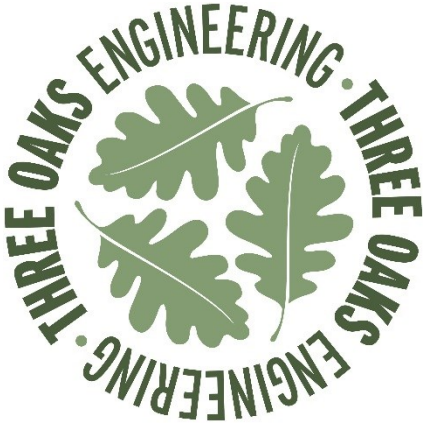
Abstracts

2020 Meeting of the North Carolina Chapter of the American Fisheries Society

Tuesday, February 4th – Thursday, February 6th, 2020

New Bern Riverfront Convention Center
203 South Front Street
New Bern, NC 28560

We would like to thank the sponsors of our 31st annual meeting of the North Carolina Chapter of the American Fisheries Society



Restoration of Wavy-rayed Lampmussel, *Lampsilis fasciola,* Spike, *Eurynia dilatata*, and Rainbow Mussel, *Villosa iris* to their Native Range in the Oconaluftee River Basin of Cherokee, North Carolina

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The Wavy-rayed Lampmussel, *Lampsilis fasciola,* and Spike , *Eurynia dilatate,* are listed as Species of Special Concern and Rainbow Mussel, *Villosa iris,* is listed as Threatened in North Carolina. Once common in their native range, which reached across most of the eastern United States, anthropogenic factors such as agricultural pollution, siltation, and river impoundments have led to the sharp decline of these invertebrates. A previous feasibility study confirmed that *L. fasciola* and *V. iris* could survive and grow in enclosures in the Oconaluftee River within the Qualla Boundary, and therefore concluded that these species could be candidates for restoration in that system. This study pursued the next step in the efforts to restore natural populations by introducing individuals of *L. fasciola, V. iris,* and *E. dilatata,* back into the Oconaluftee. Juveniles of *V. iris* and *L. fasciola* were obtained from the North Carolina Conservation Hatchery in Marion, NC; adult E. dilatata were translocated directly from the Little Tennessee river, as this species is not successfully raised in hatchery conditions. The individuals of all three species were marked and stocked at four study sites chosen based on adequate substrate Type:s. Sampling took place over the course of one growing season (May to October 2019) to record survival and growth. Additionally, measurements of the remaining silo populations from the previous feasibility study were continued, as well as monitoring of an additional three new silos at each site, to allow comparison of growth in free-living mussels and those in the enclosures. All three species had near-perfect survival both when stocked into the substrate and in silos. Additionally, we detected positive growth for all species, with individuals growing slower at upstream sites. *L. fasciola* individuals outside enclosures showed significantly greater growth than those in silos and showed significantly lower valve damage.

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Assemblage Structure of Reef Fishes in the Southeast U.S. Atlantic Ocean

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Hard-bottom habitats along the Southeast US Atlantic Coast (SEUS) support a diverse assemblage of reef fishes, many of which are economically important. Despite the importance of reef fishes in the SEUS, studies examining assemblage structure have primarily focused on small spatial scales and factors influencing assemblage structure across the entire region are not well-understood. Here, we use a spatially extensive video dataset collected from 2015-2018 by the Southeast Reef Fish Survey (SERFS) to characterize reef fish assemblage structure and identify the factors driving assemblage structure. SERFS sampled approximately 280 sites on hard-bottom habitats on the continental shelf and shelf-break from Cape Hatteras, North Carolina to St. Lucie Inlet, Florida, each year. Baited chevron fish traps were deployed for approximately 90 minutes at each station and high-definition GoPro® Hero cameras were attached over the mouth and nose of each trap. Twenty-minute sections of the videos, beginning 10 minutes after the trap landed on the bottom were read for fish (mouth-only) and to score habitat, water current, and water clarity. For a subset of economically-important taxa, the mean number of individuals present was estimated using the MeanCount approach. Reef fish assemblage structure was characterized using a suite of multivariate analyses. Similar assemblage patterns emerged using both presence/absence data and abundance data. Water depth, latitude, and relief height of substrate were all important in influencing assemblage structure. When the sites were clustered, the largest assemblages occurred at shallower sites with a northern assemblage characterized by higher counts of Red Porgy, *Pagrus pagrus,* and Vermilion Snapper, *Rhomboplites aurorubens,* and a southern assemblage characterized by higher counts of Gray Triggerfish, *Balistes capriscus,* and Red Snapper, *Lutjanus campechanus*. Understanding the assemblage structure of reef fishes in the SEUS will aid the transition from single-species to multispecies management approaches.

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Ventures in the Blackwater: A Broadtail Madtom Survey Update

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The Broadtail Madtom, *Noturus* sp.*,* is a rare, undescribed native catfish, and is the Carolina's smallest Ictalurid. The species is endemic to a handful of coastal plain basins in the Carolinas and is listed as a federal Species of Concern, state Special Concern in North Carolina, and state Threatened in South Carolina. Numerous knowledge gaps exist for this hard-to-collect species, including present population status. Spanning a 50-year period from the fish's first documented discovery in the 1960s, Broadtail Madtoms have been found in successively fewer localities and lower densities. In NC, extensive survey efforts at over 120 sites between 2008 and 2013 yielded only seven individuals, all in the Lumber River basin. Until 2019, the species had not been collected in Lake Waccamaw since 2002. No Broadtail Madtoms have been seen in the Cape Fear basin since 2001. The low water conditions in fall of 2019 provided increased accessibility to historical sites and previously unsampled locations. In October and November 2019, the Central Region of the Aquatic Wildlife Diversity Program surveyed 55 sites in the Lumber River and tributary creeks of the Lumber basin, Lake Waccamaw, as well as the South and Black Rivers of the Cape Fear basin, to provide data to inform management decisions and to aid forthcoming species descriptions. Sampling effort averaged 32 kick-seines per site. A total of nine individual Broadtail Madtoms were located at four sites, from the Lumber River and its tributary, Shoe Heel Creek. Additionally, 20 "madtom motels"- small, artificial cover structures - were deployed at three historical sites. Staff will periodically check the structures for occupancy and deploy up to 50 additional units across multiple localities.

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Utilizing MoveVis Package in R to Visualize Largemouth Bass Movement in a Coastal Lake

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Largemouth Bass, *Micropterus salmoides*, are popular sportfish at Lake Mattamuskeet, a large (16,187 ha), shallow (mean depth < 1.0 m), lake surrounded by a system of canals at Mattamuskeet National Wildlife Refuge in Hyde County, North Carolina. The study objective was to define the temporal and spatial scale of Largemouth Bass movement with acoustic telemetry. Specifically, this study tested the hypothesis that Largemouth Bass movements into deeper, canal habitats are triggered by decreasing water levels in the main lake and dewatering of shoreline habitats. Between March and May 2017, a total of 31 VEMCO VR2W receivers were strategically placed in proximity to the canal connections to the lake. During May–June 2017, a total of 42 Largemouth Bass were collected, anesthetized, surgically implanted with VEMCO V9 acoustic transmitters (or tags), and released at seven locations. Receiver downloads between 15 May 2017 and 12 March 2019 revealed more than 620,000 detections of 29 acoustic-tagged Largemouth Bass. These detections were compiled in the VEMCO User Environment (VUE) then downloaded as .csv file for further analysis within the R environment. The moveVis program provided tools to visualize the movement of Largemouth Bass at Lake Mattamuskeet. Along with the vast capabilities of R programming, the incorporation of packages like moveVis warrants the time and effort by fisheries managers to learn and utilize R programming.

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NOTES

Population Estimate of the State and Federally Threatened Spotfin Chub, *Erimonax monachus,* Using Underwater Observations

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Determining population demographics of threatened or endangered species can be difficult if the methods used must be minimally invasive. However, knowing the population status of species of conservation interest must be understood for successful management. We used underwater observations (i.e., snorkeling) to determine population estimates of a state and federally threatened species, Spotfin Chub, *Erimonax monachus,* in the Cheoah River in North Carolina. Seven sites were randomly located between the Santeetlah Dam and the confluence with the Little Tennessee River. Each site was surveyed by three snorkelers using multi-pass snorkeling between July 17- 25, 2019. Population estimates were generated using a simple N-mixture model without covariates and a more complex model incorporating site specific habitat as a predictor of abundance. Four hundred and sixty-six observations of Spotfin Chubs were recorded across all sites and passes. The simple model without covariates of abundance estimated total population size of 12,139 (95% CI = 9,821 – 15,453). Incorporating site specific percent bedrock improved model fit and indicated percent bedrock was positively related to abundance. Total population size estimated with the covariate model was 13,905 (95% CI = 11,620 – 22,181). Our results yielded new insight into the status of a state and federally threatened species while confirming previous knowledge about microhabitat use. Locally, the results of this work suggest the Spotfin Chub is well established in the Cheoah River and maintain a substrate affinity to bedrock. Broadly, the field methods used here are logistically feasible, cost efficient, and impart little to no stress on the fish. We suggest this methodology be considered when total and site-specific population estimates are needed to manage species of concern. Additionally, more detailed site-specific habitat can improve model estimates by explaining site specific variability in abundance. Thus, resulting in more precise total population estimates.

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Propagation Efforts of the Carolina Madtom

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The Carolina Madtom, *Noturus furiosus*, is an imperiled endemic catfish found only in the Tar and Neuse River basins in North Carolina. The species is a candidate to be federally listed as endangered. A collaborative effort between the North Carolina Wildlife Resources Commission and Conservation Fisheries Inc. (CFI) was initiated in 2018 to collect brood stock to propagate the Carolina Madtom to help conserve the species. Snorkeling survey efforts were conducted in the summers of 2018 and 2019 to collect broodstock to transfer to CFI. As a result of 2018–2019 collections, CFI is currently holding 32 individuals (Tar Basin n = 30, Neuse Basin, n = 2) to be used for propagation efforts. In 2019, a considerable amount of effort was allocated in the Neuse Basin resulting in no individuals collected. In 2019 no successful spawning took place due to a lack of mature females. Propagation efforts should be more successful in 2020 as juvenile females mature. Progeny from these efforts will be used as an ark population and to stock into reaches where Flathead Catfish, *Pylodictis olivaris*, do not occur. The upper Neuse Basin may be an appropriate area to reintroduce Carolina Madtoms because the physical habitat appears suitable and to date, Flathead Catfish have not been documented upstream of Falls Lake Dam. Future surveys will also be conducted in the upper Tar Basin to determine Carolina Madtom and Flathead Catfish distribution.

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NOTES

Effects of Beavers on Montane Stream Fish Communities

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Beaver dams form temporary lentic habitats, potentially altering stream hydrology, sediment dynamics, nutrient cycling, riparian communities, and water chemistry. Other studies have shown that beavers have complex effects on fish communities, and may both positively and negatively affect diversity. These effects are largely site-dependent however, and may vary significantly with pond successional stage. To examine how beavers affect stream fish communities in the mountains of western North Carolina, we surveyed fish in nine streams with active beaver ponds and seven with inactive pond complexes during summer 2019. We quantified differences in landuse, stream habitat and fish community structure in four reaches associated with each dam. Fish diversity was lower for upstream, pond, and tailrace samples taken from streams with active beaver impoundments compared to streams with inactive beaver impoundments, while fish diversity at sites 300+ m downstream of impoundments was not different between streams with active and inactive beaver dams. Diversity exhibited a weak negative relationship with increasing catchment forest cover at inactive sites but there was no relationship between diversity and forest cover at sites with active beaver dams. Although dissolved oxygen (DO) saturation was not significantly lower for either active or inactive ponds when compared with upstream reaches, some active ponds may experience very low levels of DO saturation. Active dams may serve as sediment sources to downstream reaches and indicator species analysis revealed significant preference of several sediment-intolerant fishes (e.g., Rainbow Trout, *Oncorhynchus mykiss*, and *Nocomis spp.*) for inactive sites. These data indicate that mountain streams with active beaver ponds support less diverse fish communities compared to streams with inactive beaver ponds. In cases where sediment-sensitive fishes of conservation concern are present, beaver dam removal may improve habitat quality. Dam removal may also be an effective management strategy for improving rainbow trout fisheries, but is unlikely to affect Brown or Brook Trout.

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NOTES

Active Beaver Ponds Improve Freshwater Oligochaete Habitat

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The parasite *Myxobolus cerebralis,* the causative agent of whirling disease in salmonid fish, was first detected in North Carolina in 2015. Whirling disease has caused declines in trout fisheries elsewhere in the United States, and is a potential concern for North Carolina's trout fisheries. An intermediate host, the oligochaete *Tubifex tubifex*, is needed to complete the life cycle of *Myxobolus cerebralis*. Previous research has shown oligochaete worms to be a dominant component of beaver pond invertebrate assemblages. To test whether beaver ponds in North Carolina might provide habitat for *Tubifex tubifex*, we surveyed 9 active and 7 inactive beaver ponds in the summer of 2019. Five sediment cores were collected from each beaver pond by placing a bottomless 5-gallon bucket into the substrate, and removing the top 2 cm of substrate with a fish tank net. Samples were then washed through a 300 micrometer sieve and all worms were preserved in 95% ethanol. Oligochaetes were more likely to be detected and densities were higher in active compared to inactive beaver ponds. 181 worms were transported to the Aquatic Parasitology Lab at Auburn University, where they are currently being identified and tested for *M. cerebralis* and other fish parasites using genetic assays. The infection status of these worms is not yet known, but no individuals were definitively identified as *T. tubifex* based on morphological examination. Also, no abnormal trout were detected during concurrent fish surveys. The abundance of salmonids was also not significantly different between streams with active compared to inactive beaver ponds. Our work indicates that although beaver ponds do provide habitat for oligochaetes, few tubificids were collected in these habitats and thus beaver ponds may not be a major source of whirling disease in North Carolina.

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NOTES

Linking Acoustic Telemetry and Population Genetics to Investigate Stock Structure of Atlantic Cobia

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As part of a coast-wide initiative among multiple investigators, we used telemetry tagging and genetic analyses in North Carolina and Virginia and collaborative receiver networks in the Southeast US to address questions about Cobia , *Rachycentron canadum,* stock structure and the boundary between Gulf of Mexico and Atlantic stocks. From May 2018 to September 2019, we surgically implanted acoustic transmitters in 98 Cobia caught in North Carolina and Virginia. Within two years, receiver networks between Florida and Delaware detected 87% of these fish. Most notably, we detected 26% of Cobia south of the current Georgia/Florida stock boundary, but within the recognized stock mixing zone, and 7% of Cobia overwintered south of the purported mixing zone. We suggest Atlantic Cobia exhibit philopatry, as we observed repeated returns to Chesapeake Bay during the summer spawning period. Genetic analyses confirm homogeneity within the Atlantic stock and corroborate our telemetry findings. Our results highlight the spatial complexity of Cobia movements in the Southeast US and provide information that can be incorporated into future Cobia stock assessments.

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NOTES

Determining River Herring eDNA Shedding and Decay Rates to Develop a Methodology for Quantification

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River herring, (Blueback Herring, *Alosa aestivalis,* and Alewife, *A. pseudoharengus*), were once abundant in North Carolina waters and were an economically important fishery but their populations across their ranges are smaller due in part to anthropogenic causes. A method of quantifying the spawning population sizes is needed because North Carolina's turbid and large river systems make traditional sampling difficult. By detecting trace DNA shed by river herring, the relative abundances and locations of spawning could be more easily determined. In order to obtain accurate eDNA shedding and decay rates, we performed three experiments. Two time series experiments used different quantities of herring in tanks of various size to determine how much eDNA is shed from known biomasses of fish. The third experiment was abundance sampling to discover if there could be a linear relationship between biomass of fish and amounts of eDNA in ambient water. While there was a general trend of increasing eDNA over time while the fish were in the tank, the relationship between herring abundance and eDNA amounts did not appear to be linear in the samples that have been processed at this point. Using these DNA concentrations we were able to determine a preliminary eDNA shedding rate (1.63×10^{-3} (ng/L)/h) and decay rate (2.64×10^{-6} (ng/L)/h) for river herring. These results will be compared with data from samples gathered from the Tar/Pamlico and Neuse watersheds in order to see how these trends appear in the environment. With this information, a model can be developed to quantify eDNA sampling data for river herring in NC, which has not been done previously and can be used for future monitoring projects.

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NOTES

Population Status of the North Carolina Endemic Pamlico Crayfish, *Procambarus medialis,* in the Neuse and Tar-Pamlico basin

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North Carolina is home to approximately 41 native crayfish species, and several undescribed species. Fourteen of these native, described species are endemic to North Carolina, and many other species have a large portion of their range in North Carolina. The Pamlico Crayfish, *Procambarus medialis*, is one of these endemic crayfish and historically has occurred in the Neuse and Tar-Pamlico river basins. Described in 1995, limited data exists about this species' range and life history requirements. Recent surveys have revealed a 63% decline in occurrence and the species has not been detected in the Tar basin since 2001. Only four populations have been recently detected in the Neuse Basin, with the most robust population occurring in the Croatan National Forest. Currently, 75% of the known populations are roadside ditches that are highly susceptible to anthropogenic impacts. The species has recently been proposed to be uplisted to "State Threatened" in North Carolina due to these rapid declines in occurrence. A life history study has been initiated to gather baseline information on the reproductive cycle, demographics, and population dynamics. Despite North Carolina's diverse crayfish assemblage and high occurrence of endemism, they are an understudied taxa group where basic life history and distributional data is lacking. This study will result in a better understanding of Pamlico Crayfish life history and distribution and lead to more informed conservation for the species.

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Population Characteristics of Invasive Catfish in the Pee Dee River

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Since the 1960s invasive catfish have spread through North Carolina and have had major impacts on native aquatic species in both riverine and reservoir systems. While these catfish can have a negative effect on the ecosystem, a fishery has developed in many locations, including the Pee Dee River, North Carolina. In 2019, following overexploitation concerns from anglers, a regulation measure was put in place to limit the daily harvest of catfish in the Pee Dee River, below Blewett Falls Dam to the South Carolina border, to 5 fish, in aggregate. In fall of 2018, the North Carolina Wildlife Resources Commission began surveys to evaluate catfish populations in the Pee Dee River. These surveys focused on invasive Flathead Catfish, *Pylodictis olivaris,* and Blue Catfish, *Ictalurus furcatus*, as well as non-native Channel Catfish, *Ictalurus punctatus*. Electrofishing surveys were conducted October-November 2018, May-June 2019, October-November 2019, and will continue in spring of 2020. Flathead catfish (n=156), Blue Catfish (n=205), and Channel Catfish (n=229) have been collected thus far. Mean catch-per-unit-effort for Flatheads, Blues, and Channels was 10.29, 11.11, and 7.61 fish/hour, respectively. Otoliths were removed from a subsample of Blue and Flathead Catfish and aging is in progress. To date, aged Blue Catfish range from 6 to 21 years old, with a mean age of 10.34 years old. Population characteristics will continue to be evaluated and sampling will resume in spring 2020. Preliminary results indicate an abundance of large, invasive catfish in the Pee Dee River and further data collection will allow for science-based decision making in the future.

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NOTES

A Thing Worth Doing: Successes in a Rare Fish Stocking Program

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Augmentation of fish populations using captively propagated stock is a very old management tool, but it can still be a complex and expensive undertaking that is not without risk, particularly when dealing with rare species. The Robust Redhorse, *Moxostoma robustum*; (State Endangered in NC) is a rare sucker endemic to just a few large river systems in the Carolinas and Georgia. The species was described from the upper Yadkin River in 1870 but today, the only population still extant in North Carolina is restricted to the reach of the Pee Dee River below Blewett Falls Dam, near the South Carolina state line. Intensive mark-recapture surveys, initiated in 2005, revealed that fewer than 100 spawning adults remained in the river, so augmentation efforts using stocked juveniles began in 2014. All broodstock and offspring are tracked using genetic markers to avoid deliberate inbreeding and to monitor population health. A subset of stocked juveniles were also fitted with acoustic tags to shed light on the previously unknown habits of young (ages 1 to 4) animals. Robust Redhorse are a long-lived (20+ years), slow-maturing fish, but we have documented successful recruitment of stocked fish into the adult spawning population in 2018 and 2019. In addition, data from individual recaptures of known age was used to construct an age-length key for the Pee Dee population. This case illustrates that the investment of considerable time, money, and effort required by a stocking project can be well worth doing: these stocked animals have provided invaluable insight into the life history of Robust Redhorse and their continued survival and recruitment is poised to play a significant role in the persistence of the species in this river.

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NOTES

The Suitability of Habitat Suitability Models for Imperiled Stream Fishes

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Aquatic habitat suitability models are commonly incorporated into hydraulic models to assess the quantity and quality of lotic habitat available for a specific fish or invertebrate taxon or life stage. These modeling procedures are predominantly used to predict habitat conditions under variable stream flows in regulated river networks or in systems impacted by human water use. However, habitat suitability models can be further applied to understand habitat dynamics of imperiled stream fish to guide conservation planning and management activities. I provide three examples in which habitat suitability modeling informed and enhanced North Carolina imperiled fish understanding and conservation. This approach was applied to determine causes of decline and assess the suitability of potential population restoration sites in (1) an imperiled, endemic, non-game catfish, the Carolina Madtom, *Noturus furiosus*, (2) an endangered, endemic minnow, the Cape Fear Shiner, *Notropis mekistocholas*, and (3) an imperiled large-river sucker species, the Robust Redhorse, *Moxostoma robustum*. These results may be applied to improve efficacy of reintroductions, habitat manipulations, or other conservation measures. I conclude that habitat suitability modeling is a simple means to inform species occurrence and abundance relationships with habitat quality and quantity to guide conservation efforts of imperiled, native stream fishes.

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NOTES

Characterizing Brain Morphology of Caribbean and Indo-Pacific Reef-Associated Fishes Using XRAY Microtomography (Micro-CT)

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Marine teleosts account for roughly one-third of vertebrate diversity and exhibit high levels of morphological, physiological, and behavioral diversity. As such, they represent ideal candidates for studying measures of functional diversity, which can provide a mechanistic link between organisms and their ecosystems and help us better understand how organisms evolve to changing environmental conditions. Brain morphology among teleosts varies in external form and internal structure and was historically characterized by dissecting and cross sectioning the brain. While informative, this method does not account for volumetric measures of investment in specific regions, which have been hypothesized to correlate strongly with aspects of both temporal and ecological niche. XRAY microtomography (micro-CT) has recently emerged as a non-invasive method for studying fish brain morphology, but to date has only been used on a handful of families. In this pilot study I utilize micro-CT to characterize the brain morphology of 73 reef-associated fishes. Of these, 53 individual species from 35 families are represented. Images were processed using a combination of manual and automated segmentation. Scans were first imported into the 3D visualization software AMIRA and presegmented at every fifth slice to create a set of training samples. Brain regions of interest (Optic tectum, olfactory bulb, telencephalon, cerebellum, hindbrain, and rest of brain) were manually outlined and region boundaries were refined using a thresholding tool. Training samples were then uploaded to the to the biomedical image segmentation application, Biomedisa, along with a reference image file, where the remainder of the segmentation was completed. Scans were cleaned and region volumes were calculated in AMIRA and summed to provide an estimate of total brain volume. 3D reconstructions and quantified measures of investment will compliment an assembled meta-dataset of morphological and isotopic data for collected and museum-cataloged specimens, which will be used for subsequent phylogenetic and comparative analyses.

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NOTES

Phylogeographic Patterns Among the Lanceolate *Elliptio* Species Complex

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Integration of molecular, morphological and biogeographic data improves our abilities to elucidate species boundaries and phylogenetic relationships. This approach also benefits field research by improving the ability of biologists to recognize species using comparisons of phenotypic attributes. The extreme amount of morphological variation observed among *Elliptio* species has led to the proliferation of species names and generated a long-running debate about the phylogenetic structure within this genus. Although earlier works have considered *Elliptio* to be comprised of three species complexes; *E. complanata*, *E. icterina* and *E. lanceolata*, current species lists recognize 30 *Elliptio* taxa including 7 taxa in the lanceolate group. Within the lanceolate group *E. lanceolata* is currently listed as federally threatened under the Endangered Species Act. We examined phylogenetic relationships among seven-species within the lanceolate *Elliptio* complex from 20 Atlantic Slope river basins using both mitochondrial (CO1 and ND1) and nuclear (ITS1 and 28S) DNA sequences. We constructed haploType: networks to examine species boundaries and biogeographic trends of gene exchange and to guide our single gene and multi gene Maximum likelihood and Bayesian phylogenetic analyses. Our data revealed the existence of three taxa in the lanceolate *Elliptio* complex. *E. lanceolata* was recovered as a monotypic and highly divergent from the core non-lance *Elliptio* group (*E.complanata* and related taxa). We also found support for two morphologically distinct and genetically divergent lineages, a northern *E. fisheriana* and a southern *E. angustata* lance clade that are more closely related to the core *Elliptio* group than the *E. lanceolata* taxa. Future steps are to revise taxonomy and provide guidance to resource managers tasked with managing this imperiled group of organisms.

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NOTES

Mesohabitat Modeling for Atlantic Pigtoe and Notched Rainbow in the Upper Neuse River Basin

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As development continues across North Carolina it is imperative that freshwater mussel species and their habitat are protected. We used geographical information systems to model mesohabitat for the imperiled Atlantic Pigtoe, *Fusconaia masoni,* and Notched Rainbow, *Villosa constricta,* within the Upper Neuse River basin by evaluating existing habitat parameters associated with these species. These parameters included: velocity, erosion, stream power and anthropogenic barriers which were used to calculate the range and habitat quality using 75 to 100 meter reaches within the study area. *Fusconaia masoni* and *V. constricta* ranges spanned approximately 203 and 311 stream km, respectively. Habitat quality values ranged from -144.74 to 540, with the highest number representing the most viable habitat. These values were divided into a 1-5 habitat quality ranking (HQR) system, where HQR 5 had the best habitat qualities. Within the study area, *F. masoni and V. constricta* had 95.7 and 258.48 stream km of actual viable habitat, respectively. Eleven sites were visited to field verify the GIS model. Ten *F. masoni* and 31 *V. constricta* individuals were located during the field surveys. Two *F. masoni* were observed within HQR 3 reaches, and 6 within HQR 4 reaches. All *F. masoni* were located within an overall habitat quality ranking (OHQR) of 4. Fourteen *V. constricta* were observed within HQR 3 reaches and 17 within HQR 4 reaches. Thirty *V. constricta* were observed in an OHQR of 4, and 1 within an OHQR of 3. There was no statistically significant difference between HQR's at the reach level. However, there was a significant difference in the OHQR for the *F. masoni* ($p = 0.0187$), but not for the *V. constricta* ($p = 0.2528$). Our model lays down the groundwork for future habitat models by reveling the importance of larger habitat reaches which can assist with conservation efforts.

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NOTES

Estimating Run Size of River Herring Using DIDSON Technology

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River herring, Alewife, *Alosa pseudoharengus*, and Blueback Herring *A. aestivalis*, once supported important commercial and recreational fisheries along the Atlantic coast. River herring harvest in North Carolina predominantly occurred in the Albemarle Sound and Chowan River and ranged between 6 million and 20 million pounds annually in the 1950s and 1960s. Drastic declines in harvest and abundance during the late twentieth century caused many states including North Carolina to close river herring fisheries, and the Atlantic States Marine Fisheries Commission instituted a coast-wide harvest moratorium in 2012. A sustainable fishery management plan with adequate monitoring data is required by ASMFC to reopen river herring fisheries within state waters. Run-size estimates are often the most-accepted method of population monitoring used to justify harvest in a sustainable fishery management plan, but these Type:s of estimates are lacking for North Carolina river herring populations. We initiated a pilot project during spring of 2019 to estimate spawning run sizes of river herring using dual-frequency identification sonar (DIDSON) in Vaughn's Creek, a tributary of the Meherrin River in the Chowan River basin. We attempted to collect 10-minute DIDSON videos files each hour of each day for a 13-week survey period beginning in February; however, site conditions and logistical constraints restricting our sampling timeframe to 10 weeks from 15 March 2019 through 16 May 2019. The project yielded 1,275 data files of approximately 213 hours of video. We estimate at least 400 hours will be required to process the data before run-size estimates can be calculated. Although population estimates are essential tools for river herring management, the labor required for their calculation should be considered when designing projects employing their use.

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NOTES

Fishery, Angler, and Agency Responses to Declines in *Hydrilla* in Shearon Harris Reservoir

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Shearon Harris Reservoir, located in central North Carolina, is a 1,660 ha nuclear plant cooling reservoir that was thrust into the national spotlight when a Bassmaster magazine article ranked it fourth in the 100 Best Bass Lakes of 2017. As a result, national bass fishing tournaments have taken place on the reservoir, likely increasing fishing pressure through the exposure. Shearon Harris Reservoir has been recognized by local anglers for years because of its exceptional prey base and expansive Hydrilla, *Hydrilla verticillate*, coverage. However, Hydrilla acreage has been in decline for several years and more recently, triploid Grass Carp *Ctenopharyngodon idella* were stocked to control the invasive plant. The North Carolina Wildlife Resources Commission initiated an extensive aquatic habitat enhancement project to establish native vegetation and install artificial fish attracting structures in Shearon Harris Reservoir to offset a potential loss of aquatic habitat. We present some of the challenges encountered with overcoming angler perceptions, avenues for outreach, and opportunities for increased angler interaction with the North Carolina Wildlife Resources Commission.

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NOTES

Phenology in a Changing Environment: Ecological Forecasts of Striped Bass on the Roanoke River

Quentin Nichols*, Rebecca G. Asch, and Roger Rulifson

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Climate change and climate variability are leading to shifts in the seasonal timing of fish migration and reproduction (i.e., phenology) across many ecosystems and species, with changes especially common among anadromous fishes, such as Striped Bass, *Morone saxatilis*. Understanding how Striped Bass will be affected by climate change is an important issue for stakeholders across the US East Coast given its use as a recreationally and commercially targeted species. Other spawning populations of this species vary their spawning migration timing with respect to seasonal temperatures. North Carolina hosts the Albemarle Sound/Roanoke River (A/R) stock, which is the southern most major spawning population of Striped Bass. Large A/R Striped Bass (>900 mm TL) have been shown to migrate long distances in the summer reaching Cape Cod, MA before overwintering offshore in the coastal waters of North Carolina and Virginia and then returning to their spawning grounds in early spring. This study's objective is to create an ecological forecast of the timing of the Roanoke River spawning run, which can be used to determine the best time to protect large spawning females and assess the optimal timing of water releases from dams under future climate change. The study will use historical data from a Striped Bass egg survey conducted from 1959-1992 and contemporary creel survey data to model spawning migration timing as a function of river, estuarine, and coastal temperature, regional climate indices, dissolved oxygen concentration, wind speed, river flow pulse duration timing, and Striped Bass population size structure.

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NOTES

North Carolina's Catfish Management Plan: Managing Catfish and People in an Everchanging Invasive Catfish World

N. Corey Oakley

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In December 2017, the North Carolina Wildlife Resources Commission requested that staff biologists design a plan to address the growing needs of catfish management in North Carolina. North Carolina's catfish resources include 13 species containing both native and nonnative catfish including invasive Flathead Catfish and Blue Catfish. Additionally, recreational catfish angling is complex with user groups having varied interests such as harvest oriented, desiring to catch a trophy catfish, or participating in catfish tournaments. This complexity often creates conflicts among scientists, policy makers, and constituents. The Commission's Catfish Committee created a plan that looked to balance scientific information, constituent desires, and social implications that would address the growing conflicts of catfish management in the state. The plan includes recommendations that establish population management zones and units to better manage for both native and invasive catfish which is a significant change from previous catfish management efforts in North Carolina. The plan also recommends conducting research and surveys to better understand all catfish populations throughout the state and seek alternative methods to reduce invasive catfish populations. The committee stressed the need to protect North Carolina's native catfish by designing education campaigns demonstrating the value of native fishes. A critical factor in the protection of native catfishes will be an emphasis on the prevention of invasive catfish introductions through targeted outreach to all constituents. As the catfish landscape continues to change in North Carolina, the plan will adapt and change to meet the biological and social needs of catfish management throughout the state.

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Notes

Hanging in There: Appalachian Elktoe in the Little Tennessee River

Dylan Owensby* and Luke Etchison
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The Appalachian Elktoe, *Alasmidonta raveneliana*, is a Federally Endangered mussel species endemic to the upper Tennessee River drainage in North Carolina. It is currently known to occupy six disconnected sub-drainages (the Nolichucky, French Broad, Pigeon, Tuckasegee, Little Tennessee, and Cheoah rivers). Prior to 2004, one of the mussel's healthiest populations occupied the Little Tennessee River between the Emory Dam (near Franklin, NC) and Fontana Reservoir. However, a dramatic die-off of *Alasmidonta* species in the Little Tennessee River beginning in 2005 led to Appalachian Elktoe population declines of approximately 80% within one year. Appalachian Elktoe were not detected at any longterm monitoring sites in 2015. Research efforts were immediately undertaken to explain the die-off, but there has been no "smoking gun" discovered. Despite their population declines, Appalachian Elktoe are still hanging on in low numbers in the Little Tennessee River. A large-scale mussel occupancy study was completed in summer 2019 with 37 sites surveyed (semi-quantitative) in the Little Tennessee River. There were only four Appalachian Elktoe seen during these efforts (CPUE: 0.05 mussels/person-hour), roughly consistent with CPUE data from surveys during the last five years. However, a new healthy population was discovered in 2019 in Burningtown Creek, a medium-sized tributary to the Little Tennessee River. Although more research is needed to identify causes of mortality, we hope to eventually reintroduce Appalachian Elktoe to the Little Tennessee River using the Burningtown Creek population as a broodstock source.

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NOTES

Exploring Legacy Datasets to Infer Spatial and Temporal Trends in the Cape Fear River Ictalurid Community

Kyle T. Rachels

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The Cape Fear River Basin is located along the southeastern Atlantic Slope and is the largest river basin located within North Carolina. Historically, the Ictalurid community was characterized by 5 species of bullhead, *Ameiurus spp*. and 3 species of madtom, *Noturus spp*. Channel Catfish, *Ictalurus punctatus*, were introduced in the early 20th century, followed by Flathead Catfish, *Pylodictis olivaris*, in 1965 and Blue Catfish, *I. furcatus,* in 1966. The goal of this project was to examine historical North Carolina Wildlife Resources Commission datasets to elucidate spatial and temporal trends in the Ictalurid community in the lower Cape Fear River Basin. Rotenone surveys conducted in the 1960s documented abundant madtoms and White Catfish, *A. catus,* throughout the basin, with Channel Catfish and White Catfish the dominant species in the three largest rivers. Native catfish species comprised the majority of the Ictalurid community through the early 1990's. In the last 20 years, only six individuals of native catfish species have been collected in the three largest rivers in the basin, concurrent with the capture of 2,994 nonnative catfish. The most abundant species historically, White Catfish, has not been observed since 2008. Flathead Catfish are abundant and have been implicated in the rapid decline of native Ictalurids. Despite the widespread distribution and abundance of nonnative catfish, native species are still found in some reservoirs and tributaries upstream of the Fall Line. The North Carolina Catfish Management Plan prioritizes the conservation of native catfish in Atlantic Slope rivers; however, extirpation may have already occurred in several watersheds.

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NOTES

Evolution of the Brook Trout Genetic Baseline in North Carolina

Jacob M. Rash[1]*, David C. Kazyak[2], and Barb A. Lubinski[2]
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Brook Trout, *Salvelinus fontinalis,* is the only salmonid native to North Carolina, and as such, it is a species of significant biological and cultural importance. The North Carolina Wildlife Resources Commission (NCWRC) has conducted numerous efforts to support Brook Trout conservation. Beginning in earnest during the 1990s, genetic characterization of the state's Brook Trout populations is one of the NCWRC's more enduring and dynamic conservation activities. Initially, allozyme testing was employed, with over 480 collections having been genoType:d at the creatine kinase locus. In 2010, the NCWRC began utilizing more contemporary molecular methods by conducting an extensive survey of Brook Trout genetic diversity and variation. To date, 467 collections (9,507 individuals) from Brook Trout populations have been genoType:d at 12 microsatellite loci. These data have provided insight into evolutionary relationships across spatial scales, population demography, hatchery introgression, and the fundamental unit of management for Brook Trout: the population. As such, this genetic baseline has served as an invaluable tool in informing management actions (e.g., habitat improvement, population restoration, and land protection) in North Carolina and throughout the species' native range. We plan to continue to supplement the existing genetic baseline to characterize additional populations and further enhance conservation efforts.

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NOTES

Causes and Solutions to Barotrauma in Marine Reef Fishes

Brendan J. Runde

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When reef fish such as snappers and groupers are hauled to the surface from the seafloor, the pressure differential causes internal gases to expand. This can result in organ damage or displacement and is called “barotrauma.” Severe barotrauma often leads to an inability for the fish to submerge after release, and floating is essentially a death sentence for fish. The first panel of this presentation describes the causes of barotrauma. The second panel details manifestations of barotrauma as well as a key methodology for mitigating its effects: descender devices. Descender devices return afflicted fish to a depth where internal gases contract and therefore allow the fish to overcome the positive buoyancy caused by barotrauma. This information is timely, as the South Atlantic Fishery Management Council has recently (September 2019) approved regulations that require the presence of descender devices on board any vessel fishing for bottom fish in our region. The author will demonstrate one Type: of descender device, the SeaQualizer, and verbally describe recent results regarding the efficacy of recompressing barotraumatized fish.

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NOTES

Assessing the Response of Freshwater Mussel Populations Following Dam Removals

Vincent Santini* and Michael Gangloff

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Dam removal has many obvious benefits to stream ecosystems and biota including increased connectivity as well as improvements to water and habitat quality. However, funding for post-removal monitoring is often limited or non-existent and few studies have quantified the effects of short or long-term impacts of removals on stream faunas. Additionally, surprisingly few dam removal projects quantified pre- or post-removal mussel populations or measured changes in stream physical habitat conditions and so it is difficult to determine whether dam removals benefit or harm freshwater mussel populations. Our goal is to address this information gap by examining the long-term impacts of dam removal on freshwater mussel populations in the eastern US. We have compiled information on 185 dam removal projects across 22 states conducted during the last two decades. Although we were only able to find mussel survey information on 29 out of the 185 dams that support freshwater mussel populations, pre-removal studies were conducted in only 13 (~ 48%) of these systems. The number of projects with post removal studies is larger (22 projects, ~ 76%). During summer and fall 2019 we conducted mussel surveys in streams where dam removals occurred in order to better understand the long-term consequences of these actions. Surveys were conducted in the former dam tailwater reach as well as at reference sites up- and downstream of the former impoundment. We prioritized sites where pre-impoundment mussel surveys were conducted. Data from this study will provide important context for understanding the time frame for the response of mussel populations following dam removals as well as provide guidance for future dam-removal projects.

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NOTES

NCFishes.com: A Website Devoted to North Carolina's Freshwater and Saltwater Fishes

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*Presenting

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The website was initially developed in 2014 by Scott Smith and Jesse Bissette, both employees of the NC Division of Marine Fisheries, to showcase their photographs of freshwater and marine fishes found in the eastern part of North Carolina. They quickly expanded to fishes found in other parts of the state. Recently it was decided to upgrade and expand the site to provide a more informational and interactive experience, similar to the Fishes of Georgia website, with a phylogenetic listing of families and species. Each species will have multiple photographs, a dot distribution map, and an information page. The latter will include definitive characters, explanations on how to differentiate from similar looking species, and other pertinent aspects of that species. Blog posts composed of minor notes on collection trips, range expansions, nonnative species, underwater videos, and other ichthyology related topics are also being considered for inclusion.

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NOTES

Effects of Interstitial Fine Sediments on Appalachian Elktoe Survival and Growth

Michael Thompson[1]*, Rachael Hoch[2], and Michael Gangloff[1]

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Freshwater mussels spend much of their lives buried within sand and gravel substrates but increased concentrations of fine sediments associated with forestry, agriculture, urbanization and road construction are widely believed to have negatively impacted many riverine species. Elevated concentrations of fine sediment measured in the South Toe River downstream of the US Highway 19E expansion project and the confluence of Little Crabtree Creek are believed to be playing a role in the decline of endangered Appalachian Elktoe populations. In April 2019, we began a field trial to examine the role of interstitial sediments on caged mussels. The field study was paired with a concurrent trial conducted at the Marion Conservation Aquaculture Center (MCAC). For both experiments, Appalachian Elktoe were propagated from South Toe broodstock at the MCAC. We placed juvenile mussels into cages filled with river substrate. Five mussels were placed in each caged and 6 cages were placed at each of 7 sites in the South Toe River. Mussel length, width, height, and survival were measured seasonally. The hatchery experiment used a similar design but mussels were placed in sediments obtained from 4 sites in the South Toe River. Fine (<500 µm) sediments were collected using freeze-core sampling at 1) a control site located upstream of the highway impact, 2) a highway-impacted site, 3) a site located several km downstream of the highway-impacted site. A fourth sediment-control group was grown using standard hatchery sediments. Mussel length, width, height, weight, and survival were measured monthly. Preliminary results of the field trial reveal mussels grown in cages downstream of Highway 19E have lower growth rates than mussels grown in cages upstream, and in the hatchery trial, mussels grown in the impact sediment have 67.5% survival, compared to 90% survival of mussels grown in upstream sediment.

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NOTES

Monitoring the Federally Endangered Humpback Chub, *Gila cypha*, and Other Fishes in the Lower Colorado River, AZ - A Volunteer Opportunity of a Lifetime

Bryn H. Tracy[1]*, Michael J. Pillow[2], Ryan Green[3], and Taylor Greene[4]
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In September 2019, I was extremely fortunate to be chosen as a volunteer on a U.S. Geological Survey's Grand Canyon Monitoring and Research Center-funded study under the direction of the U.S. Fish & Wildlife Service in Flagstaff, AZ to assist in a long-term monitoring project of the federally endangered Humpback Chub, *Gila cypha,* and other fishes in the Lower Colorado River. How could I pass up an opportunity to work with an endangered species in a biologically, physico-chemically, and geologically unique riverine ecosystem? This study, on the largest tributary to the Colorado River downstream from the Glen Canyon Dam, focused on estimating the abundance of various size classes of the Humpback Chub through mark-recapture efforts employing 180 hoop nets set at three reaches across 20 transects per reach for three days per reach. All chubs were either tagged with PIT (Passive Integrated Transponder) or VIE (Visible Implant Elastomer) tags. My presentation will show the wondrous beauty of the habitat that the Humpback Chub occupies and the stark environment of the Little Colorado Canyon. I will also share my experiences and comaraderies of working with young fishery professionals that share a common goal of protecting a culturally and ecologically important national treasure.

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NOTES

Summary of Duke Energy's Lake Norman Monitoring Over the Past Six Decades

Nick Wahl

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Lake Norman, the largest reservoir in North Carolina, was created in 1963 with the completion of Cowans Ford Dam on the Catawba River. Since that time, Duke Energy has maintained a robust monitoring program to evaluate potential impacts from Marshall Steam Station and McGuire Nuclear Station on the lake. Water quality and chemistry samples have shown no adverse impacts from operations on the lake environment, and the thermal plumes from the two facilities do not interact. Additionally, fish community sampling has demonstrated that overall, populations remained stable across years, and any changes to fish population abundances have been primarily related to legal or illegal introductions of new fish species, including Hybrid Striped Bass, Alabama Bass, and Alewife.

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NOTES

Managing a Brown Trout Tailrace Fishery in North Carolina

Chris Wood

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Bridgewater Tailrace (BWTR) is a 29-km waterway extending from Lake James to Lake Rhodhiss on the Catawba River in western North Carolina. An 18-km reach is classified as Special Regulation Trout Waters by the North Carolina Wildlife Resources Commission (NCWRC) and managed as a put-grow-and-take Brown Trout, *Salmo trutta,* fishery. Early studies demonstrated recruitment of stocked fingerling (25-75 mm TL) Brown Trout was highly variable and possibly impacted by elevated discharge water temperatures during late summer months. Recent upgrades to Bridgewater Hydro Station resulted in more consistent minimum flows and dissolved oxygen levels, which may help ameliorate historical recruitment issues. In 2011, the NCWRC initiated a multi-year study to evaluate annual stockings of 10,000 advanced fingerling (200-255 mm TL) Brown Trout stocked during late fall after the threat of elevated discharge water temperatures. Differences among and within years were determined for CPUE, relative weight (W_r), and proportionate contribution of stocked brown trout. Catch rates were variable among years, and several years showed significant differences between spring and fall surveys for CPUE and W_r; however, temperatures appeared suitable for year-round survival so other mechanisms must be considered. Age and length data suggested that recruitment to age 2 was extremely limited, and older fish were rare. A variety of factors not evaluated during this study may be preventing stocked fish from recruiting to older year classes, including flow alterations, habitat limitations and excess angler harvest. Stocking advanced fingerlings in the fall appeared to establish a fishery composed primarily of age-1 brown trout. Nonetheless, trophy fish were present in low numbers, body condition was good, and growth rates were fast, suggesting that minor alterations to the current management approach such as increasing the minimum size limit may continue to enhance the fishery. Age-structured modeling simulations predicted that an increased minimum-length limit (MLL) of 356 mm to be the best regulation for optimizing structural size indices and yield. Based on this study, the NCWRC adopted a 356-mm MLL and two-fish creel limit per day for the BWTR on 1 August 2018.

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NOTES