quality and flashy hydrology, which could potentially influence the fish movement distribution compared to populations found in higher quality habitat. It is hypothesized that the proportion of “movers” and “stayers” differ between stream systems exhibiting varying levels of upstream urban land use. Blacknose dace and creek chub were marked using visible implant elastomers and recaptured twice in two urban and two rural streams to determine movement patterns. Movement distributions varied across stream type, as well as species. Overall, more fish were recaptured in the same pool from which they were marked in rural as compared to urban streams (65.9% vs. 26.7%), yet individuals displayed a similar maximum range across stream types. Urban blacknose dace were found to move less ( $4.1 \pm 6.8$  m) than rural blacknose dace ( $27.3 \pm 9.4$  m). However, urban creek chub were recaptured at greater ( $22.6 \pm 11.7$  m) distances from the initial pool than rural individuals ( $7.5 \pm 6.7$  m). These results suggest that rural streams have a greater proportion of “stayer” individuals than urban systems, and that differential species behavior may be associated with stream habitat quality.

Keywords: Fish movement, urbanization, stream habitat, blacknose dace, creek chub

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### Spatial and temporal dynamics of black bass populations and habitat in two eastern Oklahoma streams

Dauwalter\*, D.C. and Fisher, W.L. Oklahoma Cooperative Fish and Wildlife Research Unit, Department of Zoology, Oklahoma State University. U.S. Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit, Department of Zoology, Oklahoma State University

We examined the spatial and temporal dynamics of stream habitat in relation to black bass populations in Baron Fork Creek and Glover River, Oklahoma. Habitat features including percent gravel, large woody debris density, rootwad density, and thalweg depth increased, and percent bedrock decreased, from upstream to downstream in Baron Fork Creek. In contrast, percent gravel and percent boulder decreased, and percent bedrock and thalweg depth increased, from upstream to

downstream in the Glover River. Stream habitat changed with seasonal fluctuations in streamflow in both streams, but more so in Baron Fork Creek than in the Glover River. Smallmouth bass dominated the black bass assemblage throughout Baron Fork Creek, but dominated only in the upstream reach of the Glover River. Recruitment variability, survival, relative weight, and abundance of smallmouth bass varied differentially among upstream and downstream reaches in Baron Fork Creek. The presence of smallmouth bass in channel units was related to several habitat variables, and changed among streams and seasons. However, smallmouth bass densities in channel units were only dependent on water velocity. Smallmouth bass spatial distributions also changed among seasons in one stream reach of Baron Fork Creek, potentially in response to the thermal characteristics of a backwater.

Keywords: smallmouth largemouth spotted scale channel unit presence/absence density survival Wr

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### **Environmental features influencing angling success in Mississippi's wadeable streams.**

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Wadeable streams in Mississippi typically support sport fisheries dominated by largemouth bass Micropterus salmoides, spotted bass Micropterus punctulatus, and longear sunfish Lepomis megalotis. Because small streams are functional parts of their terrestrial ecosystems, fishery management decisions reflect dimensions of their aquatic and terrestrial environments. We sampled streams throughout Mississippi by angling and related catches to aquatic and terrestrial characteristics of streams during baseflow periods. Total catch per unit effort (CPUE: fish/h) was positively related to alkalinity and negatively related to mean diameter at breast height (DBH) of riparian conifer trees ( $R^2 > 0.76$ ;  $P < 0.02$ ). Total bass CPUE was negatively related to stream width and DBH of conifer trees, and positively related to DBH of riparian hardwood trees ( $R^2 > 0.78$ ;  $P < 0.03$ ). Water chemistry apparently influences angling potential for these streams, reflecting soil characteristics in respective watersheds. This influences autochthonous and allochthonous production, both of which our study suggests relates to recreational bass fisheries in Mississippi's wadeable streams. Streams with larger hardwood trees in riparian zones generally had more productive bass angling than did streams with other riparian zone characteristics, which likely reflects the quality of allochthonous inputs to streams. We are currently expanding our investigation of fishery potentials in Mississippi's small streams by incorporating EPA National Wadeable Streams Assessment protocols to provide management guidance to stakeholders.

Keywords: Wadeable streams Angling Bass Assessment

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### **An evaluation of the relative influence of spatial, statistical, and biological factors on models of stream fish species presence**

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Models relating fish species presence to landscape and local (e.g., stream gradient) features are increasingly being used by aquatic biologists to estimate species presence in unsampled areas. The accuracy of these models directly influences the ability to make sound stream management decisions. Model accuracy, however, can be influenced by a variety of factors, such as spatial scale modeled and statistical modeling procedure. To evaluate and quantify the effect of biotic and abiotic factors on model accuracy, we fit parametric and nonparametric models of species presence at two spatial scales using watershed (e.g., land use, geology) and stream (e.g., link magnitude, gradient) characteristics. The best fitting parametric and nonparametric models were selected using Akaike Information Criteria and a Monte Carlo hypothesis testing procedure, respectively. We then evaluated the influence of model type, spatial scale, and species-specific traits, on the prediction error of the best-fitting models. Our evaluation of 47 species indicated that prediction error was highly variable within a species due to the influence of model type and spatial scale modeled. Variation in error rates among species was lower and was

related to species specific characteristics, such as tolerance to anthropogenic change, and whether or not the species is cosmopolitan. We recommend that biologists consider the effects of scale and species traits in order to make sound management decisions.

Keywords: Modeling spatial

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## Water Quality

### Effects of Artificially Introduced Groundwater on Fish Assemblages and Water Chemistry in Central Florida Lakes

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Water levels in central Florida lakes have declined as a result of several factors since the 1960's. In an effort to maintain water levels, the Southwest Florida Water Management District (SWFWMD) issued permits to allow landowners to pump water from aquifers into lakes. Consequently, lake augmentation may alter water chemistry and other lake parameters. I assessed effects of groundwater augmentation on fish assemblages and water chemistry in seven Florida lakes. Fish were collected by electrofishing, and the length and weight of all captured fish was recorded. Fish population parameters were compared to information from a 60-lake database of non-augmented lakes in Florida (Hoyer and Canfield 1992). Current lake water samples had higher mean levels of pH, total alkalinity, total phosphorus and Secchi depth, and lower mean levels of color and chlorophyll than historical ranges prior to pumping. Current samples also had lower mean nitrogen levels and higher mean chloride levels. Values for mean catch per unit effort, species richness, and biomass of harvestable fishes were lower in augmented lakes than the means in nonaugmented lakes, however, multiple linear regressions indicated that fish population responses of augmented lakes to environmental variables were similar to nonaugmented lakes of similar limnological characteristics. Multivariate analysis showed the augmented lakes have diverging environmental trends and a high probability of a low abundance of individual fish species.

Keywords: Fish Population Lake Augmentation Aquifer Florida

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### Stream ecosystem response to mitigative limestone treatment in acid impaired streams, WV

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We quantified water chemistry, primary production, and benthic macroinvertebrate and fish community structure in 20 Central Appalachian streams: 4 acidic streams, 8 naturally circumneutral streams, and 8 historically acidic streams treated annually with limestone sand. The objective was to determine the extent of chemical and biological recovery and temporal trends in the recovery process of limestone treated streams compared to circumneutral reference conditions in Central Appalachia. Results indicate that the application of limestone sand to acidic streams is effective in fully and immediately recovering some of the chemical and biological characteristics of naturally functioning stream ecosystems, such as pH, alkalinity,  $\text{Ca}^{2+}$ , Ca:H ratios, trout densities and trout young of the year densities. However, recovery of many characteristics such as macroinvertebrate density and percent acid sensitive macroinvertebrate taxa biomass is strongly dependent upon spatial proximity to treatment, and still others, such as  $\text{Al}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^+$ ,  $\text{Na}^{2+}$ , and  $\text{NO}_3^-$  concentrations, macroinvertebrate taxa richness and biomass, number of acid sensitive macroinvertebrate taxa, and fish biomass are never fully recovered. Full recovery of acid impaired streams will most likely require treatment at the watershed scale including multiple mainstem treatment locations and treating streams as a regional network rather than isolated stream segments.

Keywords: Acid precipitation, Central Appalachian, limestone treatment, stream restoration

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### An investigation of fish response to reservoir discharge events in the Stony River, Grant County, West Virginia

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Lotic systems are impacted by a variety of stressor that can indirectly or directly influence fish behavior and movement. Of considerable interest are the impacts of impoundments and thermal enrichment upon fish populations. The fish community of the Stony River, WV is exposed to a variety of potential stressors. In the summer, a discharge from a power plant cooling reservoir located on the Stony River can result in large increases in discharge and temperatures can exceed  $30.6^\circ\text{C}$  (thermal discharge). Further, Stony River is impacted by mining-impacted tributaries that contribute heavy metals to the system. To study the impact of reservoir discharges upon fish populations we studied community composition and movement of fish prior to and following thermal and non-thermal discharges from Mount Storm Lake along an environmental gradient. Radio

telemetry was used to monitor larger (>85 g) smallmouth bass movements and parallel wire electrofishing was used to define community composition. The community survey along the environmental gradient after discharge events did not differ from before discharge events. Preliminary radio telemetry data suggest that bass movement was induced by increased discharge with no correlation to increased temperature. The temperature increase associated with reservoir discharges has minimal effects on the fish movement and community composition in the Stony River.

Keywords: fish movement, thermal discharge, radio telemetry, community composition

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### **Effects of Variable Flows on Water Chemistry and Fish Communities below the Hillsborough Dam, Florida**

*Catalano\*, M. J., Allen, M. S., Murie, D. J. University of Florida, Gainesville, FL*

We evaluated the effects of variable flows on water chemistry and fish communities below the Hillsborough River Dam, Florida, to recommend biologically-based minimum flows that protect low-salinity estuarine habitats. Temperature (C), salinity (ppt), dissolved oxygen (DO; mg/L), and fish catch per effort (CPE) from fyke nets were measured during five different flow regimes from October 2002 to July 2004. Flows >1.2 m<sup>3</sup>/s maintained freshwater/oligohaline habitats and fish communities throughout the study reach on four of five sampling dates. However, during prolonged low flows (<0.12 m<sup>3</sup>/s), a salt wedge (salinity>5ppt) moved to within 1300 m of the dam, which caused freshwater fishes to congregate in the remaining suitable habitat just below the dam. We conclude that prolonged flows <0.12 m<sup>3</sup>/s may reduce fish species richness and diversity through loss of habitat heterogeneity and volume. However, because we lacked data on intermediate flows (0.2-1.1 m<sup>3</sup>/s), we failed to detect the threshold flow at which fish assemblage impairment began. We recommend sampling within this flow range to detect thresholds for minimum flows. In addition, we documented urban runoff and low DO following heavy precipitation in July 2004, which indicates that the fish community may also be limited by basin-scale perturbations such as urbanization.

Keywords: minimum flows dams estuaries fish communities

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### **Local and Regional Impacts of Acid Mine Drainage in a Central Appalachian Watershed**

*Freund\*, J.G. and Petty, J.T., West Virginia University, Morgantown, WV*

Acid mine drainage directly impacts between 10% and 15% of stream miles in the Mid-Atlantic Highland region. However, the upstream impacts as a result of fragmentation and a reduction of the potential number of colonizing species have not been considered in previous research. The Cheat River, West Virginia, provides an ideal model system: the upper basin is unimpacted by AMD but is otherwise similar to the AMD-impacted lower basin. Water chemistry conditions in the lower basin varied from unimpacted to severely impaired. Moderately impaired sites, 51% of all lower basin sites, were highly variable in water quality and possessed highly variable fish assemblages. Species richness in the upper basin was strongly correlated with basin area and spatial position ( $R^2 = 0.79$ ). However, when this model was applied to the lower basin, the model performed poorly ( $R^2 = 0.34$ ). Likewise, models developed from the lower basin data set as well as subsets of unimpacted and moderately impaired sites also performed poorly. A key finding was that streams in the lower basin with good water and habitat quality possessed fewer species than expected. Several important indicator species and functional groups provided strong evidence that a lack of watershed connectivity and a reduction to the regional species pool explained much of the fish assemblage deviation in sites upstream of AMD impairment.

Keywords: Acid Mine Drainage (AMD) fish assemblages water quality

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## **Investigation of crayfish survival in a system impaired by acid mine drainage and thermal pollution**

*Horn\*, C.D., Mazik, P.M., and Hartman, K.J. West Virginia University Division of Forestry*

Crayfish are an important component of freshwater ecosystems and are present in most lotic systems in temperate North America. We examined potential reasons for the absence of crayfish in the Stony River below Mt. Storm Lake, WV, which is exposed to both thermal and acid mine drainage pollution. Four week *in situ* bioassays were performed along an environmental gradient with the native crayfish *Cambarus bartonii* during summers 2003 and 2004. Survival of crayfish was analyzed in conjunction with temperature and acid mine drainage related variables (pH, specific conductivity). Crayfish survival was significantly lower at sites with higher temperatures during summer 2003, and no significant differences were observed in summer 2004. Temperatures were higher in 2003 than 2004 due to increased discharge from Mt. Storm Lake. No relationship between acid mine drainage variables and crayfish survival was apparent. Results suggest that temperature may be limiting to *C. bartonii* in the Stony River, and that water quality impairments caused by acid mine drainage are not directly lethal.

Keywords: crayfish, thermal pollution, AMD

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## **Mercury In Redhorse Sucker Tissue And Otoliths From The North Fork Holston River System**

*James C.S. Anderson\*, Jennifer R. Berrigan and Daniel M. Downey*

Otoliths (ear bones) grow continuously throughout the lifetime of fish and are frequently used for age determination. It was hypothesized that mercury, as a doubly charged cation ( $Hg^{2+}$ ), might incorporate into the otolith crystal by replacing  $Ca^{2+}$ . If so, otolith analysis could provide an alternative to the time consuming and tedious tissue digestion method currently used for mercury screening. More than 200 golden and black redhorse suckers (*Moxostoma erythrurum* and *Moxostoma duquesnei*, respectively) were collected for the study from three locations in the mercury contaminated North Fork Holston River. Otoliths and tissue were analyzed for total mercury. Instrumental Neutron Activation Analysis (NAA) was used to assay otoliths with samples irradiated at North Carolina State Research Reactor. The 46 day Hg-203 was assayed by gamma ray spectroscopy at JMU. Fish tissue was analyzed by the standard protocol of acid digestion and Cold Vapor Atomic Absorption (CVAA). This presentation will describe the analytical results and age and growth data from this work.

Keywords: Redhorse sucker otolith microchemistry mercury

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## **The Role of Bioenergetics in Bioaccumulation of Organic Contaminants: A Case Study**

*Liebert\*, Dan and Baker, Joel UMCES Chesapeake Biological Laboratory, Solomons, MD*

Striped bass from Chesapeake Bay were collected in spring and fall from 1999 to 2003 and analyzed for lipid content and polychlorinated biphenyls (PCBs). These fish showed a strong seasonal pattern of lipid and PCB concentrations with maxima of both in spring and minima of both in fall. As well, a seasonal difference in relative abundance of more chlorinated (heavy) versus less chlorinated (light) PCB congeners was observed. In spring, striped bass PCBs were dominated by lighter, more labile PCBs while PCBs in striped bass collected in fall were dominated by heavier more lipophilic congeners. To investigate a possible cause for our observations, we used a bioenergetic model for Chesapeake Bay striped bass and field measurements to generate lipid, consumption, and ventilation inputs for a toxicokinetic bioaccumulation model. This model demonstrated that seasonality of energetic status and respiration rates can account for the observed seasonal differences in PCB congeners. During summer and fall months when temperatures are high, respiration and ventilation rates are at a maximum and lipid content is at a minimum; these conditions allow for a rapid efflux of lighter, more labile PCB congeners, while heavier congeners remain bound in tissues.

Keywords: Striped bass, PCBs, bioenergetics, bioaccumulation

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## **An Assessment of Fish Community Structure and Seasonal Habitat Use of Headwater Wetlands in Southwest Georgia**

*McPherson\*, Jr., R.D., and Peterson, J.T. US Geological Survey, Georgia Cooperative Fish & Wildlife Research Unit, D.B. Warnell School of Forest Resources, University of Georgia, Athens, GA.*

Headwater wetland streams are first or second order streams where water is not restricted to a clearly defined channel during baseflow. While large wetland-floodplain systems have been shown to function as spawning and nursery areas for many fishes, little is known about the function of headwater wetlands. Therefore, we examined fish community structure and seasonal habitat use in three headwater wetlands during 2003 - 2004. Species richness and fish density in headwater wetland streams were, on average, lower than similar-sized headwater streams with confined channels. Fish communities in headwater wetland streams were primarily composed of young-of-year and small size species, especially those tolerant of low oxygen such as mosquitofish, pirate perch, and banded pygmy sunfish. However, fish community structure was highly variable among wetlands and seasons presumably due to site-specific wetland characteristics. Headwater wetland streams with significant groundwater inputs tended to have the greatest fish density and species richness during the winter, which was consistent with previous studies of fish communities in confined channel streams. These findings suggest groundwater-dominated headwater wetlands function as seasonal refugia during winter. In contrast, headwater wetland streams with significant amounts of forest cover had the lowest fish density and species richness during the spring, which was likely due to very low dissolved oxygen levels resulting from the decay of leaves. Fish density, species richness, and dissolved oxygen were similarly low in all wetlands during the summer 2004 as a result of greatly reduced flows and short-term drought. Our findings suggest not all headwater wetlands function equally, nor does a single wetland function equally across seasons.

Keywords: Wetland, Floodplain, Headwater Stream, Fish Community Structure, Seasonal Habitat Use, Groundwater.

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## **Effects of impoundments on the fish assemblages of low order streams**

*Kashiwagi, M.T., and Miranda, L.E. Mississippi Cooperative Fish and Wildlife Research Unit, Mississippi State*

Dams are interruptions to the connectivity of stream ecosystems. In low-order stream systems subject to desiccation during low precipitation periods, this break in connectivity may influence the ability of species to recolonize headwater sections. We compared fish assemblages collected from sections above and below impoundments in the Tombigbee National Forest, Mississippi. Preliminary analyses indicate that there is a significant difference in species composition in the stream sections above and below the impoundments. Sections upstream from the impoundments contained mainly cyprinid species, while downstream sections held more centrarchid and catostomid species. While the dam may prevent the upstream movement of recolonizing species, the continuous flow provided by the impoundment may enhance fish assemblages in reaches below the dam during low precipitation periods.

Keywords: dams, stream fish assemblage, connectivity

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## Population Dynamics of Reintroduced Barrens Topminnows

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The Barrens topminnow, *Fundulus julisia*, is a state-listed threatened species endemic to Coffee, Warren, and Cannon counties in middle Tennessee. The declining number of Barrens topminnow populations prompted reintroduction efforts in several locations throughout its historical range. At many locations, persistence has been brief and reproduction nil. Therefore, data were collected to determine the biotic and abiotic factors affecting Barrens topminnow persistence and reproduction including the abundance of mosquitofish, *Gambusia affinis*, a species implicated in the decline of native spring-dwelling fishes in other locales. Lighted larval traps were set at seven reintroduction sites with mosquitofish densities ranging from 0 fish/m<sup>2</sup> to over 20 fish/m<sup>2</sup>. Reproduction was confirmed at three sites, but recruitment to the juvenile stage occurred only in sites free of mosquitofish. The critical period in the recruitment process was probably at the larval stage, which is when topminnows have been shown in laboratory experiments to be particularly susceptible to mosquitofish predation.

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## **Marine/Estuarine Fisheries Science Symposium**

### **Catch composition and fate of sub-legal discards in the snapper/grouper/porgy commercial fishery, Onslow Bay, North Carolina.**

*Rudershausen\*, P.J., and Buckel, J.A. North Carolina State University Dept. Zoology, CMAST, Morehead City, NC*

Minimum size regulations may be ineffective because heavily exploited reef fishes often sustain barotrauma when hooked and retrieved rapidly from deep water. We undertook a study to: a) characterize current depth strata occupied by commercially important species, and b) evaluate the efficacy of minimum size limits on vermilion snapper and red porgy by documenting hooking location and gastric distention, and quantifying post-release indices of potentially sub-legal specimens. Roughly 960 rod-hours of hook and line sampling took place on 30 trips from May-November, 2004 in Onslow Bay, North Carolina in waters from 19 to 143 m deep. Compared to historical data, our effort suggests that exploited reef fishes may occupy more narrow depth strata than three decades ago. Water depth and gastric distention did not influence post-release indices. Distributions of post-release indices for sub-legal vermilion snapper and red porgy were significantly different than random; there were higher incidences of fish swimming down than floating at the surface. While released fishes may experience delayed post-release mortality from predation or swim bladder damage, low rates of gastric distention and gut hooking for these two species and favorable post-release indices suggest that minimum size limits may be an effective management tool to reduce rates of fishing mortality for some species.

Keywords: snapper porgy hooking mortality barotrauma

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### **The role of Phragmites invasion in altering the distribution and abundance of marsh fishes: an examination by invasion stage in mid-Atlantic estuaries**

*Fox\*, D. A., Delaware State University (DSU), K. L. Hunter, Rutgers University Marine Field Station (RUMFS), L. M. Brown, (DSU), and K. W. Able (RUMFS)*

The management and control of invasive species is a topic of vast ecological importance. Presently, estuaries along the eastern seaboard of the U.S. are experiencing a rapid expansion of the common reed (*Phragmites australis*). As *Phragmites* becomes established in natural marsh systems, there is an associated loss of marsh surface depressions coupled with extensive plant litter accumulation and altered hydrology. These changes in marsh topography have been shown to have a dramatic affect on the distribution and abundance of fauna that utilize the marsh surface. This study assessed the impacts of the *Phragmites* invasion at specific stages (i.e. natural, initial, early, and late) on resident larval and juvenile marsh fishes in three national estuarine research reserve sites in the mid-Atlantic region (Great Bay, NJ, Blackbird Creek, DE, and Monie Bay, MD). Results indicated reduced flooding frequency during daytime high tides as the *Phragmites* invasion progressed. There was a precipitous decline in total abundance of larval and juvenile *Fundulus heteroclitus* and *F. luciae* with an increase in *Phragmites* invasion stage across all study locations (mean CPUE: natural = 7.9, initial = 3.8, early = 1.4, and late = 0.3). These results indicate that *Phragmites* may impact overall productivity of brackish marsh systems through a loss of habitat for *Fundulus* spp.

Keywords: *Fundulus* *Phragmites* Invasion Habitat *Spartina*

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### **Growth and recruitment rates of juvenile blue crabs *Callinectes sapidus* in Chesapeake Bay**

*Puckett\*, B.P., Secor, D.H., and Ju, S.-J. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD*

Recent declines in Chesapeake Bay blue crab landings and total abundance have stimulated concern about the status of the blue crab stock and the sustainability of the fishery. Here, we evaluate recruitment rates to blue crab fisheries through lipofuscin-based ageing of pond-reared and field-collected blue crabs and modeling of juvenile growth rates. In 2003, two cohorts (March and July hatch dates) of known-age juvenile crabs (c. 70 days old), produced at a research hatchery, were

released into separate earthen brackish-water ponds and sampled monthly. To sample wild juveniles, monthly (June-October) bottom trawls were conducted in the lower Choptank River (2003) and Patuxent River (2004). Lipofuscin, a fluorescent granule accumulating in post-mitotic cells, was extracted from eye-stalks, and fluometrically assayed. Lipofuscin accumulation increased exponentially with chronological age in pond-reared crabs, indicating that this method is feasible for ageing wild juveniles. Mean absolute growth rates for pond-reared and field-collected blue crabs ranged from 0.97 to 1.42 mm d<sup>-1</sup> during their first year of life. The high growth rates reported here indicate that blue crab generation time is short, and that peeler fisheries in the summer and hard crab fisheries in the fall/winter are predominately dependent on new recruits younger than 18 months.

Keywords: blue crab recruitment lipofuscin

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### **An evaluation of surgical closure techniques for long-term retention of telemetry transmitters in American eels (*Anguilla rostrata*)**

*Thomas\*, J. C., D. A. Fox (Delaware State University), and G. A. Lewbart (North Carolina State University College of Veterinary Medicine )*

According to recent surveys, American eel (*Anguilla rostrata*) stocks are in decline. In an attempt to address these declines, there have been recent calls for an increased understanding of American eel habitat requirements. While telemetry has proven a powerful tool for gaining insights into habitat utilization in other species, low transmitter retention rates have limited its success in American eels. In fact, debate exists over the best method of transmitter placement for American eels. To address this problem, we are conducting research to identify the most appropriate method of implantation to maximize transmitter retention times. Individual eels (n=120) have been randomly assigned to one of four treatment groups (control, no closure, suture, and surgical adhesive with skin graft) to assess each technique's effect on transmitter retention. Contrary to published findings, results indicate that suturing of the incision is the most effective implantation method. A better understanding of transmitter implantation techniques will allow for increased utilization of resources and data collection in field projects utilizing telemetry.

Keywords: American eel telemetry surgery

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### **Fish community assemblages in Maryland's (USA) coastal lagoons**

*Murphy\*, R. F., and Secor, D. H. University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory*

The fish assemblage and community dynamics of fishes in Maryland's four coastal lagoons were analyzed using data from a long-term (1991-2002) monitoring program administered by the Maryland Department of Natural Resources. These connected series of lagoons have limited exchange with the ocean, but conditions are apparently favorable for a high diversity of species (N>150). During the months May to October, temperature ranged from 16° to 32.7° C and salinity from 21 to 36. The assemblage was dominated by six species, with Atlantic silverside (*Menidia menidia*) being the most abundant. Principal Components Analysis (PCA) revealed strong seasonal groupings among the dominant fauna (95% of total catch) in addition to specific embayment differences (Chincoteague, Assateague, Isle of Wight, Sinepuxent). Seasonal and location effects on abundances were evident for the dominant species when regressed against PCA-generated eigenvalues. Analysis of Similarity (ANOSIM) revealed significant differences based on species abundance (R = 0.445, p < 0.004) between the four interconnected systems. Traditional metrics of diversity (Shannon-Weiner index and species richness) also showed contrasts among seasons and embayments.

Keywords: Coastal Lagoons, Assemblage, Diversity

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## Ocean Ecology of Mid-Atlantic Juvenile Bluefish

Callihan\*, J.L. and Secor, D.H. University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, MD.

Shallow oceanic waters may provide valuable nursery grounds for fishes assumed to principally utilize estuaries during early life. Bluefish, *Pomatomus saltatrix*, are regarded as such obligate estuarine users; however, little is known of their ocean ecology during the juvenile period and much remains unknown about environmental and biotic controls on recruitment. During May to October, we conducted monthly trawl sampling in 5-18 m depth oceanic waters off the DelMarVa Peninsula in 2003 and 2004; comparable data was available from the Chesapeake Bay. Otolith microstructure analysis was used to estimate hatch dates and growth rates. We evaluated patterns of abundance, diet, growth, and cohort dynamics over seasons and years within and among these habitat types. Relative abundance was consistently higher during July–October in ocean versus Chesapeake Bay habitats. *Anchoa* sp. were the most common prey item in both habitats. Hatch dates were generally bimodal; the summer cohort appeared to predominate in ocean environments. Growth rates of juvenile bluefish were higher in the coastal ocean (1.69 – 1.91 mm day<sup>-1</sup>) versus Chesapeake Bay (1.4 mm day<sup>-1</sup>). We hypothesize that juvenile bluefish are not strictly estuarine-dependent, and that during late summer/early fall, oceanic nursery habitats result in greater juvenile production than estuarine nurseries.

Keywords: bluefish, juvenile, growth, diet, recruitment, coastal dependence

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## Recruitment patterns of white perch and yellow perch in Albemarle Sound, North Carolina

Luthy\*, S.A., Buckel, J.A. (North Carolina State University), and Grist, J.D. (North Carolina Division of Marine Fisheries)

Recruitment information is critical to a complete understanding of population dynamics and is valuable in formulating stock assessments and fishery management plans. A subset of a survey conducted by the North Carolina Division of Marine Fisheries in Albemarle Sound (60 ft bag seine samples taken at 20 “core” stations from June through October, 1972-2003) was used to calculate indices of abundance and to examine patterns of recruitment in white perch (*Morone americana*) and yellow perch (*Perca flavescens*). White perch recruitment was highly variable about a slightly decreasing trend, except for a period of relatively low and stable recruitment from 1984 to 1992. Yellow perch recruitment exhibited a slightly increasing trend and was less variable and consistently lower than that of white perch. Yearly geometric means of catch per unit effort (CPUE) of young-of-the-year (YOY) fish were correlated with the yearly geometric means of CPUE of age-1 fish caught in the subsequent year for both white perch ( $r = 0.759$ ;  $p < 0.0001$ ) and yellow perch ( $r = 0.467$ ;  $p = 0.0081$ ). Incorporating abiotic and biotic variables via multiple regression may improve the ability to predict recruitment to age-1 in each species, given YOY abundance indices.

Keywords: juvenile abundance recruitment perch

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## Daily Movements and Site Fidelity of White Perch (*Morone americana*) in Two Small Tributaries of the York River, Virginia

McGrath\*, P.E., and Austin, Herbert M.

White perch (*Morone americana*) is one the most common species residing in the brackish tributaries of the Chesapeake Bay. White perch is a commonly sought after commercial and recreational species and is one of the few species that are permanent residents in the Bay. There is very little known about their site fidelity, home range, or tidal interactions. This acoustic tagging study examined fifteen white perch residing in two small tributaries of the York River. White perch exhibited a high degree of site fidelity along with a small home range. The fixed kernel method was utilized to measure home range size. The output contours considered were the 95% contour (total home range) and the 50% contour (core area of activity). The kernel method areas were .0128 sq. km. and .0021 sq. km., respectively. White perch typically had two core areas of activity, which often correlated to the tidal stage. They were often found during high tide upon the flooded marsh or up in shallow creeks and

in the relatively deep main channels during low tide. White perch did not show any movement with sudden changes in salinity and/or temperature resulting from tropical storms or Hurricane Isabel.

Keywords: white perch, site fidelity, home range

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### **Use of Otolith Microconstituent Analysis to Characterize Atlantic Bluefin Tuna Stock Structure**

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Scientific evidence has been insufficient to support stock structure assumptions in the management of Atlantic bluefin tuna. Past studies indicate that otolith elemental fingerprints are significantly different between the two principal bluefin tuna nurseries (US Continental Atlantic and Mediterranean), but are insufficiently distinct - 60 to 80% classification rates - to allow precise study of mixing rates. Such rates are common to otolith microconstituent applications and may in part be due to an inability to measure transition and heavy metals reliably. Also, for future application to be successful, we must develop a method to isolate otolith growth that corresponds to first year growth from the otoliths of adult tuna. Here, we develop coupled methods - otolith micro-milling and separation/preconcentration methods, which should allow measurement of trace transition metals in the core regions of otoliths from adult bluefin tuna. The addition of transition and heavy metals to the suite of abundant otolith metals substantially improved our ability to discriminate yearlings between the two nursery regions. Further, development of a coring procedure and tests of our decontamination procedure on cored otoliths indicate that we can utilize transition and heavy metals to distinguish nursery areas from cored regions of adult bluefin tuna.

Keywords: bluefin tuna otolith microconstituents stock structure

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### **Investigations of carbon-14, carbon-13, and nitrogen-15 in the white shark (*Carcharodon carcharias*) from the eastern Pacific**

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*Coale, K.H.* Moss Landing Marine Laboratories

Age and growth estimates of the white shark (*Carcharodon carcharias*) from the eastern Pacific Ocean indicate a relatively long life span and slow growth rate; however, these estimates have not been validated. To obtain reliable age, growth, and longevity estimates useful for stock assessment and fishery models, validation of age estimation is essential. By counting vertebral growth zones, ages can be estimated; however, not all sharks deposit annual growth zones, nor are they easily discernable in all species. It is necessary to validate the periodicity of growth zones in vertebrae by an independent method. Radiocarbon ( $^{14}\text{C}$ ) age validation uses the discrete  $^{14}\text{C}$  signal produced from thermonuclear testing in the 1950s and 1960s retained in skeletal structures as a time-specific marker. The goal of this study was to assess the metabolic stability of  $^{14}\text{C}$  in white shark vertebrae, evaluate validation of age estimation procedures, and better understand the carbon source to white

shark vertebrae. Annual growth zones of vertebrae spanning the 1930s to 1980s were cored and analyzed for  $^{14}\text{C}$ ,  $^{13}\text{C}$ , and  $^{15}\text{N}$ . Stable isotopes provided useful trophic information, however validation of age estimates was confounded by the trophic source of carbon, large-scale movements, and possible metabolic reworking of the vertebrae.

Keywords: radiocarbon white shark age validation

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### **Age and growth of Hudson River shortnose sturgeon (*Acipenser brevirostrum*)**

*Woodland\*, R.W., and Secor, D.H. Chesapeake Biological Laboratories (CBL), Solomons, MD*

We investigated age structure and growth characteristics of the Hudson River shortnose sturgeon population; a population that has shown a several-fold increase in abundance in recent decades following federal protection and improved water quality standards. Specimens were captured using 30 x 1 m gillnets with one of three mesh sizes (10.2, 15.2 or 17.8 cm stretch mesh) bi-monthly from the fall of 2004 through the summer of 2005. Length and weight were measured, and a small section (~1cm) of the pectoral spine was removed for age determination prior to release. Annuli in fin spines were interpreted under reflected light microscopy with the aid of a digital imaging system. Ages of sturgeons 42 to 88 cm Fork Length ranged from 5 to 27 years. Growth rates showed a declining trend with increasing age according to a von Bertalanffy growth model: 34 mm yr<sup>-1</sup> (292 g yr<sup>-1</sup>) and 3.3 mm yr<sup>-1</sup> (89 g yr<sup>-1</sup>) for ages 5-9 and ages 10-22, respectively. These are preliminary estimates, as several hundred pectoral spine samples remain unanalyzed. Though future research will continue to investigate the validity of our interpretation of fin spine annuli, estimated age structure indicates that many year-classes (e.g., favorable recruitment years) have contributed to the recovery of Hudson River shortnose sturgeon.

Keywords: shortnose sturgeon age and growth recovery

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### **Assessing the Impacts of Channel Dredging on the Migratory Behavior of American Shad, *Alosa sapidissima***

*Aunins\*, A.W., and Olney, J.E. Virginia Institute of Marine Science, Fisheries Science Department, Gloucester, VA.*

Maintenance dredging of shipping channels in Virginia is permitted only after the spawning season of anadromous fishes since the activity may alter upstream migratory behavior. A lack of sufficient data exists in support of these restrictions, however. We conducted a pilot acoustic telemetry study in spring 2004 to record movements of American shad in the James River. Our purposes were to assess the suitability of gill-nets versus haul seines for fish collection, record movements of fish through the area of dredging, and to locate potential spawning areas. Listening stations were deployed at three upstream locations. Twenty-eight fish were tagged and released, but only 16 were detected. Ten of the 16 were collected by haul seine, and exhibited shorter transit times to the lowermost listening station than gill-netted fish. Monitoring data suggested spawning in areas previously considered unsuitable or unused. We propose to release 105 fish and deploy nine listening stations in spring 2005 during dredging operations. Two cohorts will be released in the lower James River; the first released during a period of no dredging and a second cohort after dredging commences. The results should permit evaluation of existing dredging restrictions and assist American shad restoration efforts.

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### **Overview of the Maryland DNR Striped Bass Monitoring Program and Recent Data Trends**

*Zlokovitz\*, E.R. Maryland Department of Natural Resources (MD DNR)-Fisheries Service*

The Maryland Department of Natural Resources-Fisheries Service conducts long-term monitoring of striped bass populations and fisheries in the Chesapeake Bay. Current projects include the juvenile index (JI) seine survey, spawning stock biomass gillnet survey, tagging, commercial checkstation monitoring, and an access-intercept survey of the spring recreational trophy season. The JI survey provides estimates of young-of-year striped bass and other juvenile finfish dating back to the 1950s,

and the tagging program is one of the most intensive mark-recapture surveys on the east coast. This presentation will provide an overview of the various striped bass surveys in Maryland tidewaters, and recent trends in data will be discussed.

Keywords: Striped Bass Chesapeake Bay Monitoring

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### **Do American shad grow on trees?**

Hoffman\*, J.C. and Olney, J.E. Virginia Institute of Marine Science, Gloucester Point, VA

Our objective was to determine the sources of production that support the growth of young-of-year American shad (*Alosa sapidissima*) in the York River, VA. Seasonal stable isotope signatures ((Delta)<sup>13</sup>C, (Delta)<sup>15</sup>N) of dorsal muscle tissue suggested that the nursery zone is both spatially and temporally heterogeneous with respect to neustonic food webs that support production. The dual-isotope approach revealed that sources of larval and juvenile American shad production in tidal freshwater habitats were related to seasonal flow patterns and river geomorphology. Isotopic signatures of muscle tissue were consistent with a diet derived from terrestrial matter during periods of high flow in late spring. During summer, isotopic signatures of juveniles were consistent with a diet derived from a mix of phytoplankton produced *in situ* and terrestrial material. Different sources of production were detectable on a spatial scale of 10 river kilometers and a temporal scale of two weeks. The study demonstrates that stable isotope analysis of fish tissue can be a powerful tool for linking essential habitat with sources of production.

Keywords: American shad anadromous habitat stable isotope

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### **Trends in forage fish abundance in the major tributaries to the Chesapeake Bay in Virginia**

Hewitt\*, A.H., and Austin, H. Virginia Institute of Marine Science, Gloucester Point, VA

In recent years, fishery managers, including those in the Chesapeake Bay region, have focused on developing an ecosystem-based approach to managing fish stocks. This approach considers all the interactions that a target stock has with its environment, including predators, prey species, humans, and habitat, and requires an understanding of complex food-webs in order to develop mathematical models with predictive power under differing management scenarios. Inherent in this type of method is the need for long-term biological data that can serve as a baseline to discern the differing effects of fishery management practices from other environmental factors. The Virginia Institute of Marine Science (VIMS) has consistently conducted a yearly juvenile striped bass seine survey in the major tributaries to the Virginia portion of the Chesapeake Bay since 1980. In addition to a juvenile striped bass index, this survey provides a time series of relative abundances of other species captured in the seine hauls, some of which are forage for larger predatory species like striped bass and bluefish. These species include Atlantic menhaden *Brevoortia tyrannus*, bay anchovy *Anchoa mitchilli*, and Atlantic silverside *Menidia menidia*. Trends in abundance of these forage fishes and others are examined over the history of the survey.

Keywords: forage abundance Chesapeake Bay menhaden silversides anchovy

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### **Socioeconomic Impacts of Hurricanes on North Carolina's Commercial Fisheries**

Chevront\*, B. North Carolina Division of Marine Fisheries, Morehead City, NC

The coast of North Carolina is frequently impacted by hurricanes. An especially active year was 1999, with three hurricanes coming ashore or closely skirting the North Carolina coast. In a period of less than two months, Hurricanes Dennis, Floyd, and Irene caused millions of dollars in damage and resulted in the loss of 52 lives. Commercial fishermen were heavily impacted. Fishing gear, vessels, and shore side structures were damaged and lost. Many of the 7,900 licensed commercial fishermen could not fish for periods ranging from weeks to months. Infrastructure supporting both commercial and

recreational fishing was damaged and destroyed. Many saltwater commercial fishermen were recipients of a state program that provided monetary grants to commercial fishing interests. In 2004, 350 grant recipients were randomly selected to participate in a follow-up survey. Of those, 242 responded. Results showed that in the five years since the storms, 12% had left fishing altogether and 55.2% of them felt that losses resulting from hurricanes were part of the reason they are no longer fishing. Of those still fishing, 28% are fishing less than before. Additional results will be presented comparing the impact of hurricanes and other factors on commercial fishing behavior.

Keywords: human dimensions hurricanes socioeconomic impacts

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### **A delineation of the Eastern Shore of Virginia summer nursery habitat of juvenile sandbar sharks, *Carcharhinus plumbeus***

*Conrath\*, C.L., and Musick, J.A. Virginia Institute of Marine Science, Gloucester Point, VA.*

The sandbar shark is a large coastal shark found globally in warm temperate and tropical waters. It is the most abundant large coastal shark found in the waters off the East Coast of the United States and is the principal species caught in the commercial shark fishery off the Atlantic coast. Defining coastal nursery and pupping areas for Atlantic shark species is important for current and future management efforts. Recent studies have found that the principal nurseries for the North Atlantic population of sandbar sharks occur in shallow coastal bays from New Jersey to South Carolina. In order to study the summer sandbar shark nursery area that occurs in the Eastern Shore of Virginia seaside bays and lagoons during the summers of 2002 to 2004 gillnets and longlines were used to sample neonate and juvenile sandbar sharks found within this region. During this period 168 gillnets and 250 longlines were set capturing 1, 271 sandbar sharks. The abundance of juvenile and neonate sandbar sharks will be compared to environmental parameters to determine if physical factors are correlated to the use of this nursery area.

Keywords: elasmobranch activity EFH

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### **Observing North Carolina Commercial Fisheries**

*Godwin, C. H.\* NC Division of Marine Fisheries, Elizabeth City, NC 27909. Price, A. B. NC Division of Marine Fisheries, Morehead City, NC 28557 Rulifson, R. A. Institute for Coastal and Marine Resources East Carolina University Greenville, NC 27858*

In 2001, North Carolina commercial fishers reported 24,270 trips for the inshore, large mesh (less than or equal to 5.0 inch stretch mesh) gillnet fishery. Fishery managers need an accurate estimate of bycatch and bycatch mortality associated with this fishery in order to make sound management decisions regarding Fishery Management Plans. The goal of this project is to establish an inshore, large mesh, gillnet observer program (LMGNOP) that covers North Carolina's Albemarle/Pamlico Sound complex. A LMGNOP will provide fishery managers with: 1) characterization of both directed catch and bycatch, 2) bycatch mortality associated with species of particular concern (e.g. striped bass *Morone saxatilis*, red drum *Sciaenops ocellatus*, and Atlantic sturgeon *Acipenser oxyrinchus*, 3) documentation of endangered or threatened species interactions, and 4) stock assessment data including estimates of landings, discards, and effort. Started in April 2004, the LMGNOP has observed over 200,000 yards of gillnet on more than 350 commercial fishing trips, which have landed over 12,000 pounds of commercially important finfish. The pool of volunteers willing to take observers now includes more than 65 commercial fishers. Data presented here will include commercial effort, catches, coverage area, and commercial fisher cooperation. The ultimate goal is to transform the LMGNOP into a permanent program observing multiple inshore finfish fisheries.

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## Monitoring tag recovery and movement patterns of bled horseshoe crabs in the mid-Atlantic region

Grogan\*, W.N., and Berkson, J. Virginia Polytechnic Institute and State University, Blacksburg, VA

To gain information on movement patterns and stock structure of horseshoe crabs a tagging study was conducted on horseshoe crabs (*Limulus polyphemus*) harvested for biomedical use in the waters surrounding Chincoteague, Virginia and Ocean City, Maryland. Twelve thousand five hundred adult horseshoe crabs were tagged and released during the summers of 1999-2002 and 2004. As of November 1, 2004, 431 resighted tags had been reported to the United States Fish and Wildlife Service Horseshoe Crab Tag Recovery Center. This constitutes a resight rate of 3.45%. Fifty-seven percent of the resighted horseshoe crabs were alive at the time of resight. The mean distance between site of release and site of recapture for all resighted horseshoe crabs was 68.33 kilometers. The maximum distance traveled was 493.74 kilometers. The majority of crabs reported were found in the Delaware Bay. The location of resighted horseshoe crabs ranged in latitude from Bristol, Rhode Island (41.7°N) to Corolla, North Carolina (36.4°N). Information from this study, together with genetic analyses of horseshoe crabs along the Atlantic coast, will provide the clearest picture of horseshoe crab stock structure in Atlantic waters, better enabling us to manage the horseshoe crab fishery.

Keywords: horseshoe crab, *Limulus polyphemus*, tagging, stock structure

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## Evaluation of tuning indices in application of ADAPT to stock assessment and its importance in Fisheries Management

Liao\*, H., and Jones, C. M. Center for Quantitative Fisheries Ecology (CQFE), Old Dominion University, Norfolk, VA 23508

ADAPT (ADAPTive framework) is a stock assessment program that has become a standard tool in many marine fisheries around the world. This is partly because ADAPT uses extra information about fish stocks (such as fishery-independent surveys) as indices to calibrate (or tune) estimates generated by VPA (Virtual Population Analysis). Therefore, the qualities of tuning indices play a critical role in estimating fish stock parameters in ADAPT. However, many previous studies using ADAPT have not reported their evaluation of tuning indices explicitly or conducted them thoroughly. Studies that have evaluated tuning indices have emphasized statistical designs only and their effect on index data. In this study, we briefly discuss the importance of evaluating tuning indices in application of ADAPT to stock assessment. We focus our discussions on several different statistical methods used to directly evaluate tuning indices themselves instead of their sampling designs. We further illustrate that well-evaluated tuning indices are essential for fisheries managers to have confidence in parameter estimates in order to make policy decisions. Finally, we recommend that tuning indices should be evaluated statistically before being used in ADAPT and results of the evaluations should be reported explicitly in stock assessment studies.

Keywords: ADAPT Indices Tuning

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## Age Composition and Growth of Red Drum, *Sciaenops ocellatus*, from Offshore Waters of the Northern Gulf of Mexico

McInerney\*, S.A., and Potts, J.C. NOAA, NFMS, Center for Coastal Fisheries and Habitat Research, Beaufort Laboratory, Beaufort, NC.

Abstract - A fishery-independent sample of 1,146 red drum, *Sciaenops ocellatus*, was collected from federal waters of the northern Gulf of Mexico in 2002. Observed lengths ranged from 210 to 1110 mm FL, and whole weights ranged from 0.1 to 16.8 kg. Opaque zones on sectioned otoliths were validated through marginal increment analysis. Age estimates ranged from 0-37 years. Statistical analyses indicated no significant differences in mean lengths at age by sex. A non-linear model was used to describe the relationship between FL in mm and otolith radius (OR) in mm,  $L = 998(1 - e^{-0.57(OR-0.69)})$ . Fork lengths were back-calculated by replacing the otolith radius with the radial measurement to each opaque zone. A double von Bertalanffy model described theoretical growth using back-calculated lengths to the last annulus and a transition age ( $t_x$ ) of

4.2 years;  $L_{inf} = 986$ ,  $k_1 = 0.32$ ,  $k_2 = 0.09$ ,  $t_1 = 0$ , and  $t_2 = -10.74$ . The weight-length relationship was represented by the power equation,  $W = 1.1 \times 10^{-8} (L)^{3.02}$ , where  $W$  = whole weight (kg) and  $L$  = fork length (mm).

Keywords: red drum ageing otoliths von Bertalanffy

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### **"Determining nursery grounds for endemic Hawaiian gobies"**

*Mckee\*, S.L.; Jones, C.M. Old Dominion University, Center for Quantitative Fisheries Ecology. Pasma, J. Whitworth College. Sorensen, P.W. University of Minnesota.*

'O'opu nakea, *Awaous guamensis*, is a member of a group of Hawaiian gobies, in which some members are endemic and threatened. Using *A. guamensis* as a proxy, we established to what extent population mixing among the group occurred, through chemical analysis of fish otoliths (earstones) by laser-ablation ICP-MS. Otoliths record habitat use in their chemistry as a chronology, from birth to capture. We analyzed fish from the estuarine reaches of two streams on the eastern side of Hawaii (Hakalau and Wailoa Rivers) and another on Kauai (Waimea River). Our objectives were to 1) determine if otolith chemistry provides a natural tag of habitat for Hawaiian gobies, and 2) determine the extent of mixing during the juvenile stage using this tag. We found that each estuarine area confers significantly different "signatures" (Mn, Zn, Rb, Sr, Cd, Ba) on the edge of the otolith, thereby indicating that each area has a unique tag. Upon analyzing the otolith-chemistry tag, we found that connectivity within and between island areas was limited, indicating that juveniles used isolated shoreline nursery grounds that potentially restrict gene flow.

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### **Reproduction and ecology of the invasive Indo-Pacific lionfish, *Pterois volitans* in the western Atlantic**

*Morris\*, J.A. and Govoni, J.J. NOAA/National Ocean Service, Beaufort, NC*

With the recent discovery of the Indo-Pacific lionfish in the western Atlantic, questions regarding the rate of population expansion, predicted distribution, and ecological impacts are valid concerns. We are conducting studies to investigate the reproductive biology of lionfish. Reproductive parameters such as length at maturity, fecundity and seasonality of spawning are being determined using spawning and rearing experiments, and by analysis of field collected specimens. Current indications are that lionfish mature early and like other scorpaeniforms produce balls of buoyant eggs. In addition, we are working on rearing experiments to produce lionfish larvae. These experiments will provide improved larval descriptions and information regarding lionfish early life history. As lionfish are venomous, we are conducting laboratory tests to determine potential lionfish predators and prey, and thus assess potential predation effects on local reef fish communities. The results of this research will provide increased knowledge of issues associated with marine finfish invasions and will provide further methodology to assess the impacts of future invasions. NOTE: THIS PRESENTATION TO BE PRESENTED DURING THE TIDEWATER CHAPTER SYMPOSIUM

Keywords: lionfish fish reproduction

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### **Angler Reporting Rates of Tagged Common Snook in Southeast Florida- Does monetary reward matter?**

*Pine\*, W. E., Mote Marine Lab; R. G. Taylor, and J. A. Whittington Florida Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission*

We determined that recreational angler tag returns for Common snook *Centropomus undecimalis* were unaffected by a reward tagging program along the Atlantic coast of Florida. To estimate non-reporting rates, 989 common snook were tagged with internal-anchor tags that bore one of eight variable-reward messages (from "Reward" with no monetary indication to "Reward \$200") during the summer closed harvest season of 1995. Approximately equal numbers and sizes of animals were tagged in each reward group. The \$200 reward was assumed to be sufficient to elicit a reporting rate of 1.0. Reporting rates during the first year ranged from 9.6% for "Reward \$5" tags to 16.9% for "Reward \$25" tags. Reporting rates did not differ

significantly among the eight categories of reward tags and did not change over the three years of evaluation. Results from this experiment provide insight into using tagging programs to estimate fishing and natural mortality and also provide insight into angler behavior related to the use of high-reward tagging programs to illicit tag returns.

Keywords: exploitation harvest tagging snook

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### **Age Validation of Bluefish *Pomatomus saltatrix* along the East Coast of United States**

*Robillard\*, E.R., Jones, C.M., and Reiss, C. Center for Quantitative Fisheries Ecology (CQFE), Norfolk, VA.*

Bluefish is one of the most valuable commercial and recreational marine fish along the East Coast of the United States. However, total landings of bluefish in the Mid-Atlantic have declined by 75% over the last 15 years. In response to this decline, managers prepared a management plan to regulate bluefish commercial and recreational catches. Yet when creating this plan, the quality of the data became a challenge, particularly estimations of bluefish ages. To correct this deficiency, we designed a new processing technique of otoliths to increase readability of annuli. We created an interpretation protocol of otolith microstructure for better precision. We validated annuli through marginal increment analysis. With known age accuracy and precision, we examined growth parameters for any evidence of compensatory response to decreased abundance. Results suggest no major change in growth rate since the late 1950's. Thus perceived decline in the population size have not resulted in changes in growth rates of this species.

Keywords: bluefish validation age management

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### **Comparisons of Benthic Macrofauna Assemblage Structure and Function on Restored and Unrestored Eastern Oyster (*Crassostrea virginica*) Reefs in Mesohaline Chesapeake Bay,; Implications for Fisheries Management.**

*Rodney\*, W.S., and Paynter, K.T. MEES Program, University of Maryland, College Park, MD.*

The destruction of the Chesapeake Bay oyster reefs has likely had a profound effect on reef macrofaunal communities and on the trophic transfer of energy from the benthos to fish. Unfortunately there is little data on Chesapeake Bay oyster reef fauna prior to the mid 1900s. Maryland's recently created oyster sanctuary reefs provide us with a unique opportunity to observe the composition of macrofaunal assemblages on unharvested reefs with high concentrations of mature oysters and undisturbed reef architecture. They can thus be used to assess the magnitude of losses to reef dwelling macrofauna communities and the associated loss of ecological functions resulting from reef destruction. We sampled reef macrofaunal assemblages on four historic Maryland oyster reefs using benthic settlement trays. At each reef, a restored plot and a paired unrestored plot were sampled. Trays were placed on the sites by SCUBA divers, filled with benthic substrate and left for several weeks. Trays were retrieved by divers and benthic organisms were enumerated and identified. Data was analyzed using 2-way ANOVA. We compared the effects of study site location, and habitat quality on densities of the five numerically dominant taxonomic groups and eight functional groups. Total motile macrofauna density was an order of magnitude higher on restored reefs, epifaunal density was more than twice as high on restored plots and sessile macrofauna density was two orders of magnitude higher on restored plots. Mean density of suspension feeders was 23 times greater on restored plots and resident carnivore density was seven times greater on restored plots. The higher densities of suspension feeders and carnivores on restored reefs are consistent with the hypothesis that the loss of dense populations of suspension feeders has resulted in a trophic bottleneck that prevents energy from phytoplankton production from reaching higher trophic levels. If, as we believe, Maryland's restored oyster reefs are similar to the natural reefs of the past, then the losses to the Bay's benthic macrofauna populations must be enormous. Since reef macrofauna include many important fish prey species, oyster reef restoration has the potential to augment fish production by increasing fish prey densities and fish foraging efficiency.

Keywords: Benthic Macrofauna, Oyster Reef Restoration, Functional Feeding Groups, Trophic Bottleneck

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## **Life history parameters of the Dusky Shark, *Carcharhinus obscurus*, revisited and their implications to estimates of population increase.**

*Romine, J. G. ; Musick, J. A.; Burgess, G. H. (JGR, JAM) Department of Fisheries Science, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 23062, USA; (HGB) Program for Shark Research, Florida Museum of Natural History, University of Florida, Gainesville, FL, 32611, USA*

Numbers of dusky sharks, *Carcharhinus obscurus*, in the Western North Atlantic have drastically declined over the past twenty years. Several fishery-dependent and fishery-independent studies have recorded the decline of this slow growing, late maturing, long-lived species. It is imperative for the survival of this species that we develop accurate demographic and biological parameter estimates to ensure proper management. Data sets from the Virginia Institute of Marine Science (VIMS) fishery-independent shark survey, Commercial Shark Fishery Observer Program (CSFOP) fishery-dependent shark survey, and previously published data were analyzed to construct better estimates of gestation period, reproductive periodicity, fecundity, offspring size frequencies, and other biological parameters. These estimates were then used in a stochastic stage-based demographic model to estimate intrinsic rate of population increase and elasticities for population stages.

Keywords: Dusky shark demographic fishery

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## **Larvae Age and Size Distribution and Effects on Recruitment Patterns of Atlantic croaker in the Chesapeake Bay**

*Turner, S.B., Jones, C.M. and Reiss, C. Center for Quantitative Fisheries Ecology, Old Dominion University, Norfolk, VA*

Atlantic croaker (*Micropogonias undulatus*) are an estuarine-dependent sciaenid, that spawns in coastal waters offshore in fall and winter in the mid-Atlantic bight (MAB). Larvae must be advected inshore to their nursery grounds in Chesapeake Bay. However, the mechanisms that transport larvae into the Bay remain unclear. To clarify the transport mechanisms, we tested a null hypothesis that larvae entering the Bay could be sourced uniformly from nearshore waters. By sampling offshore in September 2000 and nearshore at the Bay mouth one month later, we determined size and age distributions to match nearshore cohorts with those larvae that were advected into the Bay. Larvae spawned in September were the source of those collected inshore based on size and age. Offshore larvae are distributed uniformly from north to south. In contrast larvae nearshore are not uniformly distributed. Older and larger larvae are found nearshore in the northern portion of the Bay mouth and their age and size match those entering the Bay. It can be argued from these data that there is strong evidence supporting a behavioral component to advection once the larvae encounter the nearshore coastal waters.

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## **Has the recovery of weakfish hit the limits of the mid-Atlantic food web?**

*Uphoff\*, J. H., Maryland Fisheries Service*

Management of weakfish focused on alleviating overfishing during the 1980s and early 1990s; this focus has continued into the early 21st century. Estimated fishing mortality has been near or below target for an extended period. Weakfish yields improved slightly and then declined to an all-time low by 2003; this trend was inconsistent with a recovering population. Weakfish are specialist piscivores that make an early switch to fish prey; this strategy implies high densities of suitable prey. Weakfish along the mid-Atlantic have exhibited decreased growth, large drops in weight-at-age, substantially decreased population length quality, diet restriction, and a possible decrease in abundance. Coincidentally, regional (NC-NJ) indices of three important forage species (Atlantic menhaden, spot, and bay anchovy) have dropped to low levels. Abundance of striped bass, a major competitor has increased greatly at the same time. Regressions of striped bass biomass and juvenile menhaden abundance against weakfish length quality indicated a significant positive influence of forage and negative influence of striped bass. Since 1994, when age 2+ striped bass biomass reached 70,000 mt, increases in coastal striped bass have been offset by reduced weakfish biomass. These changes have maintained a combined asymptotic biomass of these piscivores of about 120,000 mt.

Keywords: Weakfish, striped bass, food-web dynamics

## Comparison of age estimates using opercula versus otoliths for Tautog (*Tautoga onitis*)

Torres\*, Roxanne C., Robillard, Eric M., Liao, Hongsheng, Jones, Cynthia M. Old Dominion University Oceanography Department Center for Quantitative Fisheries Ecology (CQFE) Norfolk, VA

Historically, opercula bones have been used to age tautog *Tautoga onitis*. This method has become conventional in practice because of the economical and technical advantages it offers. This study compared tautog ageing by opercle estimates from a previously published 1993 study and our current study. Mean total lengths-at-age for fish seven years old and younger are significantly smaller in the previous study than in ours. Additionally, we also directly compared age estimates for 2003 using opercula bones and otoliths and found high agreement between the two methods for all age classes. We demonstrated that the disagreement on ageing tautog between the 1993 study and our 2003 study was due to the difficulty in opercle annuli interpretation and ageing protocols. Using these findings, we discuss the potential influence of ageing errors on estimates of spawning stock biomass and fishing mortality. We recommend that otoliths be used for ageing tautog to provide more accurate ageing data for stock assessment.

Keywords: Tautog *Tautoga onitis* ageing otolith opercula

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## An Analysis of the Effectiveness of Using Sea Turtle Strandings to Develop Fisheries Management Strategies in Pamlico Sound, North Carolina

Bianchi \*, A. J. North Carolina Division of Marine Fisheries

The southern flounder (*Paralichthys lethostigma*) fishery is the most valuable finfish fishery in North Carolina. A large portion of the southern flounder fishery is conducted with large mesh gill nets in Pamlico Sound, North Carolina. Concerns over the growth of this fishery and an increase in the number of sea turtle strandings in 1999 and 2000 have resulted in the development of the Pamlico Sound Gill Net Restricted Area (PSGNRA). Management strategies put into place for the PSGNRA were based on reducing number of sea turtle strandings by reducing the number of incidental sea turtle takes that were occurring in the fishery, including closing a portion of the sound. However, questions have been raised about the federal closure because all strandings are not necessarily due to fisheries interactions and the number of sea turtle strandings in Pamlico Sound is still high. A number of variables were identified that could potentially contribute to sea turtle strandings. A stepwise regression analysis determined that month and dissolved oxygen were the best predictors of sea turtle strandings. The amount of commercial effort was not a significant factor and had an inverse relationship with the number of sea turtle strandings in Pamlico Sound.

Keywords: Southern flounder, North Carolina, Pamlico Sound, sea turtle, interactions, strandings, fisheries management, gill net

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## **Striped Bass Management Symposium**

### **Exploitation and natural mortality of striped bass in the Santee-Cooper system, South Carolina**

*White, M.G., III, and Bulak, J. SC Department of Natural Resources*

In 1997 and 1998, 1,302 striped bass were marked with anchor tags with return rewards of \$10 and \$100 to assess non-reporting. A portion of these fish were double tagged to assess tag loss. Short-term mortality due to tagging was assessed and was negligible. For both years combined, the recapture rate was estimated as 38%, providing an estimate of fishing mortality. In a separate evaluation, a catch curve was generated from experimental gill netting conducted in December-February over the past decade. Total mortality was estimated at 0.65 per year, indicating a natural mortality of 0.27/year, which is considerably higher than the 0.15/year assumed in previous evaluation efforts. If this value is accurate, it would have important management implications.

Keywords: striped bass mortality

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### **Assessment of the 2004 Striped Bass Die-off at Lake Norman, North Carolina**

*Waters\*, C.T. North Carolina Wildlife Resources Commission, Smithfield, NC.*

Summer mortality is a concern for managers of reservoir striped bass fisheries across the southeastern United States. The mortality is typically attributed to the lack of cool, oxygenated water available to striped bass during summer months, commonly referred to as the “habitat squeeze”. However, in the late summer of 2004, the largest reservoir striped bass die-off ever observed in North Carolina occurred at Lake Norman despite the availability of suitable habitat. A total of 2,497 dead striped bass were collected over a 22-day period. This die-off resulted when a group of fish became trapped in the hypolimnion by an anoxic metalimnetic layer. The trapped striped bass were initially in water that had cool temperatures, forage, and sufficient oxygen. Over the following weeks, mortality occurred as hypolimnetic dissolved oxygen levels decreased through normal biological processes. A review of dissolved oxygen data from previous years indicated that similar pockets form annually in Lake Norman, but have not resulted in striped bass mortality. However, circumstantial evidence suggests this may be the mechanism for fish kills in other deep-water reservoirs and begs the question: How often might similar kills occur?

Keywords: striped bass water temperature dissolved oxygen kill

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### **A Summary of Striped Bass Sampling Strategies Used on Southeastern Reservoirs**

*Waters\*, C.T. North Carolina Wildlife Resources Commission, Smithfield, NC.*

For several decades, striped bass have been successfully cultured and stocked into reservoirs across the southeastern United States, and numerous fisheries have been established. More recently these fisheries have gained increasing popularity. Angling effort, catch, and harvest have increased, and anglers have expressed concern, whether real or perceived, about declines of these fisheries. Therefore, the need to conduct annual, systematic assessments of striped bass populations has developed. Numerous studies designed to address reservoir-specific questions are documented in the fisheries literature. However, information on the basic population assessment data collected annually by state agencies is generally less accessible. The collection methods employed range from angler creels and diaries to gill netting and electrofishing. The types of data and subsequent analyses vary as well. The objective of this effort is to summarize the techniques used by state

agencies from across the southeast to collect and analyze data used to make basic management decisions. This initial evaluation should provide a basis for biologists to design standard sampling strategies for reservoir striped bass.

Keywords: striped bass assessment sampling data analysis methods

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### **Hooking Mortality and Physiological Responses of Striped Bass Angled in Freshwater and Held in Live-Release Tubes**

*Bettinger\*, J.M. South Carolina Department of Natural Resources (SCDNR), Eastover, SC. Tomasso, J.R. Clemson University, Clemson, SC. Isely, J.J. USGS, South Carolina Cooperative Fish and Wildlife Research Unit, Clemson University, Clemson, SC.*

Mortality and physiological responses of adult striped bass *Morone saxatilis* angled from Lake Murray, South Carolina, and held in live-release tubes were evaluated during spring and summer 2003. To estimate mortality, external ultrasonic transmitters were attached to 59 striped bass (mean total length [TL] = 585 mm). Striped bass were caught with angling gear, tagged and immediately released or tagged and held in live-release tubes for 2, 4, or 6 hours and then released. No mortality of striped bass was observed during spring. Overall mortality during summer was 83%. Mortality of summer caught striped bass was not related to tube residence time, fish total length, depth of capture, or surface water temperature. To characterize physiological stress we measured plasma cortisol, glucose, lactate and osmolality of 62 striped bass (mean TL = 563 mm) angled and immediately released or angled and held in live-release tubes. Plasma cortisol, glucose, lactate and osmolality were positively related to tube residence time. When the hematological characteristics were considered only in relation to tube residence time, responses characteristic of physiological stress continued for about 150 minutes after which they began to return to normal. Live-release tubes appear to be useful for keeping striped bass alive when they are angled from cool water, but they are not effective when striped bass are angled from warm water. The high summer mortality of striped bass suggests a need for restrictive fishing regulations during the summer for the Lake Murray striped bass fishery.

Keywords: striped bass catch and release physiological telemetry mortality

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### **Special Striped Bass Regulations in Tennessee**

*Negus\*, J.A., and Churchill, T. Tennessee Wildlife Resources Agency (TWRA), Nashville, TN*

Diverse striped bass fisheries and their associated user groups continue to challenge the Tennessee Wildlife Resources Agency (TWRA) to develop effective, and often unique, management strategies. Three unusual harvest restrictions may interest resource managers faced with similarly difficult situations. An elaborate oxygen diffusion system recently installed in Cherokee Reservoir to improve tailwater conditions created an expansive summer refuge for striped bass within the forebay. Tremendous exploitation and post-release mortality ensued, prompting the TWRA to establish a sizeable no-fishing zone from July 15 to September 15. The closed area conserves the striped bass stock from overexploitation and ensures adequate stock survival. Norris Reservoir has a relatively low density of striped bass and a history of producing quality fish. A recent die-off of large fish and reduction in stocking rates has led to a more conservative regulation of the fishery. Anglers are allowed two fish per day with a minimum length limit (MLL) of 15-inches from April through October, and one fish per day with an MLL of 36-inches from November through March. Releasing large fish in colder months should allow for increased survival and recruitment into the trophy size group. Melton Hill and Cordell Hull Reservoirs have limited striped bass fisheries, but excellent habitat and abundant forage. Both lakes have given up recent state record fish including the current 65 lb. 6 oz. state record from Cordell Hull. A 32 to 42-inch slot with only one over 42-inches was implemented. The regulation allows continued harvest below the slot, but maintains the trophy quality of these fisheries.

Keywords: Tennessee Striped Bass Special Regulations Negus Churchill TWRA

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## **Striped bass in Texas: a genetics overview**

*Lutz-Carrillo\*, D.J., and Fries, L.T. Texas Parks and Wildlife Department (TPWD), San Marcos, TX*

Since 1965, the Texas Parks and Wildlife Department (TPWD) has stocked 54 water bodies with more than 145 million striped bass. Today, striped bass is among the most popular sport fish of licensed anglers in Texas. Although successful striped bass fisheries have been established in many Texas reservoirs, few experience natural reproduction and thus rely heavily on hatchery-produced fish. Beginning in 1985, TPWD biologists became concerned about several aspects of these fisheries. These concerns included genetic purity of the brood stock and the potential for inbreeding and subsequent depression of striped bass populations. This presentation will describe the brood fish genetic certification process used at TPWD fish hatcheries to assure the genetic integrity of propagated striped bass. Results from two investigations indicating that striped bass in Texas are not inbred also will be presented.

Keywords: Striped bass genetic inbreeding TPWD hatchery

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## **Resolving Angler Conflicts in Striped Bass Management**

*Churchill\*, T. Tennessee Wildlife Resources Agency, Nashville, TN. Wilson, D. Virginia Department of Game and Inland Fisheries, Forest, VA. Waters, C. North Carolina Wildlife Resources Commission, Smithfield, NC*

Abstract - Striped bass managers have had several recent challenges on the human dimensions front. Three southeastern reservoirs: Norris Lake, Tennessee; Lake Norman, North Carolina; and Smith Mountain Lake, Virginia have been the backdrops for controversies regarding state management of striped bass resources and conflicts between angler groups wanting different things from their respective sport fisheries. The Norris Lake controversy has simmered for decades and was driven by a perception that the state's striped bass stocking program was limiting native sport fisheries through predation and competition. A strong local contingent against striped bass stocking at Norris Lake forced the state to change its policies toward striped bass management in the lake. More recently, controversies at Lake Norman and Smith Mountain Lake arose when striped bass anglers perceived declines in their fisheries. Stripper clubs levied substantial pressure on the states of North Carolina and Virginia to increase stocking rates and/or harvest restrictions despite warnings from biologists about potential for depletion of each lake's forage base. Both states increased their stocking rates in response to these demands and the long-term effects on the striped bass populations are being monitored. Lessons learned from these conflicts should provide angler groups and striped bass managers a template on how to find common ground for providing the best outcomes in multi-species, multi-use fisheries.

Keywords: Striped bass management, angler conflicts, human dimensions

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## **Message Boards, Websites, and Email: The Future of Reservoir Striped Bass Management**

*Dorsey\*, L.G., and Waters, C.T. North Carolina Wildlife Resources Commission, Raleigh, NC*

The organization of fishing clubs began in the late 1960's with the formation of the Bass Anglers Sportsman Society (B.A.S.S.). Since that time, other national organizations have emerged that focused on additional species. These organizations and their affiliated local chapters have used magazines, newsletters, and meetings to disseminate information and to discuss conservation issues. Recently, the preferred medium of communication has shifted towards the use of websites, message boards, and email to communicate at a much faster rate than previous methods. This is particularly true of reservoir striped bass fishing clubs in the Southeast who have become adept at using this modern communication technique to spread information and to comment on fishery management programs and actions by state agencies. State fisheries agencies have also begun to use this medium increasingly to promote programs, issue news releases, and provide data (both qualitative and quantitative) to these groups. The use of the internet and the dissemination of information via this medium will only increase.

Fisheries biologists should consider how this trend can be used to garner information from their constituents and how they can use it to more effectively communicate with not only angling groups but also with the angling population as a whole.

Keywords: striped bass internet

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### **Oklahoma Lake Texoma Striped Bass Sampling Program**

*Boxrucker, Jeff C. Oklahoma Department of Wildlife Conservation*

Lake Texoma has arguably the nations most prolific striped bass *Morone saxatilis* fishery with an estimated annual economic value of \$30 million. The economic and social value of this fishery warrants an intensified sampling program to monitor population structure on an annual basis. Striped bass recruitment has been verified in both major tributaries of the reservoir. Drift nets were used from 2001-2004 to establish spawning locations on both tributaries and evaluate relative egg production between tributaries. Annual egg catches in the Washita River were consistently higher than the respective catches in the Red River although differences as great as 300% could not be detected statistically. Seine collections of juvenile striped bass have been ongoing since the late 1970s. However, the seine sampling program was intensified beginning in 2000. Given the catch rates and standard errors generally encountered in our seine sampling, a 50% change in mean catch can be detected with 80 hauls with a 12.3-m seine. Annual fall gill-net samples were collected beginning in 1978. Gill-net sampling was modified in 1993 to partner with Texas Parks and Wildlife. Mesh complement was changed to 6-7.6 m panels ranging from 25-75 mm mesh with sampling being conducted in February. Thirty net-nights of effort is sufficient to detect a 50% change in mean catch.

Keywords: striped bass sampling

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### **Volunteer Assistance in Striped Bass Management**

*Wilson\*, D.M., Virginia Department of Game & Inland Fisheries*

Abstract - Management of striped bass (*Morone saxatilis*) can be a difficult proposition for many biologists. The lack of manpower and resources for management agencies often limits a biologist's ability to gather needed information. Volunteers can provide valuable resources for biologists to better manage striped bass populations. Volunteers (primarily from the Smith Mountain Striper Club) at Smith Mountain Lake, Virginia have provided valuable assistance to the Virginia Department of Game and Inland Fisheries in a variety of ways. Volunteers have contributed by maintaining an angler diary program, assisting with gill netting, tagging fish and maintaining the reward program for tagged fish, collecting fish for various projects, assisting with stocking programs, providing creel survey clerks, distribution of information, and by providing needed angler perspectives. Volunteer assistance has been a vital tool in the management of the Smith Mountain Lake striped bass fishery.

Keywords: Volunteer Striped Bass

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### **Striped Bass Parasites, Are They Killing Striped Bass Or Just Biologists?**

*Wilson\*, D.M., Virginia Department of Game & Inland Fisheries*

Abstract\*: In the fall of 2002 a parasitic copepod identified in the genus *Achtheres*, started showing up in the oral cavities of striped bass (*Morone saxatilis*) at Smith Mountain Lake, Virginia. During the following spring, a substantial striped bass kill at Smith Mountain Lake occurred. *Achtheres* species have been reported to parasitize a wide assortment of warmwater fish in a variety of habitats. *Achtheres* infection of striped bass was first documented in 2000 in several Tennessee reservoirs. Literature reviews have not provided any reports of major *Achtheres* fish kills in wild populations. Current information

indicates that fish mortality is not a direct result of the parasite, but secondary infections (bacterial or viral) may be the cause of fish mortality. Fall gill net data collected in 2003-2004 indicates the numbers of young fish (up to three years of age) have not been significantly affected. It is the larger fish, especially fish over 15 pounds, which appear to have been the most seriously affected. Data from the Virginia Department of Game & Inland Fisheries citation program, angler diaries, and fish tag returns show drastic declines of larger striped bass. In contrast, numerous other reservoirs that have the same parasitic infestation have not noticed any fish kills with the exception of Norris Reservoir. Since these parasites have not exhibited characteristics reported in the scientific literature, it is difficult to predict with any certainty what the future holds. Other species at Smith Mountain Lake do not appear to have been detrimentally affected from the parasites.

Keywords: Striped Bass Parasites Copepods

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### **A Century in 15 minutes: History of striped bass fisheries and management in Maryland tidewaters.**

*Zlokovitz\*, E.R., and Tarnowski, M.L. Maryland Department of Natural Resources (MD DNR)-Fisheries Service, Tawes State Office Building, B-2, 580 Taylor Ave., Annapolis, MD 21401. D.H. Secor, University of Maryland, Chesapeake Biological Laboratory, P.O. Box 38/ One Williams St. Solomons, MD 20688.*

In Maryland tidewaters, important commercial striped bass fisheries did not emerge until the 1930s, when they overtook shad and herring fisheries in economic importance. Rudimentary conservation measures at this time included minimum and maximum size restrictions. After WWII, a fundamental shift from pound nets and haul seines to less expensive and more easily handled nylon gillnets contributed to expansion of the fishery. During the post-war economic boom, recreational fisheries exploded in popularity. Commercial harvests also showed an increasing trend, peaking at 2,453,000 kg in 1961. Management was based upon supporting yields of immature striped bass, the so-called “pan-rock” fishery. During the 1970s, intense commercial and recreational fishing pressure on immature striped bass, along with a series of mediocre strength year-classes led to stock collapse and a fishing moratorium in MD in 1985. In part due to this moratorium, stocks rebounded dramatically in the 1990s. Since 1990, landings have been tightly regulated. Increased reliance on demographic monitoring and stock assessments now safeguards against future collapse of the Chesapeake Bay stock. Current and future issues in managing striped bass include multi-species interactions, forage availability, disease, water quality, and the status of fisheries in federal offshore waters.

Keywords: History striped bass management striped bass fisheries

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### **Strategies for Managing Striped Bass and Palmetto Bass Fingerling Rearing Ponds in Golden Algae Impacted Waters.**

*Kurten, Gerald L., Texas Parks and Wildlife Department (TPWD), Athens, TX*

Texas Parks and Wildlife Department’s two striped bass (*Morone saxatilis*) and palmetto bass (*M. saxatilis* X *M. chrysops*) production fish hatcheries have battled golden algae in rearing ponds since a complete loss of fingerling production in 2001. Hatchery staff have developed and refined strategies for managing nearly every critical stage of fingerling production including pond filling, egg incubation, fry stocking, pond management, pond harvest, and fingerling delivery. The most effective strategy to date has been the application of ammonium sulfate to reduce algae densities; however, ammonium sulfate is not effective for all stages of production and can also have negative impacts on fish production if not used judiciously. Current strategies, refinements, future research needs, and past experiences will be outlined.

Keywords: striped bass palmetto bass golden algae

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## **Assessing the interacting effects of population size, forage availability and summer habitat conditions on growth of reservoir striped bass**

*Thompson\*, J.S., Davias, L.A., and Rice, J.A. North Carolina State University, Raleigh, NC*

The relative role of environmental conditions and forage availability in determining the growth and condition of striped bass in southern reservoirs remains an issue of importance in the understanding and successful management of these populations. In previous bioenergetics modeling analyses of individual striped bass growth in two NC reservoirs, we evaluated the relative effects of food consumption and warm summer temperatures on growth and concluded that high forage availability may allow for relatively high growth even in systems with severe summer stratification events. However, this conclusion is clearly dependent on the relationship between forage availability and food consumption by the entire population. To address this issue we extend our analysis of individual striped bass consumption to the population level in Badin Lake, NC, a productive system with relatively high striped bass growth, high forage availability, and poor summer conditions. We then compare population-level consumption to lake-wide hydroacoustic estimates of forage biomass in several seasons during 2000 through 2002. This approach considers the combined effects of forage fish dynamics, habitat conditions and predator density on striped bass growth and may offer managers a way to tailor stocking rates and management strategies according to individual reservoir forage and habitat characteristics.

Keywords: striped bass reservoir bioenergetics growth stocking

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## **Evaluating the relative effects of temperature, dissolved oxygen, and forage on growth of striped bass: and application of bioenergetics modeling in four North Carolina reservoirs.**

*Davias\*, L.D., Rice, J.A., and Thompson, J.S. North Carolina State University, Raleigh, NC*

The relatively poor growth of stocked striped bass (*Morone saxatilis*) in some southern reservoirs has often been attributed to the habitat 'squeeze' of high summer temperatures and low dissolved oxygen (DO). However, a recent study found that a North Carolina reservoir with poor summer water quality but good forage actually supported faster growth of striped bass than a reservoir with better temperature and DO conditions but less forage. We are using bioenergetic modeling to investigate this hypothesis for four reservoirs across NC. We profiled temperature and DO weekly at fixed locations down the main channel of each reservoir from May to October, 2004. Habitat differed greatly between reservoirs in the growing season of 2004; not all reservoirs exhibited a strong temperature/DO squeeze. We made assumptions about fish temperature selection using results from a previous telemetry study. Additionally, we collected age, growth, and energy density information with a fall gillnet sample. We used bioenergetics modeling to estimate relative importance on striped bass growth of food in light of the severity of the temperature/DO squeeze. By making these comparisons among reservoirs we can better assess the capabilities of NC reservoirs for striped bass growth, and guide future stocking and management decisions.

Keywords: Striped bass, bioenergetics, habitat, management, stocking, growth

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## **Modeling The Spread of a Parasitic Copepod (*Achtheres*) in a Striped Bass Population**

*Douglas Thomasey, Kevin Peterson and Thomas Shahady Lynchburg College, Lynchburg Virginia.*

In recent years, Smith Mountain Lake and other large reservoirs in Virginia, Tennessee and North Carolina have experienced outbreaks of the copepod parasite (*Achtheres*). While not directly deleterious to these fish high infestation rates are believed to tax fish populations indirectly leading to fish kills during periods of environmental stress. To study the impact of this parasite throughout a bass population and to understand the potential spread and threat we created a partial differential equation model to manipulate conditions to understand the problem. The model manipulates stocking rates, interaction rates among bass and mortality rates of bass to generate our conclusions. We found one fish introduced into a reservoir typically led to complete infection of the bass population within 18 months regardless of the size of the population of striped bass. How closely the fish interacted was very important to the spread. Since *Morone saxatilis* are considered a "schooling" fish, the interaction between these fish is much greater and the parasite spreads much faster. On the other hand, with fish having a

low interaction rate such as the black bass, the parasite does not spread as fast. Changes in mortality rates did not change output of our model. Continuing work is necessary to understand the impact this parasite will have on stocked striped bass populations throughout the southeast.

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### **Striped Bass Tournaments, Can they be effectively used for Data Collection?**

Turner\*, Warren E. National Striped Bass Association (NSBA), Greer, SC

Abstract: Abstract - The National Striped Bass Association, Inc. (NSBA) conducts a freshwater striped bass (*Morone saxatilis*) tournament trail of over 70-tournaments spread out across the Eastern and Southern United States. Currently, some areas use Fisheries Citation Programs, Angler Diaries, and Fish Tagging Programs to collect data, as well as the telemetry, shocking, and gill net programs all of which are managed by the local fishery biologist. However, just like the desires and tools used by fishermen can vary from area to area, the methods and actual data collected by various biologists can also vary greatly from area to area. Things change! With the NSBA tournament program crossing state and regional boundaries, comes fishermen and their tricks of the trade crossing those same boundaries. Also new to the striped bass environment was the NSBA tournament live weigh in and release Championship tournaments and the growth of others wanting to use the Striper Tube to bring live fish to the weigh in. This change in attitude of bringing in live striped bass along with the traditional catch for table fare of striped bass provides a great opportunity to collect and compare data from across the entire striped bass freshwater fishery. Live striped bass weighed in on certified scales and released with tags can provide tremendous growth data.

Keywords: Striped Bass data collection tournaments

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# Poster Presentations

## Contributed Posters

### **Movement and habitat use of smallmouth bass in the Buffalo National River drainage of Arkansas**

*Bare\*, C.M., and Magoulick, D.D. Arkansas Cooperative Fish and Wildlife Research Unit, Fayetteville, AR*

Bear Creek, a major tributary to the Buffalo National River, Arkansas, is being considered for impoundment. We used radiotelemetry to examine smallmouth bass migration and habitat use in the Buffalo River and Bear Creek to determine whether damming and subsequent alterations in flow regime would affect the population. A total of thirty bass were radio-tagged in both streams and tracked over 1 year. Smallmouth bass moved between the two streams throughout the year. Individuals tagged in Bear Creek moved downstream to the Buffalo River during higher flows in autumn and wintered in the Buffalo River or remained in home pools throughout the year. Smallmouth bass tagged in the Buffalo River migrated upstream or into Bear Creek during higher flows in April and May, suggesting the tributary contains suitable spawning habitat. In both streams, fish movement was limited in summer due to drying events resulting in reduced flows and pool isolation. Smallmouth bass were negatively associated with current velocity and positively associated with water depth and cover in the form of boulders, woody debris, undercut banks, and aquatic vegetation. Altering the natural flow regime by damming part of Bear Creek may adversely affect current smallmouth bass migration habits in this system.

Keywords: radiotelemetry smallmouth bass migration

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### **Feeding Habits and Dietary Overlap of Juvenile Fishes in the vicinity of Gray's Reef National Marine Sanctuary, Georgia, USA**

*Jenkins, J.A., East Carolina University, Dept. of Biology, Greenville, NC. Hare, J.A., NOAA Beaufort Laboratory, Beaufort, NC*

The use of resources by fish has a major influence on both population and community interactions and dynamics. The feeding ecology of juvenile fishes on the continental shelf off the coast of Georgia, USA, including Gray's Reef National Marine Sanctuary (GRNMS), was analyzed. Sampling was conducted at thirty-two stations and fish were collected using a 2 m beam trawl, fished on the bottom for 5 minutes. The diet of four juvenile fish species from the families Serranidae and Sparidae were analyzed. Fish were separated into three size classes, weighed, measured and diets quantified by determining frequency of occurrence, abundance, and volume of prey items. Ontogenetic comparisons were conducted to determine if there are shifts in food preference with age. Dietary overlap was also analyzed. Behavioral and morphological differences contributed to differences found between size classes and between the four species. The results of this study will aid in the understanding of juvenile habitat utilization in GRNMS and the surrounding continental shelf off Georgia, USA.

Keywords:

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### **Age validation of the red porgy, *Pagrus pagrus***

*Neil McNeill<sup>1</sup>, James A. Morris, Jr.<sup>2</sup>, and Erik Williams<sup>1</sup>*

<sup>1</sup>National Marine Fisheries Service, NOAA 101 Pivers Island Rd., Beaufort, NC 28516

<sup>2</sup>National Ocean Service, NOAA 101 Pivers Island Rd., Beaufort, NC 28516

Recent efforts to assess the population of red porgy, *Pagrus pagrus*, in the western Atlantic have demonstrated the need for increasing accuracy of age determination using traditional otolith aging techniques. Efforts are underway to rear red porgy in the laboratory for the purpose of producing otoliths of known age to refine current aging techniques. We are using rearing practices that simulate off shore conditions in order to produce otoliths that are characteristic of this reef fish. Recirculating seawater systems with precise temperature, salinity, and photoperiod control provides rearing conditions similar to those in

which red porgy are found. Current indications are that red porgy broodstock appear to be highly susceptible to parasitic infections such as *Cryptocaryon irritans* (marine ich) and the common gill fluke. Efforts to rear red porgy larvae have yielded low numbers during the first year and modifications to our larviculture rearing systems should result in higher survivorship during year two. This research supports efforts to improve ageing techniques and provide insights into rearing practices for marine fishes common to the reef habitats of the western Atlantic.

Keywords: age validation red porgy

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### **Predicting the effects of dam removal on aquatic communities in the Salmon River, New York. Phase 1, Baseline data**

*Cooper\*, John E., Farrell, John M., and Toner, Jason A. State University of New York*

Dam removal has been used as a means of river restoration but few dam removal programs have included collecting comprehensive baseline data to evaluate the effects of removing the dam. Phase 1 of this study collected baseline data on sediment, macroinvertebrates, fish, and aquatic plants in order to be able to predict what the effects may be of removing the Fort Covington Dam. Sand comprised the highest mean weight of any sediment fraction, ranging from 58 to 98%. Embeddedness ranged from 20 to 40% in riffles. Deposition of sediment behind the dam was minimal, about 5% of the annual sediment production in the watershed. Five macroinvertebrate biotic indices were constructed from 88 families. The impact from the dam was greatest in the run areas and minimal in the riffles. The combined score from the indices indicated a slight impact. A fish index of biotic integrity was constructed from 40 fish species. The combined scores was high indicating a low impact from the dam. Five fish species will be able to migrate upriver after the dam is removed (longnose gar, American eel, carp, smallmouth bass, walleye). The abundance and distribution of aquatic plants has not changed substantially since the 1930s but abundance is estimated to increase after the dam is removed. Predation upriver of the dam will increase and carp activities may disrupt forage fish spawning success and cause some indirect damage to aquatic plants. Increased flow velocity in the former reservoir will allow the macroinvertebrate and fish assemblage to change from lentic to lotic species.

Keywords: dam removal restoration eastern sand darter

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### **Sampling zooplankton and benthic prey of juvenile striped bass, *Morone saxatilis*: utilizing multiple net types to characterize prey selectivity**

*Muffelman\*, S.C., and Austin, H.M. Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, VA*

Juvenile striped bass, *Morone saxatilis*, have been characterized as generalist feeders by researchers in and outside the Chesapeake Bay. Few feeding studies, however, have included simultaneous prey sampling along with the fish collections. From June through August 2003 young-of-the-year striped bass were collected by beach seine in the freshwater zone of the Rappahannock River. Concurrently, zooplankton samples were taken in order to characterize any prey selectivity. In an attempt to sample the entire prey field, two types of plankton collections were made in the nearshore zone. Experimentally designed neuston and epi-benthic plankton nets were hand-towed parallel to shore. Methodological problems included relatively low volumes of water filtered per plankton sample, however, there was good replication of taxon counts in repeated tows. Also, preliminary data show that larger prey including polychaetes, amphipods and fly larvae were rare in plankton collections though frequent in fish stomachs, suggesting either a preference for these prey or a bias in the sampling gear.

Keywords: striped bass plankton zooplankton prey selectivity

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## **Effects of Acclimation Time and Season on Post-Stocking Mortality of Red Drum in Fresh Water**

*Baird\*, M. S. Texas Parks and Wildlife Department, Waco, TX*

The effects of acclimation time and season on post-stocking mortality of red drum in two Texas power plant reservoirs were evaluated using current Texas Parks and Wildlife Department (TPWD) rearing and hauling procedures. Red drum fingerlings were hauled to two reservoirs (Calaveras and Tradinghouse) during summer and fall, acclimated at two different time periods, moved to in-reservoir enclosures and counted daily for 72 h. Only 960 of 9,600 fingerlings survived the 72-h experiment. Reservoir and season had significant effects on survival as indicated by their main effects ( $P = 0.0016$  and  $0.0003$ ) and two-way interaction ( $P = 0.0145$ ). Calaveras stockings were generally more successful than Tradinghouse stockings and fall stockings had consistently better survival than summer stockings. Acclimation time was marginally significant ( $P = 0.0599$ ), with fingerlings acclimated for 5 h typically having higher survival than those acclimated for 2.5 h regardless of reservoir or season. Results show red drum post-stocking survival would benefit from fall stockings and by acclimating fingerlings for at least 5 h prior to release.

Keywords: red drum post-stocking mortality acclimation time stocking season

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## **Bayesian estimates of Floy t-bar tag retention by smallmouth and largemouth bass**

*Dauwalter\*, D.C., and Fisher, W.L. Oklahoma Cooperative Fish and Wildlife Research Unit, Department of Zoology, Oklahoma State University. U.S. Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit, Department of Zoology, Oklahoma State University*

Estimates of tag retention by fishes are needed to compute unbiased estimates of population characteristics such as population size and survival. We used Bayes' Theorem and incorporated information from previous studies to calculate probability distributions of Floy t-bar tag retention by smallmouth bass in Baron Fork Creek, Oklahoma, and by largemouth bass in ponds and small impoundments. For double-tagged smallmouth bass that were recaptured in Baron Fork Creek, 3 of 3 (1.00) and 11 of 13 fish (0.85) retained both tags after 1.5 and 3.0 months, respectively. Modal posterior probabilities for 1.5 and 3.0 month tag retention were 0.79 and 0.61, and ranges of 95% credible sets were 0.29 and 0.25, respectively. Reported tag retention rates for largemouth bass ranged from 0.82 to 0.92. Modal posterior probability estimates ranged from 0.85 to 0.88, and the uncertainty (i.e., credible set ranges) in tag retention was reduced by one half from the initial estimate in which no prior information was incorporated to the final estimate in which all prior information was used. In addition to reducing tag retention uncertainty, application of Bayesian methods improved tag retention estimates particularly when small numbers of double tagged fish were recaptured.

Keywords: Probability Binomial Bayes uncertainty mark-recapture

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## **EZ Bass: Intercept telemetry of Hudson River striped bass**

*Schroepfer\*, R.L., and Secor, D.H. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD*

Hudson River striped bass show highly variable migration patterns, as seen through tagging studies and otolith microchemical analyses. Recent studies have shown resident, estuarine, and ocean migratory contingents of Hudson River striped bass. In this study, migration patterns of the resident contingent of striped bass were examined using ultrasonic telemetry. Twelve fish were tagged with internal transmitters in the upper Hudson River (river km 180-248) in September 2004. Remote, underwater receivers were placed at river km 248 (Green Island Bridge), 180 (near Rip Van Winkle Bridge), and 75 (Bear Mountain Bridge) to intercept tagged fish. The freshwater tidal extent of the Hudson River (km 75-248) was also surveyed for tagged fish in November 2004. Preliminary results showed a directed migration down-river by most fish (10 of 12) in mid-October and November. Additionally, two "wanderers" repeatedly migrated up and down most of the freshwater tidal Hudson River during this period. Remote receivers will operate through October 2005, and three additional

surveys of the Hudson River will be completed in the coming year. The remote, datalogging receivers will enable us to detect movements downriver to overwintering habitats as well as movements upriver in the spring for spawning and feeding.

Keywords: striped bass, ultrasonic telemetry, migration

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### **Amplification of Microsatellite DNA from Archived Otoliths: a Technique for Hatchery Management**

*Robbins\*, S.R.*

In 1996, the South Carolina Department of Natural Resources (SCDNR) initiated a hatchery program for the stock enhancement of red drum, *Sciaenops ocellatus*. To track hatchery fish, fingerlings were bathed in oxytetracycline (OTC) to mark the otoliths. In order to determine the success of the program, otoliths and life history data have been collected for a series of years. The otoliths were extracted from captured fish, dried and stored in paper envelopes. As a result, the SCDNR has an extensive collection of otoliths, allowing an historical look at the South Carolina red drum population. Currently, the SCDNR is using genetic techniques for stock assessment, analysis of population structure, and to ascertain the contribution of hatchery fish to wild stocks. This study addresses the use of the archived otoliths to answer these questions. Genomic DNA was isolated from 114 otoliths and 32 fin clips taken from a subset of the same fish. The OTC mark was still readable following DNA isolation. The isolated DNA was amplified at eight microsatellite loci. We show that the archived otoliths are suitable for microsatellite DNA amplification and that the collection and storage methods resulted in uncontaminated otoliths, as indicated by comparisons with the fin clips.

Keywords: red drum, hatchery management, genetic analysis

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### **An Evaluation of the Rules Governing Stream Trout Movement**

*Hyatt, M., and Gowan, C. Randolph-Macon College, Ashland, Virginia*

Stream salmonids feed by positioning themselves in the current, capturing prey as it drifts past their focal point. The quality of focal points changes over time due to variation in stream flow, temperature, and prey abundance, but at any instant trout appear to be optimally distributed throughout the stream segment. This indicates that stream trout make ongoing decisions about where to forage and must periodically move to find better locations. Brook trout (*Salvelinus fontinalis*) were observed in Lick Run, Virginia to determine rules governing movement within a stream. By controlling food delivery into three study pools, I was able to alter the normal behavior of trout. When food delivery rates were high, fish foraged away from cover and made frequent forays, which was not the case when prey was not delivered. Food delivery rates also influenced movement among pools. When prey was not delivered, larger fish moved upstream in the evening, presumably searching for food. However, when food was delivered to downstream pools during the afternoon and evening, these same individuals did not move upstream. Understanding movement rules will lead to a better knowledge of the mechanisms controlling population abundance, species composition, community structure, and community stability among years.

Keywords: trout movement brook trout

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### **Growth rate and mortality of golden perch *Macquaria ambigua* in two Australian freshwater impoundments**

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We studied growth and mortality of golden perch in two Australian freshwater impoundments using data from a cooperative angler-tagging program. The growth of golden perch was modeled using the computer program GROTAG. Annual growth varied between the impoundments, ranging from 5.90 to 7.24 cm per year among fish 25-cm total length (TL) and 0.25 to

1.57 per year among fish 45-cm TL. Annual mortality of golden perch was estimated from decreases in recapture rates over time and ranged from 5.6% in Lake Somerset to 5.9% in Lake Boondooma.

Keywords: Growth mortality Macquaria Australia

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### **Identification and quantification of quality habitat for the yellowcheek darter, *Etheostoma moorei***

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The yellowcheek darter, *Etheostoma moorei* (Raney and Suttkus), is endemic to the Little Red River, Arkansas. Much of its habitat was flooded by the formation of Greers Ferry Lake in 1962, forcing the species into four isolated tributaries of the river. Populations decrease significantly in size during drought years. Thus, creation of additional dry season habitat could benefit the species. To determine quality dry season habitat, eight riffles were systematically sampled at various water levels throughout the summer and fall of 2004. At each site we classified depth, velocity, substrate size, and percent cover available to the darters and related these to darter abundance. Watershed-level characteristics were evaluated to determine the widespread conditions that create suitable microhabitat variables. This data will also be associated with local reach-level conditions that result in quality dry season habitat. The results will be used to generate recommendations for construction of additional dry season habitat.

Keywords: yellowcheek, darter, *Etheostoma moorei*, habitat

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### **Characterizing movement of young-of-year American shad within the nursery habitat using stable isotopes**

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The objective of our study was to estimate the time spent in various nursery habitats by young-of-year American shad (*Alosa sapidissima*) using stable isotopes ( $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$ ). The stable isotopic signature of an organism is obtained from its diet; the rate at which an organism will arrive at equilibrium with its diet is a function of growth and metabolism. We characterized the change in the stable isotope signature of muscle tissue throughout the early life history of York River, Virginia American shad. Juveniles in the tidal freshwater habitat had habitat-specific  $\delta^{13}\text{C}$  signatures. This indicated that juveniles were residing in specific habitats within the nursery zone. To estimate the rate of movement of juvenile American shad between habitats, we developed an isotopic turnover model that was applied to individual fish. The model results indicated that juvenile American shad must reside in these different zones for at least 6-8 weeks to account for the observed isotopic patterns. We conclude that this approach can provide evidence for habitat utilization at scales of 5-10 river kilometers, particularly for diadromous fishes that move across large gradients in stable isotope distribution.

Keywords: American shad movement stable isotopes

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### **A GIS-based Characterization of Commercial Sponge Populations in the Florida Keys, Florida (USA)**

*Torres\*, Roxanne C., Butler, Mark J., Shellito, Brad Old Dominion University Department of Biological Sciences*

Nearshore hard-bottom communities constitute ~ 30% of the coastal zone of the Florida Keys, Florida (USA). Sponges are characteristic of these communities and several large sponges are commercially fished, representing approximately 1% of the total invertebrate harvest in 1999. *Hippospongia lachne* (sheepswool sponge), *Spongia barbara* (yellow sponge), and *Spongia graminea* (glove sponge) dominate the commercial sponge harvest in south Florida and were the focus of this study. Our goal was to determine the spatial structure of these communities with particular emphasis on the region distribution of commercial sponge species in the Florida Keys. A GIS model was produced representing the spatial distributions and abundances of *H. lachne*, *S. barbara* and *S. graminea*. For each site, distance to land, water depth, and bottom type

classification were used to determine the influence of these variables on the distribution, abundance, and co-occurrence of the three sponge species. A kriging interpolation was used as a predictor of abundances in adjacent areas. This information, along with other data collected on hard-bottom community structure, sponge growth, and sponge fishery impacts, will be used to assess the efficacy of current management policy in maintaining a sustainable fishery and healthy sponge communities in the Florida Keys.

Keywords: GIS Sheepswool *Hippospongia lachne* Yellow *Spongia barbara* Glove *Spongia graminea* Sponge Florida Keys

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### **Habitat use and growth of age-0 juvenile red drum (*Sciaenops ocellatus*) in southeastern North Carolina**

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Recruitment success of marine fishes is believed to be directly linked to growth and survival during early life stages. Since newly settled fishes suffer high mortality rates that are typically size dependent, habitats that promote high rates of growth are critical to enable individuals to reach large body sizes rapidly. We examined the growth rates and distribution of age-0 juvenile red drum in southeastern North Carolina. Specifically, variation in growth was evaluated across spatial and temporal scales throughout the fall recruitment period as well as post-winter. Preliminary data shows densities in these systems range from 0-0.24 ind/m<sup>2</sup>, with fall growth rates of wild-caught fish between 0.30-0.40 mm/d<sup>-1</sup>. Growth rates in 2003 appeared to be slightly higher than observed in 2004. A field caging study conducted at multiple sites throughout the post-settlement period yielded similar growth rates (0-0.69 mm/d<sup>-1</sup> and 0-0.037 g/d<sup>-1</sup>). Caging data demonstrated a positive linear relationship between water temperature and growth represented by the equation  $G = 0.0043T - 0.079$ , where G is growth in grams/day and T is average daily water temperature (°C). A high level of variability in growth was observed among individuals and habitats, indicating that timing of estuarine arrival and initial settlement habitat may have a strong influence on early juvenile survival and year-class success.

Keywords: red drum estuarine growth habitat

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### **Bioenergetics assessment of trout growth under alternative flow regimes in the Smith River, Virginia**

*Anderson\*, M. R., and D. J. Orth, Department of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg, VA T. J. Newcomb, Michigan Department of Natural Resources, Lansing, MI*

Temperature, diet composition, and consumption can interact to influence growth rates of fishes. Thermal regime and food availability in the Smith River, Virginia, tailwater are variable and are impacted by hydropeaking operations, which may limit growth of brown trout. Bioenergetics modeling was used to assess brown trout growth during summer months under baseline conditions and three alternative flow regimes, which included: 1) 12°C outflow, 2) new turbines which halved generation magnitude and doubled release duration, and 3) steady baseflow. Also, increased percentages of fish in the diets were assessed to determine the influence of fish on trout growth. The steady baseflow option benefited age-0 and age-1 trout in the lower 18 km of the tailwater (1-4% increase in growth). The 12°C outflow option benefited age-0 trout in the first 5 km downstream of the dam (9% increase in growth); however, the 12°C outflow resulted in reduced growth in trout in the downstream reaches (2-7% reduction). Increased occurrence of fish in the trout diets resulted in higher potential increased growth. No alternative flow regime benefited the entire tailwater. Selection of alternative flow regimes should seek to maximize growth potential while minimizing potential reduction in growth in other sections of the tailwater.

Keywords: brown trout, hydropeaking operation, bioenergetics, Smith River

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## **Spatial and temporal variability in recruitment timing and relative abundance of juvenile red drum (*Sciaenops ocellatus*) in southeastern North Carolina**

Stewart\*, C.B. and Scharf, F.S. Department of Biological Sciences, University of North Carolina at Wilmington, Wilmington, NC

For many estuarine dependent fishes, there is growing evidence that processes occurring during the juvenile life stage contribute to shaping year-class strength. Variation in recruitment timing and relative abundance of newly settled red drum was examined in southeastern North Carolina over two years. Red drum were collected continuously from estuarine arrival through age 1 using 18.3m and 30.5m bag seines, as well as multi-panel gillnets. Settled juveniles (17-25mm TL) were first captured in late August, with newly settled fish appearing into early November. Fish shifted from polyhaline habitats located close to the ocean inlet to mesohaline habitats by early spring, as demonstrated by patterns of relative abundance. Preliminary results demonstrate that CPUE was nearly 10 times greater in 30.5m bag seines compared to 18.3 m bag seines during spring when fish ranged from 93-155mm TL, indicating that smaller seines are likely inefficient for estimating abundance for larger juveniles. Capture rates of older individuals during summer gill net sampling were less variable through time compared to catch rates in beach seines (gill net CV = 34%; beach seine CV = 114%), suggesting a stabilization of mortality rates as fish approached age 1. Initial results from the 2004 cohort indicate considerable differences in relative abundance

between estuarine systems (New River CPUE = 3.97; Cape Fear River CPUE = 1.74), indicating that recruitment of red drum may vary across broad spatial scales.

Keywords: red drum recruitment mortality abundance

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## **Ontogenetic and seasonal variation in the diet of juvenile red drum (*Sciaenops ocellatus*)**

Foster\*, C.R., and Scharf, F.S.

The red drum is an integral part of coastal ecosystems throughout the southeastern US. However, information on estuarine food habits specific to this region is lacking. Because growth during early life may be critical to survival, understanding variation in diet and its potential contribution to growth patterns will aid in the identification of factors affecting recruitment success. We examined food habits of age-0 juvenile red drum from initial estuarine arrival through age 1 for two separate cohorts in southeastern North Carolina. The stomach contents of 607 red drum (15-350 mm TL) were analyzed from the 2003 cohort. Red drum between 15-75 mm TL consumed mostly benthic invertebrates (e.g., crustaceans and polychaetes). Fish and larger decapod crustaceans (crabs and shrimp) became important in the diets of red drum larger than 100 mm TL. For fish greater than 200mm TL, diets were dominated by Atlantic menhaden (*Brevoortia tyrannus*), with percent diet by weight = 58.6% and percent frequency of occurrence = 46.6%. In addition to menhaden, several other commercially important species, including brown shrimp (*Penaeus aztecus*) and blue crabs (*Callinectes sapidus*) were also frequently recovered from the stomachs of larger red drum. Preliminary analysis of food habits from the 2004 cohort indicates similar findings, demonstrating consistent ontogenetic patterns in red drum diets during their first year.

Keywords: red drum juvenile diet ontogeny Atlantic menhaden

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## **An Individual-based Model for Alligator Gar: Why Failing to Consider Intersexual Differences in Growth and Mortality Rates Leads to Overfishing**

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We developed an individual-based model for alligator gar to evaluate the length at which harvest was maximized. We used two approaches. In the first, we ignored potential intersexual differences in growth and mortality rates, as is commonly done in fishery modeling. In the second approach, we explicitly modeled intersexual differences in growth and mortality rates. We

found that ignoring sexual differences in population rates resulted in an estimate of 67-in TL, whereas including the sexual differences in rates resulted in an estimate of 76-in TL. Thus, ignoring these differences reduces harvest by at least 5%, results in growth-overfishing, and a 12% reduction in minimum length. Although our model is specific to alligator gar, it suggests that sexual differences need to be considered.

Keywords: Alligator gar population model harvest model

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### **The Rocky Barra Bounty: A Research-driven Fishing Competition**

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The Rocky Barra Bounty, held each October on the Fitzroy River in Queensland, is one of the best known competitive fishing events in Australia. The main emphases of the competition are to: (1) provide anglers with a challenging competitive fishing event, (2) collect information that is used to monitor population dynamics of barramundi *Lates calcarifer* in the Fitzroy River; (3) and examine the relationship between angling practices and survival of released fishes. The competition is unique in organization and rules of conduct. Anglers capture, measure, tag, and release fish, and then must telephone in their capture information within 10 to 15 minutes to register the fish. Awards are given to the teams that catch the greatest cumulative lengths of fish (e.g., barramundi only, all species combined) and for the largest fish captured. To minimize the possibility of unethical behavior, major prizes are awarded by random draw. Results of the Barra Bounty indicate that the Fitzroy River barramundi population has increased in the past year and that population size structure has increased since 1999.

Keywords: Alligator gar population model harvest model

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### **Population Genetics of Virginia Largemouth Bass *Micropterus salmoides* Populations**

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The biological species largemouth bass *Micropterus salmoides* is comprised of two subspecies, northern largemouth bass *M.s. salmoides* and Florida largemouth bass *M.s. floridanus*. There exists a widely-held perception that Florida largemouth bass or F<sub>1</sub> northern x Florida hybrids outperform northern largemouth bass, which has led to widespread stocking of Florida largemouth bass into native northern largemouth bass populations. Twenty-six Virginia populations of largemouth bass were screened for the frequencies of isozyme markers diagnostic for the two subspecies. Liver and muscle tissue were used to analyze enzyme activities by histochemical staining following electrophoresis through cellulose acetate gels. Both northern- and Florida-subspecific alleles were observed in all the populations surveyed. No geographic pattern in genetic variation was seen. This finding suggests that native geographic genetic structuring once existed, but was obliterated by past stocking practices. Alternatively, that largemouth bass is a non-native species in most of Virginia, and lack of geographic stock structure is caused by stocking of largemouth bass from varied sources.

Keywords: largemouth bass *Micropterus salmoides*, Florida largemouth bass *M.s. floridanus*, population genetics, isozyme, allozyme

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## Patterns of Genetic Differentiation In The Slabside Pearlymussel, *Lexingtonia Dolabelloides* (Lea 1840), In The Tennessee River Drainage

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The restoration and recovery of rare mussel species will require the re-establishment of populations into historically occupied habitats. The possible existence of evolutionary significant units (ESUs) should be considered before inter-basin transfers can be made. Therefore, introductions should not be conducted prior to analysis of compatibility between source and recipient populations. Eighty individuals of *Lexingtonia dolabelloides* were sampled from four populations in the Tennessee River drainage. We sequenced 603 base-pairs of a mtDNA gene (*ND-1*) and 512 base-pairs of a nuclear gene (*ITS-1*). Analyses of molecular variation (AMOVA) values for both genes indicated that most of variation in *L. dolabelloides* resided within populations (82.9-88.3%), with much less variation (11.7-17.1%) among populations. Clustering of haplotypes in minimum spanning networks did not conform to population boundaries, reflecting high within-population and low between-population variability. Coefficients of population differentiation indicated some degree of uniqueness in the Duck River population. A Mantel test showed no significant correlation between geographical stream distance and genetic distance, thus not supporting a pattern of isolation-by-distance. Overall, the results do not provide evidence for the existence of ESUs but support the presence of unique variants. Nevertheless, the Duck River population contains distinct genetic material that should be conserved.

Keywords: *Lexingtonia dolabelloides* mussels evolutionary significant units ESUs Tennessee Duck North Middle Fork Holston River genetics mtDNA nuclear DNA population differentiation haplotype minimum spanning networks Mantel test

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## Relative Abundance and Biomass of Reef Fish in Calabash Caye, Belize

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Network models (Ecopath) are being used to study impacts due to fishery harvests, but biomass data of fishes are required to parameterize the model. We used visual census and length class estimation to determine the biomass of the major fish consumers on a coral reef in Belize. Transect and radial count surveys of reef fish were conducted at dawn and dusk for 10 days in June 2004 at Calabash Caye, Belize. Fish were enumerated by species within 10cm size classes. Fish size classes were converted to biomass using the length-weight relationship equation,  $W=aL^b$ . A total of 51 species, in 30 genera and 19 families, were identified on the reef. Preliminary data indicates that families of small herbivores and benthos consumers were more abundant in the morning and zooplanktivores and benthos consumers were most abundant in the evening. Median biomass estimates were 1,413,400.345 g fish per m<sup>2</sup> in the morning and 252,349.017 g per m<sup>2</sup> in the evening. This Ecopath model and fish biomass estimates will be used as a baseline for comparison when a new marine protected area is established around Calabash Caye.

## **Characterization of Hickory Shad *Alosa mediocris* and other Anadromous Fish Spawning in the Lower Tar River, North Carolina**

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Hickory shad *Alosa mediocris* once contributed to an important commercial fishery despite the continuing popularity for recreational fishing along the Atlantic Coast. However, the current status for hickory shad populations from North Carolina through Florida is not well documented. Adult hickory shad in North Carolina use the Tar River for spawning but little is known about the spawning areas and timing of spawning in this riverine system. Additionally, little information is available on the natural aquatic resources of this watershed, the lower portion of which is blocked to upstream access by a dam in Rocky Mount. The objectives of this study are: 1) to determine timing and location of spawning by sampling for eggs to larvae; 2) to quantify habitat suitability through water quality analysis; 3) to assess abundance of early hickory shad and 4) to identify the possibility of reduced fish passage for hickory shad through physical obstructions such as dams and highway culverts. Preliminary results indicate that the spawning period is from early March to mid-June and that hickory shad are spawning in the tributaries opposed to the main stem of the Tar River in Edgecombe and Pitt Counties, NC.

Keywords: hickory shad, eggs, larvae, physical obstructions, habitat, spawning, abundance