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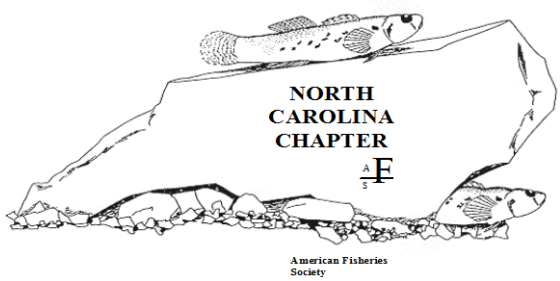

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Introduced flathead catfish, dam removal, and the endangered Cape Fear shiner

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The flathead catfish *Pylodictis olivaris* is a widely introduced, large predator, impacting native fishes. We quantified diel and seasonal movement, habitat use, and diet of introduced flathead catfish in the Deep River, North Carolina, in a reach between two hydropower dams during 2004-2005. Seasonally, flathead catfish utilized larger areas during summer (mean linear range 6,903 m) and fall (mean 6,569 m) than those during winter (mean 599 m). Daily linear ranges differed between summer (mean 305 m) and fall (mean 220 m). Microhabitats occupied during summer (mean depth 2.5 m) were shallower than those during fall (mean 4.8 m) or winter (mean 4.8 m), and mean velocities were similar among seasons (means for summer 0.048 m/s, fall 0.053 m/s, and winter 0.054 m/s). Flathead catfish inhabited a downstream, deeper, impounded river section throughout the year, except during spawning, when it also shared upstream habitat with the endangered Cape Fear shiner *Notropis mekistocholas*. Examination of 698 samples of flathead catfish stomach contents (356 empty) found only rare occurrences of minnow prey species and no Cape Fear shiners. These findings suggest that flathead catfish microhabitat does not overlap with the shallow, higher velocity microhabitat of the Cape Fear Shiner even within the same river reach. The removal of the downstream Carbonton Dam in this reach should result in reduced habitat supporting flathead catfish and expansion of areas suitable for the Cape Fear Shiner.

Dam removal efficacy: an ongoing study of the freshwater mussels and fishes on the Deep River at Carbonton Dam

Ryan Heise (NCWRC), Thomas Kwak (NC Coop Research Unit), Gregory Cope (NCSU), and Wayne Starnes (NCMNS)

In the fall of 2004, the Wildlife Resources Commission, North Carolina State University, Cooperative Fish and Wildlife Research Unit, and the Museum of Natural Sciences began a collaborative, multi-year study of the effects of removing the Carbonton Dam. The dam was located on the Deep River (upper Cape Fear River Basin) along the Chatham/Lee County line near Hwy 42. The objectives of this study are to determine the short- and long-term effects of dam removal on freshwater mussels and fishes by pre- and post-removal monitoring of their abundance and diversity within the tailrace, impoundment, and at reference sites. Changes in mussel and fish populations will be quantified to document any downstream impacts as well as recovery of riverine fauna within the former impoundment. We documented the fish communities (fall 2004 and spring 2005) using three-pass boat and backpack electrofishing at sites upstream and downstream of dam prior to its removal. A combination of timed visual surveys along

with quadrat excavation was used to sample mussels in fall 2005 (pre-removal). We captured a total of 43 species of fish, including the Cape Fear shiner, a federally endangered species, during pre-removal surveys. A total of 9 mussel species were located, including one state endangered, three threatened, and one significantly rare species. Post-removal mussel and fish sampling will begin this spring; sampling will continue annually for at least 3 years. Findings of this evaluation will guide future dam removal planning and prioritization.

Status of the Appalachian elktoe (*Alasmidonta raveneliana*), a federally endangered mussel

Steve Fraley, Aquatic Non-game Coordinator, Jeff Simmons, Aquatic Non-game Biologist, Western Region, North Carolina Wildlife Resources Commission

The Appalachian elktoe is endemic to the French Broad and Little Tennessee River systems (Tennessee River basin) in the Blue Ridge physiographic province, primarily in western North Carolina. The US Fish and Wildlife Service listed the species as Endangered under the federal Endangered Species Act in 1994, published a Recovery Plan in 1996, and Critical Habitat was designated in 2002. Until 1996, only two small populations were believed to survive, one each in the Nolichucky River subbasin and a short reach of the Little Tennessee River. Surveys between 1996 and 2002 found three additional populations, as well as a wider distribution in the Nolichucky subbasin, within the French Broad system; and two additional populations in the Little Tennessee system. In 2003, in cooperation with the NCDOT and USFWS, we began an assessment of all known and potential populations of the Appalachian elktoe in NC. Surveys were nearly completed by September 2004 when two tropical storms struck western NC, causing severe flooding throughout its range. With support from NCDWQ, many sites previously surveyed were revisited in 2005 to assess impacts from flooding. Lower densities at most sites was the primary impact observed. Presently, five distinct, relatively healthy, and apparently viable populations are known. In September 2005, the USFWS announced a 5-year review of the species to ensure the accuracy of its listing classification. Comparison of present status to criteria given in the recovery plan suggests that the Appalachian elktoe warrants downlisting from Endangered to Threatened. We also propose revision of the Recovery Plan to provide an updated and detailed plan for full recovery and de-listing.

Mussel Relocation in the Piedmont of North Carolina

Robert B. Nichols, Central Aquatic NonGame Biologist, NCWRC

From 2001 to 2004, the North Carolina Wildlife Resources Commission Aquatic Nongame biologists began a mussel relocation project that was funded by the Clean Water Management Trust Fund. The objective of this project was to accelerate the recolonization of several Piedmont streams, where historical environmental damage

extirpated mussels but had been reversed, by reintroducing the common mussels, *Elliptio complantata* and *Elliptio icterina*, from high density source sites. A secondary objective of the project was to develop the experience and techniques required to successfully relocate mussels using common species. We established and monitored 15 populations in the Yadkin Pee Dee River Basin and the Roanoke River Basin. Sites were monitored two weeks after relocation occurred to assess mortality from handling and relocation procedures and annually to evaluate persistence of the populations. Of the 15 populations that were established between 2001 and 2004, 7 out of 15 are persisting.

Are northern strain brook trout really different; or is it just the accent?

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We report on a series of experiments designed to examine potential ecological differences between wild southern strain brook trout and wild brook trout descended from hatchery stock (Northern strain). Over the last century, brook trout derived from northern brood stock were extensively stocked over the western mountains of North Carolina. Recent attempts to identify remaining "pure" southern strain brook trout populations have found that wild southern strain brook trout populations exist, but most wild brook trout populations are of mixed origin, and a few are composed of "pure" northern strain fish. In an attempt to begin to understand the potential ecological impact of this genetic mixing, we looked for differences in tolerance to elevated temperature and to lowered pH, differences in diet and growth in common garden experiments, and differences in growth at sub-lethal pH. We found that we could detect differences in temperature and pH tolerances, though the magnitudes of the differences is probably not ecologically significant. In an experimental stream reach, Northern strain brook trout ate more, and the distribution of prey in northern strain trout stomachs was different from that in southern strain trout stomachs. Growth of individuals was very similar in a common-garden experiment and in the growth trials at sub-lethal low-pH. But, in all experiments involving artificial stream channels, mortality of southern strain brook trout was found to be significantly higher than that of northern strain fish. In conclusion, wild brook trout descended from hatchery stock do exhibit ecological differences when compared to wild southern strain fish. But, the exact nature of those differences may be difficult to determine given that to date the most obvious difference is tolerance to being held under laboratory conditions.

Characterization of North Carolina's Hatchery Supported Trout Fisheries

Doug Besler, Regional Research Coordinator, North Carolina Wildlife Resources Commission

Roving creel surveys were conducted on 15 hatchery supported trout streams in western North Carolina between 1997 and 1999. The objective of this study was to describe

angler use patterns and trip characteristics for selected waters in the hatchery supported trout program. Approximately 30,000 anglers were interviewed during the three-year survey. Angling pressure, catch, and harvest varied substantially between 1997, which was a data design collection year, and 1998–1999. All data reported for the 1997–1999 creel surveys are based on incomplete angling trips. Overall, anglers captured trout (combined species) >203 mm, those considered stocked, at the average rate of 1.81 trout/h. This capture rate exceeded the North Carolina Wildlife Resources Commission (NCWRC) programmatic goal of 1 trout/h. On average, 56% of anglers captured at least one trout at the time they were interviewed. The majority of anglers (76%) captured fewer than three trout and only 4% captured their legal creel limit of seven trout. Hatchery supported trout anglers were harvest oriented and creeled 86% of all stocked trout caught. Rainbow trout Oncorhynchus mykiss, brook trout Salvelinus fontinalis, and brown trout Salmo trutta were harvested in proportions similar to those stocked. Brook trout were most likely to be captured within two days of stocking, while rainbow trout and brown trout persisted longer in the streams before being harvested. The varied species stocking mixture used by the NCWRC appears to providing anglers with a diverse catch experience as well as meeting the NCWRC goal of spreading trout catch out over time. Overall, approximately 10% of effort, 15% of catch, and 16% of harvest occurred on opening day alone in 1998–1999. Most anglers fishing hatchery supported trout waters were North Carolina residents, were ≥16 years of age, were male, and used natural bait. This demographic base is similar to other NCWRC trout programs. Most hatchery supported anglers rated their trip as good, however, only 10% rated their trip as excellent. Angler trip rating satisfaction was directly related to trout catch and was not related to trip length suggesting that moderate catch rates are important to hatchery supported trout anglers.

Spatial and Temporal Patterns of Fish Larvae in the upper Pigeon River, North Carolina

Michael J. LaVoie, Graduate Student - MS Biology Candidate, Western Carolina University

The Pigeon River (Haywood County, NC) has undergone vast improvements in water quality from upgrades in paper manufacturing and wastewater treatment in Canton. Species richness of the fish community has recently improved through both re-colonization from tributaries and the reintroduction of previously extirpated species. Surveys have indicated that a group of fish species are present upstream of Canton but are absent or found in reduced numbers below the city. Potential barriers to colonization exist in the main stem of the river at Canton in the form of an impoundment and low-head dam, as well as thermal and chemical effluents. The downstream drift of larval riverine fishes has been shown to be an important dispersal and recruitment mechanism for some species. In order to examine the potential for colonization from upstream, fish larvae will be collected with drift nets at three spatially separated sites from the first week in March until larval fish are no longer found in samples. Spatial and temporal patterns in larval fish abundance and community composition will be analyzed. This study will

assist native fish restoration efforts by determining what larval fishes are able to access the impacted reaches of the Pigeon River and if other factors are hindering the success of restoration efforts through barriers to colonization.

Effects of urbanization on stream fish assemblages in the Piedmont of North Carolina

Aaron J. Bunch, U.S. Geological Survey, N.C. Water Science Center-N.C. State University

This study was part of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program's effort to link the effects of urbanization and stream health by monitoring fish, invertebrates, and algae assemblages. An urban intensity index (UII) was used to select 30 piedmont streams that represented a gradient from low to high urban intensity within a homogeneous environmental framework. This helped limit natural sources of variability and made the effects of urbanization easier to detect. Multivariate (ordination) and multimetric (assemblage metrics) methods were used to assess biological response. We measured 314 fish metrics (richness, abundance, biomass, and total length) based on taxa groups, tolerance, and other characteristics. Correlations between all 314 fish metrics and the urban intensity index were relatively weak ($|\rho| \leq 0.65$) compared to invertebrates. Additional analyses are underway to define the assemblages that would be expected at each site in the absence of urbanization. Urban effects will then be measured as the degree to which the actual assemblages differ from the expected. We expect to improve the efficacy of detecting responses of assemblages to urban intensity factors in watersheds.

A preliminary Ecopath-Ecosim model of a North Carolina reservoir foodweb: challenges, insights, and future directions

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As new species continue to be introduced into reservoir ecosystems, researchers are challenged to manage foodwebs of increasing complexity. To better understand and manage reservoirs in North Carolina, we described the trophic linkages of a 'typical' North Carolina reservoir using the Ecopath with Ecosim (EwE) modeling package. First, using the Ecopath mass-balance approach, we created a snapshot of the reservoir foodweb. We then employed the time-dynamic simulation tool Ecosim to project the future effects of selected ecosystem perturbations - such as increased harvest of a sportfish species or a change in the stocking rate of striped bass - on the rest of the reservoir community. We discuss the challenges of parameterizing a model of a southern US reservoir ecosystem. Finally, we consider additional issues in North Carolina fishery management that may be addressed with EwE, and what additional data would be needed to improve this model for use in managing the state's reservoirs.

Emergency Watershed Protection Activities in Two WNC Counties

Micky Clemmons, Senior Scientist, Buck Engineering, PC

In the fall of 2004 hurricanes Frances and Ivan moved across Western North Carolina within 10 days of each other. Both storms caused 100 year floods on many of the regions rivers and streams. In response to the damage to property that this flooding caused the Natural Resources Conservation Service (NRCS) made Emergency Watershed Protection Program (EWP) funds available to the counties that suffered storm impacts. Buck Engineering worked with Avery, Burke and Madison Counties to assess damage, and design and construct channel repairs on sites where the NRCS had prepared Damage Survey Reports (DSR). This presentation will show examples of channel damage in Madison and Burke Counties and how these sites were repaired. Reasons for stream bank failure and other observed damage will also be discussed.

Monitoring the Effects of Stream Restoration Activities on Trout and Nongame Fish in Three Western North Carolina Streams

Kevin Hining, District 7 Fisheries Biologist I, North Carolina Wildlife Resources Commission

Stream restoration activities in North Carolina have increased annually over the past decade, and this trend is likely to continue. Many of these projects are undertaken to reduce erosion and improve water quality; however, improving fish habitat is often a secondary consideration. Despite this, quantitative assessments of stream restoration projects on stream biota are rare. In an effort to evaluate the impact of stream restorations on fish, the North Carolina Wildlife Resources Commission began monitoring the fish community within Sharp Creek and Laurel Creek, both located in Watauga County, and Big Sandy Creek, located within Stone Mountain State Park, Alleghany County. The objective is to measure any changes in trout density, biomass, and size structure, as well as to measure the nongame fish assemblage before and after restoration relative to a control section. In both Sharp Creek and Laurel Creek, the density and biomass of trout prior to the restoration work were similar to or exceeded those obtained from several high quality wild trout streams in western North Carolina. This suggests that intensive stream restoration work was probably not merited if fish habitat improvements were a prime objective. Although the overall impact of restoration work on these fish communities is still unclear, the data collected so far does reveal a need for fish and game agencies to critically evaluate stream restoration activities prior to implementation, particularly when improvement to fish populations is a goal of the activity.

An Assessment of Largemouth Bass at Lake Norman for 1993-2005

Christian Waters, Piedmont Fisheries Research Coordinator, NC Wildlife Resources Commission

In recent years, anglers at Lake Norman have touted the improved quality of the largemouth bass fishery. Anglers often report that it takes 8.1 kg or more for a five fish limit to win a tournament. To assess this change, data from standardized spring electrofishing were analyzed for 1993-2005. Thirty shoreline sites with a length of 100 m were sampled annually. The mean number of largemouth bass (≥ 200 mm) collected per site ranged from 7.5 to 12.3 for 1993-2001 before declining to a low of 5.6 fish per site in 2005. Annual proportional stock density (PSD) values ranged from 46 to 55 for 1993-2002, but increased to 71, 68, and 82 in 2003, 2004, and 2005. The number of largemouth bass collected of stock size (200-300 mm) has steadily declined over time while the number of largemouth bass collected of preferred size (380-509 mm) doubled in 2003-2005 compared to previous years. Mean annual relative weight (Wr) values ranged from 78 to 83 for 1993-2003 with a slight increase to 88 and 86 in 2004 and 2005. The observed reduction of recruitment to stock size appears to have triggered a density-dependent response for larger largemouth bass. The improved body condition and increased survival of largemouth bass greater than 300 mm as resulted in a better fishery, but will this short-term gain last?

Development of Novel, Non-lethal Sampling Techniques to Assess Organic Contaminants in Fish

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As concerns mount over the human health risks associated with consumption of fish contaminated with persistent organic pollutants, there exists a need to better evaluate fish body burdens without lethally sampling many of the important commercial and sport species of interest. The aim of this study was to investigate two novel methods for estimating organic contaminants in fish that are a concern for both fish and human health. The removal of fish adipose fins, commonly done in mark-recapture studies with salmonid species, was evaluated as a non-lethal sampling technique to estimate concentrations of polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) in flathead catfish *Pylodictis olivaris*, relative to those found in muscle fillets of

the same fish. We also assessed the efficacy of using polydimethylsiloxane (PDMS) as a mobile passive sampling device (PSD) attached directly to wild flathead catfish for assessing location-specific exposure of the fish to waterborne contaminants. The results of this study have demonstrated for the first time that organic contaminant concentrations in adipose fin were highly correlated ($R^2 = 0.87$) with muscle fillet concentrations, indicating that the adipose fin of certain fishes may be used to accurately estimate tissue concentrations without the need for lethal sampling. Moreover, mobile PSDs attached directly to fish and used here for the first time, accurately estimated ultra-trace concentrations of waterborne PCBs and OCPs without any apparent harm to the fish, indicating that there are no practical or physical barriers to the use of mobile passive samplers attached to aquatic organisms.

Crayfish Inventory and Monitoring in Western North Carolina

Jeffrey W. Simmons, Aquatic Non-game Biologist and Stephen J. Fraley, Aquatic Non-game Coordinator, Western Region, North Carolina Wildlife Resources Commission

Approximately 390 native North American crayfishes are known, representing nearly two-thirds of the world's crayfish fauna. The majority of these species occur in the southeastern United States. North Carolina (particularly in the west) supports a substantial proportion of that diversity, with 38 indigenous crayfish species presently described, 10 of which are endemic, and three introduced species, many of which are of significant conservation interest. In the late 1990's the NCWRC began a focused effort to inventory and establish baselines for monitoring populations of both native stream-dwelling and burrowing crayfishes and invasive non-native species. In 2004-05, that effort was completed for the French Broad, Little Tennessee, Hiwassee, Watauga, Catawba, Broad, New, and Savannah River basins in western NC. A total of 27 species were collected from 250 sites sampled in 2004-05. A third of these were terrestrial sites with burrowing crayfish that were located through private landowners and other cooperators. Results include extension of the known occupied range of many native species, including a new NC river basin record for *Cambarus reduncus*. Observations of life history traits, such as reproductive condition, fecundity, and habitat use, were recorded. We also worked closely with crayfish taxonomists to provide collection data and specimens to help resolve certain taxonomic problems and to provide material to assist completion of a number of new species descriptions that are in progress. Data collected during these and previous NCWRC inventories, as well as data obtained from the NC State Museum of Natural Sciences and other cooperators (e.g. NCDWQ, National Park Service, TVA), were incorporated into a detailed GIS project. This was useful in identifying data gaps to guide our sampling efforts and, over time, will provide a convenient tool for monitoring the status of native crayfish populations, the spread of invasive species, and informing conservation and management decision making.

Electrofishing Surveys and Radio Tracking for Robust Redhorse (*Moxostoma robustum*) on the Pee Dee River

Ryan Heise, Rob Nichols - (NC WRC), John Crutchfield, Mike Swing, Vann Stancil - (Progress Energy)

The robust redhorse (*Moxostoma robustum*) is a large, long-lived member of the sucker family. This species is proposed for endangered status in North Carolina and is a federal species of concern. The Robust Redhorse Conservation Committee (RRCC) is a cooperative, voluntary partnership formed between state and federal resource agencies, private industry, and the conservation community to improve the status of the species. One of the major goals of this group is to evaluate the distribution of this species in its historical range - major Atlantic slope river drainages in Georgia, South Carolina, and North Carolina. Our objectives in the Pee Dee River are to determine if a robust redhorse population persists and document habitat use and migratory patterns. A total of 15 robust redhorse were captured from 2000-2005 (including two recaptures). Eleven adult robust redhorse have been captured in a 9 rkm reach immediately downstream from Blewett Falls Dam. To improve our catch rates and to learn more about their life history, radio-tags were first implanted in 2004 (2 captures). In 2005, five of the eight captures were outfitted with radio-tags. Telemetry relocations and capture data indicate that some of these fish make long distance movements, use the shallow gravel habitats near Blewett Falls for spawning, and show strong site fidelity. Efforts on the Pee Dee River will continue in order to further our understanding of their life history requirements.