2019 VA-WV-VT Joint Meeting Presentation Abstracts

Tuesday, February 19th to Thursday, February 21st, 2019

Blacksburg, VA

Largemouth Bass Population Response to a Protected Slot Limit Regulation in a Small Impoundment

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*Presenting

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South Mill Creek Lake in Grant County, WV, is a 19 ha, eutrophic, centrarchid-dominated small impoundment lying at a surface elevation of 396 m. The lake's Largemouth Bass *Micropterus salmoides* (LMB) population was regulated by a minimum size limit of 305 mm until 2007. Consistently low PSD values, low quality-size CPUE, high mortality despite high recruitment, and poor population size structure typified the population under the minimum size limit regulation. Furthermore, a tagging study conducted in 2004 revealed a reported angler harvest of 18%, the highest of 12 WV small impoundments surveyed. In 2007 a protected slot limit regulation (305 – 406 mm) was implemented to increase survival of cohorts to quality size. Boat electrofishing surveys were conducted across a 14-year span to evaluate fishery performance during both regulatory regimes. Significant increases in yearly PSD values and quality-size CPUE were observed. High annual survival of the strong 2008 year class into the protected length slot drove indications of positive regulatory impacts. Evaluations of growth rates under both regulatory regimes suggest that the slot limit imposed no unexpected negative impacts on growth related parameters. Results suggest that angler compliance with regulations may be enhancing the quality of this population. A follow-up creel survey conducted during the 2016 warmwater angling season to evaluate post-regulation exploitation. Results indicated a 24% harvest interest rate among all angler age categories and an 8% exploitation rate for LMB < 305 mm (N = 202 anglers). Furthermore, it was realized that fishing pressure at this lake was high (est. 3,185 angler catches), exploitation was detected (est. 103 harvested), and the protected slot limit had a 90% satisfaction rate among anglers. The protected slot limit regulation was considered successful, and could be applied to other fisheries where black bass populations exhibit poor size structure.

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Assessment of Small Impoundment Bluegill Populations in Northern West Virginia

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Bluegills are often one of the most abundant sportfishes in public waters, and are popular with many anglers. However, in West Virginia, little management of this species occurs and no specific regulations exist. We assessed Bluegill populations within five small impoundments in northern West Virginia currently under different management regimes. Our main objectives were to estimate relative abundance, age and size structure, condition, growth, and mortality of populations. We also sought to determine how other factors (e.g., Largemouth Bass, angler harvest, etc.) influence Bluegill populations. Bluegills and co-occurring species were collected in small impoundments using boat electrofishing. We calculated catch per unit effort (CPUE; fish/hr.) as a measure of relative abundance and utilized fish lengths and weights to determine proportional size distribution (PSD) and relative weights. Sagittal otoliths were removed from a sub-sample of Bluegills and used for age and growth analysis. From 2016–2018, 3,523 Bluegills were collected across five small impoundments, of which 566 individuals were used for age and growth analysis. Bluegill population characteristics (CPUE, age, growth, mortality) varied across each small impoundment. Total lengths of aged individuals ranged from 40–237 mm and ages ranged from 0–9 years. Across all small impoundments, PSD ranged from 11–57 and PSD-P ranged from 0–23. Bluegills reached preferred length (200 mm) in as little as 3 years in some small impoundments, and never reached preferred length in others. Results from this study suggest factors such as Largemouth Bass abundance and size structure, presence of competitors (i.e., Gizzard Shad and Common Carp), and harvest can influence the age, growth, and size structure of Bluegill populations. These results will aid in future management efforts of these small impoundment Bluegill populations.

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Efforts to Enhance Channel Catfish Natural Recruitment in Virginia Small Impoundments

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Channel Catfish are stocked in multiple small impoundments throughout the state to increase angling opportunities. In most small impoundments Channel Catfish stocking is the only source of recruitment. To better understand if catfish spawning box installation can contribute to the harvestable (15 inch) population we chose five small impoundments and began clipping adipose fins of stocked fish in 2014. Impoundments were staggered over three years for sampling feasibility with limited staff. Past studies indicated limited or no recruitment of Channel Catfish in Virginia's small impoundments, which is consistent with our sampling results in 2017 and 2018. Installation of catfish spawning boxes was conducted the winter after sampling for natural recruitment. In the summer 2018 we found Channel Catfish utilized spawning boxes successfully in the two impoundments they had been installed. Boxes were used extensive in Lake Robertson with up to 100% occupancy of 29 boxes on a given day. Slate Lick Lake was the second impoundment observed and received multiple flooding events in early June raising the water level 15 feet above normal pool and increasing turbidity hindering sampling ability. Channel Catfish utilized boxes at Slate Lick Lake post flooding, but occupancy only reached a maximum of 30% when temperatures were consistently above 25 C. Paired Channel Catfish produced egg masses within one week and fry within two weeks. Boxes were used multiple times is some instances. Stocked Channel Catfish will continue to be adipose clipped after spawning box installation. These cohorts will be sampled to determine if spawning boxes increase the abundance of wild harvestable size Channel Catfish. Sampling methods will utilized night electrofishing, gill netting and tandem hoop netting. Otoliths will be used to examine age and growth. Growth data will also allow us to obtain information to better adjust minimum size and creel limit regulations.

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Evaluation of Sampling Gears and Population Characteristics of Catfish in the Monongahela River, WV

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Angler interest in catfishing has increased in West Virginia, specifically in larger rivers such as the Ohio and Kanawha Rivers. Given the increased interest for catfish, special regulations were recently imposed to enhance and conserve catfish fisheries on the Ohio and Kanawha Rivers. A large tributary to the Ohio River, the Monongahela River, is a popular fishing destination and is targeted by anglers for catfish. However, catfish populations have not been thoroughly evaluated on the Monongahela River, and little is known about the population. The primary objective of our study was to gain knowledge on catfish population characteristics in the Monongahela River to aid in future management of this fishery. Secondarily, we sought to develop long-term sampling protocols for channel and flathead catfish in riverine systems of West Virginia. During 2018, we sampled seasonally using hoopnets, trotlines, and low frequency electrofishing. In total, 592 catfish were collected, in which 498 were channel catfish and 94 were flathead catfish. Length, weight, sex, and age data were obtained from collected individuals. Total lengths of collected individuals ranged from 189 – 950 mm for channel catfish and 215 – 1054 mm for flathead catfish. Ages of collected individuals ranged from 2- 32 years for channel catfish and 4 – 35 years for flathead catfish. Additionally, sampling will again be conducted seasonally in 2019. Population characteristics (e.g., relative abundance, size structure, age structure, growth, etc.) will be modeled to aid future management decisions and differences in gear success will be evaluated and used to develop sampling protocols. Data collected will be valuable in guiding future monitoring and management of this and other riverine catfish populations in West Virginia.

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Examining Multi-scale Effects of Land Use on Fish Abundance within the New River Basin

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Biotic communities in streams are often negatively affected by human land uses, such as removal of riparian vegetation and conversion of adjacent land to agriculture or urban development. However, the scale(s) at which watershed land uses can predict characteristics of stream communities is widely debated. While some authors emphasize the influence of the riparian corridor on distribution patterns of species and communities, others contend that land use across the entire upstream watershed is more important. We hypothesize that the land-use context with the most influence on stream biota is species-dependent, reflecting the specific traits that make species sensitive (or not) to environmental shifts associated with particular land uses. To test this hypothesis, we collected fishes from 101 sites across the New River basin in North Carolina, Virginia, and West Virginia. For each species occurring at an adequate number of sites, we used machine learning techniques (LASSO and BRT) to compare the predictive ability of land use (percentage coverage by forest, agriculture, or urban; number of road-stream crossings) on species abundance at three spatial scales: 1) local riparian - within 30 m of the stream segment (section of stream between its nearest upstream and downstream confluences) within which the fish survey occurred, 2) watershed riparian – within 30 m of the sampled stream segment and all upstream tributaries, and 3) entire upstream watershed. Because land use varies with physiography in the New River basin, we included physiographic variables (stream gradient, topographic relief within the upstream watershed, elevation, soil texture, and surficial geology) as co-variates. Our research seeks to provide species-specific relationships and guidelines for describing the effects of land use and physiography on fish distributions, thereby adding clarity to the ongoing debate regarding the adverse ecological impacts of land use on stream biota.

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A simulation study to evaluate the influence of sub-sampling bin sizes on growth parameter estimation

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Fish population dynamics are governed by rates of births, deaths and individual growth. In temperate waters, growth of bony fishes is frequently estimated from ages assigned via examination of annular rings on hard structures (e.g., otoliths). However, determining ages from hard structures can be time consuming and expensive, limiting the number of fish that can reasonably be aged. Further, many species must be sacrificed to reliably determine ages. Thus, it may not be desirable to sacrifice all fish sampled to determine ages, particularly for species of conservation concern. Consequently, fisheries managers often subsample from an original sample to reduce resources expended and unnecessary mortality. Several subsampling strategies have been used in fisheries science, including random and stratified random subsampling schemes. Stratified subsampling schemes often sample a predetermined number of fish within size bins and over-sample less common size groups relative to more common size groups. However, it is unknown how the width of length bins influences parameter estimation. The goal of this study was to determine how bin width can influence the accuracy and precision of growth parameter estimates. We used a simulation study to assess four different bin widths (i.e., $1/40$, $1/20$, $1/4$, and $1/2$ of L_∞) and four different subsample sizes (i.e., 10, 15, 20, and 25 samples) to assess the influence of sample size. We found that subsampling can introduce biases into growth model estimation. The largest bin we examined provided the most accurate estimates of L_∞ from the von Bertalanffy model at low sample sizes, but estimated other parameters less accurately and bias increased with sample sizes. Researchers should evaluate proposed sampling and subsampling procedures for potential bias in growth parameter estimation.

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Protective Slot Limit, Changing Angler Behavior, and Increased Survival Has Unintentional Consequences for Striped Bass Fishery

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Preservation of a trophy striped bass fishery at Smith Mountain Lake, Virginia, has been a management priority for decades due to its popularity and being the only Virginia reservoir that consistently produced trophy size striped bass (state citation size of 9.1 kg or 940 mm). A striped bass fish kill in 2003 lead to a protective slot limit (508 mm – 914 mm) for the months of November-May to improve the size structure and expedite the recovery of the trophy fishery. The new regulations required anglers to release larger sized fish and many began changing their behavior by continuing to voluntarily-release fish outside of protective sizes or seasons. Average annual release rates of tagged fish, 508 mm and larger, increased from 14% in 2001 to 68% in 2011. First year survival of stocked fingerling striped bass was high from 2005-2011. By 2009, gizzard shad *Dorosoma cepedianum* populations drastically declined and by 2014 striped bass growth of adult fish was nearly stagnate. As a result, striped bass stockpiled in the protective slot limit and few reached trophy status.

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Examining mutualistic interactions between nest-building stream fish and Clinch dace using two modeling approaches

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Understanding how habitat influences species distributions is a fundamental question in ecology and management. Ecologists have traditionally modeled species distributions as a function of only abiotic components of the environment. However, more recent modeling frameworks have allowed for simultaneous inclusion of biotic and abiotic factors in a single predictive model. To-date, ecologists have primarily incorporated negative biotic interactions between species (*i.e.*, competition and predation) into these models; however, positive species interactions (*i.e.*, facilitation and mutualism) have been shown to be equally important in determining species distributions. Hierarchical Modeling of Species Communities (HMSC), is a new modeling approach that can quantify the strength of interactions (both positive and negative) among species in a community and can provide increased understanding of the biotic components shaping species distributions. We compared the predictive performance of HMSC models to traditional, univariate models that do not account for biotic interactions in streams occupied by chubs (*Nocomis spp. and Semotilus spp.*) and stonerollers (*Campostoma spp.*). These taxa are known for are known for constructing spawning nests or pits that are mutualistically used by other species of nest associates, such as the Clinch dace, with many species becoming obligatory nest associates in degraded habitats. Importantly, many nest associates are data-poor, making species-habitat relationships and distribution difficult to quantify using traditional statistical frameworks. This talk will compare species-habitat predictions generated by traditional logistic regression with HMSC models that incorporate species interactions and discuss the strengths and weaknesses associated with each modeling technique.

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The federally endangered Candy Darter (*Etheostoma osburni*): how did it happen and can we prevent population extirpation or species extinction?

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The Candy Darter was listed as a Federally Endangered Species, effective as of 21 December 2018. This species is an endemic to the upper Kanawha River system (i.e., above Kanawha Falls) of the Ohio River Basin in West Virginia and Virginia. Although the Candy Darter population had experienced modest declines in the late 1900s for various reasons, the introduction of a close relative (Variegate Darter) into its range is rapidly jeopardizing its existence via hybridization. This presentation will discuss the timeline of the Variegate Darter introduction, the history and status of the Candy Darter in West Virginia, and a plan to hopefully preserve this federally endangered species in West Virginia.

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Population genetic structure of the endangered Candy Darter in West Virginia and implications for management

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The endangered Candy Darter *Etheostoma osburni* is a narrow endemic to the Kanawha River basin in West Virginia and Virginia. It has been extirpated from much of its historic range in West Virginia, restricting it to sections of the Gauley and Greenbrier river drainages. In addition to its small range and shrinking population sizes, the species is under threat of losing genetic diversity because of introgressive hybridization with the Variegate Darter *E. variatum*. Establishing the population genetic structure of pure Candy Darters and assessing their genetic diversity can inform conservation practices such as translocations, captive breeding, and re-introductions. We genotyped 68 individuals from seven sites in the New River Drainage with 12 microsatellite loci to evaluate their population genetic structure. Multiple genetic analyses revealed significantly high levels of genetic differentiation between the Gauley and Greenbrier River drainages (K=2; F_{st} = 0.132). Significantly high relatedness was observed between individuals within 6 of the 7 sites. Based on our results, Candy Darters in the Gauley and Greenbrier River drainages have been living separated long enough to result in high levels of genetic distinctness. We found no evidence of migration between the two drainages and conclude that the populations in the two drainages should be managed separately.

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Variation in detectability among riffle-dwelling fishes in two Virginia streams

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Understanding how physical habitat factors influence detectability and occupancy can inform management of imperiled fishes. We examined detectability of fish species inhabiting riffles in two tributaries of the New River in Virginia. The Candy Darter *Etheostoma Osburni*, recently listed as federally endangered, is a habitat specialist for cool high-velocity riffles, while the Bluehead Chub *Nocomis lephocephalus* is ubiquitous in streams across the New River drainage. We compared variation in detectability of these species at patch- and riffle-specific spatial resolutions across a set of riffle-runs. Within each riffle-run we identified, then separately sampled, habitat patches that varied in depth, velocity, and substrate type. We used three-pass electrofishing between block nets to sample fishes in specific habitat patches in each stream. We used multi-season occupancy models to assess pass-specific detectability of both species. Occupancy models containing depth, velocity, and substrate type as covariates of detection out-performed the null models for both species. The proportion of substrates 3 – 256 mm in diameter (gravel – large cobble) positively affected detectability of Candy Darter. However, the probability of detecting Bluehead Chub was negatively affected by the proportion of substrates 3 – 256 mm. Our analyses suggest that accounting for the variation in detectability associated with season, habitat configuration, taxon, and population density can increase the reliability of measures of fish distribution and movement patterns. Furthermore, understanding the efficacy of electrofishing methods can inform the sampling effort necessary to produce reliable and cost-effective estimates of fish presence and absence.

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Assessing Brook Trout (Salvelinus fontinalis) Populations Above and Below Waterfalls in Virginia

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Anthropogenically driven factors, such as increasing temperature and sediment in valley streams, acidification of mountain streams, and the introduction of non-native trout, are restricting habitat suitable for healthy populations of eastern brook trout (*Salvelinus fontinalis*) throughout their native Appalachian range. Brook trout are important as top predators in mountain streams and as a favorite of anglers. It is crucial that remaining populations in ideal habitats be identified and preserved. Waterfalls are geologic knickpoints preventing base-level lowering that create unique landscapes above them, which may alleviate the temperature-productivity/acidity "habitat squeeze" for populations of brook trout and could serve as potentially ideal targets for conservation efforts despite being isolated. This study compares brook trout populations above waterfalls to those below them in Virginia mountain streams. One-hundred meter reaches above and below seven waterfalls in Virginia's George Washington and Jefferson National Forest were sampled for brook trout via 3-pass, block-netted, backpack electroshock depletions. All trout were counted, weighed, and measured for fork length. The response variables are differences in 1) estimated population biomass, 2) estimated population abundance, and 3) length-weight index (Fulton's Condition Factor) between brook trout above and brook trout below waterfalls. We found overall biomass (885.3 vs 284.6 grams per 100m) and abundance (26 vs.12 individuals per 100m) of brook trout populations above waterfalls to be greater than their below waterfall counterparts. We also found brook trout above waterfalls to have a greater condition factor (1.086g/cm^3 vs 1.0636g/cm^3) than those below waterfalls (α=0.1). Lastly, we found populations above waterfalls where their presence was previously unknown. Despite being isolated, brook trout populations above waterfalls were just as if not more robust than those below and may be good targets for conservation.

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Using sex ratios of Brook Trout to identify population resilience and spawning adult size structure

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Brook Trout are the only native species of trout in West Virginia. They inhabit cold, headwater streams in the mountainous region of the state. Some Brook Trout populations may either resist changes over time or recover more quickly from environmental variation than others. These populations may be said to be resilient and identifying drivers of their resiliency is important for conservation of these populations into the future. Through research on 25 streams in West Virginia, we hope to find out what drives variations in total Brook Trout numbers across time. One metric that may influence population resilience is sex ratios. Defining the size of both male and female fish during the spawning period may help determine reproductive potential within a given stream. We analyzed data from 2016-2017 and found females (153mm & 34g) to be slightly smaller than males (165mm & 41g) across sites on average. By comparing the ratio of males to females, we can begin to see if there is any correlation in sex ratio and stream population variation. The expected result is that streams with a low population of females will also have higher levels of variation in population. When grouping the 25 streams by average abundance of mature adults, two distinct groups were identified. Streams with higher Brook Trout numbers (> 20 total mature adults) are 59.1% female and 40.9% male, while streams with lower Brook Trout numbers (< 20 mature adults) are 51.7% female and 48.3% male. As the sex ratios approach 1:1 the population numbers decrease. Furthermore, a negative trend was identified between the average female proportion of the population sample and the long-term coefficient of variation for overall Brook Trout abundance. Females are drivers of reproductive magnitude and are vital to ensure stable population numbers and genetic variation into the future.

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Why are there no big Brook Trout in headwater streams?

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It has long been wondered why current Brook Trout population size structure in headwater streams do not match the perception of "large" fish from historical photos. I combined bioenergetic-based estimates of rations required to maintain fish with estimates of prey inputs. The short answer to the question posed in the title is that productivity is too low to support large fish in these smaller streams. In summer, terrestrial insect (TI) inputs in forested streams average only 17.3 mg/m^2/day. Whereas it takes 3 g of TI prey to maintain a 100 g fish. Based upon TI inputs it would require nearly 60m of stream length to maintain a single 100 g trout. Without connectivity to enable access to larger systems with greater food resources production of "large" trout is very limited

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Stream Restoration and Monitoring Efforts and the Introduction of Brook Trout (Salvelinus fontinalis) Into Catharpin Creek, a Small Spring-fed Stream in Bull Run Mountains Natural Area Preserve Located 35 Miles Outside of Washington, DC

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Previous research regarding suitable habitats for Salvelinus fontinalis (brook trout) found that Catharpin Creek in Virginia Outdoor Foundation's Bull Run Mountain Natural Area Preserve (VOF-BRMNAP) had potential to facilitate survival of brook trout fry through warmer seasons. Brook trout are members of the char genus (Salvelinus), a charismatic mega-fauna. They are native to eastern United States and are currently under intense multi-agency conservation efforts. Results from initial assessment of the sub-watershed, while indicating conditions suitable to support sustainable brook trout populations, also suggested conditions were not optimum and warranted restoration efforts. Efforts have included removal of invasive species such as multiflora rose (Rosa multiflora) and the propagation of species, such as native alder (Alnus spp.) and black willow (Salix nigra), which are conducive to providing shade that ensure survival through the summer and providing predator protection. A plan for future efforts include further removal of woody invasives and the plantings of native saplings. There are four release sites within VOF-BRMNAP's Jackson Hollow Catharpin Creek, in which 50 trout fry were released in spring 2017, and 277 released spring 2018. Future efforts include more native plantings, removals of woody invasive plant species near inhabitable pools, and expansion of restoration efforts on the site. Ultimately, Catharpin Creek restoration plans exemplify the impact high school students can have on natural resource management and conservation efforts.

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Lake Fertilization and Nutrient Budgets: Lake Management versus Chesapeake Bay Total Maximum Daily Load (TMDL) Reduction

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Nitrogen and phosphorus entering the Chesapeake Bay must be reduced to meet the requirements of the Environmental Protection Agency (EPA) 2010 Chesapeake Bay Total Daily Maximum Load (TMDL). Lake fertilization by the Virginia Department of Game and Inland Fisheries (VDGIF) is long standing accepted management tool for fisheries enhancement to stimulate algal blooms. The intentional addition of fertilizers into recreational fishing lakes has been brought into question as contributing to nutrient loading of the Bay. To evaluate this concern, since March 2017 we have been conducting a comprehensive lake water chemistry evaluation of four lakes in the watershed of the Bay: Lake Brittle, Burke Lake, Huntsman Lake and Lake Shenandoah. The first two were fertilized by application of Sportmax® during the two summers included in the evaluation period. Samples were taken at each lake from feeder streams, tail waters and within-lakes, assayed and compared for the evaluation. More than twenty chemical and analytical parameters have been measured, with total phosphorus (TP) and total nitrogen (TN as NO_3-N + NH_3-N + organic N) of primary concern. Stream gauge data and rainfall records were used to develop loading and discharge values for water volume, that were combined with observed concentrations to give nutrient budget data. During the first season of sampling rainfall and runoff were slightly below average values. In the second year of the study, rainfall increased by more than 73%. Daily average nitrogen loads and discharge (kg/d) during the first year of the study were: Brittle (23, 17), Burke (44, 43), Huntsman (13, 28) and Shenandoah (56, 26). The first year daily average phosphorus loads and discharge (kg/d) were: Brittle (1.74, 0.57), Burke (5.38, 0.35), Huntsman (0.25, 1.07) and Shenandoah (0.41, 30). These data revealed that VDGIF lakes were storing nutrients, while the unfertilized Huntsman Lake was discharging nutrients, In year two, nitrogen loads and discharge (kg/d) were: Brittle (52, 34), Burke (23, 12), Huntsman (33, 32) and Shenandoah (77, 55), while the phosphorus values were Brittle (2.23, 1.24), Burke (5.85, 1.17), Huntsman 1.46, 1.95) and Shenandoah (0.38, 0.31). The values were greater in year two due to the high discharge, but nutrient nitrogen and phosphorus were again stored in VDGIF lakes and released from the unfertilized lake.

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Mucking Around with Aquatic Plants in Claytor Lake: What have we Learned?

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Aquatic vegetation is an important habitat component in southern reservoirs, but native vegetation in these important fisheries is often displaced by unwanted non-native species, creating less desirable habitat conditions. Claytor Lake, a 1,764 ha mainstem reservoir of the New River in Pulaski County, Virginia, which contained a number of native aquatic plants historically, was colonized by hydrilla (*Hydrilla verticillata*) in the early 2000's. Hydrilla control during the early 2010's using triploid grass carp (*Ptenopharyngodon idella*) resulted in hydrilla suppression and the loss of remaining native aquatic vegetation beds in Claytor Lake. While the management plan developed to guide hydrilla control discussed native vegetation restoration as an ultimate outcome, additional partnerships were created and grant funding was awarded to make the dream a reality. After 5 years of native vegetation restoration work on this reservoir, we share our story as an example of what can be accomplished when diverse constituencies converge in natural resource management.

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Population Genetic Analysis of Striped Bass in the Roanoke River Basin

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Striped Bass is a widely sought gamefish in the Commonwealth of Virginia. Smith Mountain Lake has gained national attention, supports numerous fishing guides, and has an organized angler group, the Smith Mountain Striper Club. The Roanoke River drainage, including Smith Mountain Lake, Lake Gaston, and Leesville Reservoir, has some of the most popular striped bass fisheries in the Commonwealth. Because the system has several dams, formerly anadromous striped bass populations became land-locked and have been maintained by stocking. Fisheries management programs involving stocking need to augment populations in a responsible manner. A key basis for responsibly augmenting populations is to characterize genetic variation and incorporate the findings into responsible hatchery and stocking practices. The allelic diversity of the population at microsatellite markers is a useful measure of genetic diversity, providing the basis for parentage analysis and characterization of population structuring. We have generated microsatellite DNA data on Striped Bass populations across the Commonwealth of Virginia as well as various populations in the Southeast and the Hudson River. These data provide insight into the genetic and demographic histories of Striped Bass populations across the range. These findings can be used to inform management and stocking protocols for Striped Bass in the Roanoke River drainage.

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Effects of spatial autocorrelation on the diet composition analysis: an example based on a migratory species along Eastern Coast of China

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Spatial autocorrelation has been widely used in species distribution studies but rarely considered in diet analysis. We compared three estimators in estimating the prey composition in the diet of a migratory predator species whitespotted conger (*Conger myriaster*) sampled along Eastern Chinese Coast in 2011. The three estimators are spatial independent, cluster-based, and spatial kernel density approaches. These three estimators showed the ontogenetic and seasonal variations in the diets of whitespotted conger. Different estimates of the diet prey composition of whitespotted conger were presented based on these three estimators, and their accuracy and precision were compared. The spatial kernel density approach resulted the lowest MSE values following by the cluster-based method, which suggest that the spatial estimators worked the best in the diet analysis when the predators sampled at each site showed potential spatial dependence, even if the spatial correlation was weak.

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Evaluating drivers of Brook Trout stock/recruitment relationships in West Virginia headwater streams

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Understanding the productivity of a fish stock can greatly improve the management of the population. Given the recreational importance of Brook Trout in West Virginia, proper management of their populations is imperative. Being able to predict recruitment based on stock abundance can help guide harvest regulations and restoration activities aimed at managing stock size. Data from 25 headwater Brook Trout populations from 2003-2017 were used to build stock/recruitment relationships. Models were built using linear and segmented linear regressions to evaluate relationships between stock size and the abundance of Age 0 fish the following year. Of the 25 sites, 9 had significant stock/recruitment relationships and the remaining 16 did not. Random forest analyses based on classification trees were built to evaluate potential biotic and abiotic drivers of the presence of stock/recruitment relationships. Habitat variables did the best job of predicting which streams would have significant relationships. Small streams (<2.8 m mean wetted width) tended to have significant relationships while larger streams did not. When broken into linear or segmented relationships new patterns emerged. Streams with a linear stock/recruitment relationships tended to have slow Age 0 growth (<74 mm mean Age 0 length) but overall high average condition (>-0.009). Streams with segmented relationships were smaller (< 2.8 m mean wetted width) and low gradient (<13% mean slope). While some of our streams did have stock/recruitment relationships, many did not. These tended to be larger streams which likely have increased influence from fluvial migrants. This fluvial influence likely reduces our ability to detect stock/recruitment relationships due to a potential inability to properly estimate stock size. Variability in recruitment due to factors other than stock size may also be driving an inability to detect relationships.

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Understanding Virginia Anglers' & Other Wildlife Recreationists' Conservation Behaviors & Perspectives about the State Agency

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Social factors can influence how and whether wildlife recreationists, such as anglers, participate in conservation and interact with state wildlife agencies. In order to better engage recreationists we must understand their thoughts and behaviors. A human dimensions approach helps to develop this understanding by using social science to investigate what recreationists think and do related to conservation and why. We conducted 8 focus groups with wildlife recreationists (e.g., anglers, birders, wildlife viewers, hunters) to help the Virginia Department of Game and Inland Fisheries (VDGIF) understand how to best engage recreationists in Virginia while promoting their involvement in conservation.

We found recreationists participated in multiple types of conservation behaviors, including social environmentalism (i.e., involving others in conservation) and land stewardship (i.e., enhancing habitat) activities. Motivations for recreation behaviors included a desire to interact with others (i.e., affiliative motives) and to connect with the outdoors (i.e., appreciative motives). Constraints differed among recreation groups, with birders and wildlife viewers impeded by structural constraints (e.g., lack of time) and hunters and anglers impeded by interpersonal constraints (e.g., interactions with others). Further, we investigated recreationists' trust in the VDGIF. Trust was often rooted in positive, personal interactions with VDGIF employees (i.e., affinitive trust) and on positive perceptions of past demonstrated effectiveness by the agency (i.e., rational trust). Additionally, we explored recreationists' perceptions of the VDGIF's ability to serve different recreation groups. We found anglers felt they received unequal levels of service compared to other segments of anglers in Virginia.

Understanding the thoughts and behaviors recreationists have towards conservation and the VDGIF can guide the agency in better serving and engaging a diversity of recreation constituencies. The results from focus groups will also aid in developing a survey instrument that will further explore recreationists' thoughts and behaviors throughout Virginia.

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The TIA Alliance: Students and Conservation Organizations Working Together for the Integrity of Our Aquatic Ecosystems

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Signed on November 17th, 2018, the **TIA Alliance** charter is a symbolic culmination of activities initiated six years ago by students on the *Trout Out of the Classroom* team at James Madison High School, Vienna, VA. Composed of **T**rout Unlimited, the **I**zaak Walton League of America, and the **A**merican Fisheries Society, the member organizations of the TIA Alliance will work together to emulate *Trout Out of the Classroom*'s AAA (Awareness, Action, Analysis) Process on the national level. Awareness entails identifying an environmental quality problem, followed by Action in which students conduct a pre-assessment and field research. In the third step, Analysis, students examine data, conduct a post-assessment, and share quality-assured data and results with the scientific community and responsible natural resource agencies. Due to its mission-driven nature, the process can be replicated anywhere in the country, no matter the problem that needs to be addressed. The TIA Alliance will provide students with resources and training required to implement an action plan so that they can make a tangible difference in their local watersheds. TIA organizational direction will develop through consensus of the three TIA governors (one from each organization). The promotion of youth engagement in natural resource conservation activities will benefit not only the students involved, but also the respective TIA organizations. Trout Unlimited can implement a defined program for high schoolers to bridge the gap between their *Trout in the Classroom* and *5 Rivers* programs. The Izaak Walton League will institute steps to help reach their goal of monitoring 100,000 streams by 2022. The American Fisheries Society is working to create special membership and mentoring opportunities for high school students. Regardless of the different opportunities and resources each nonprofit provides, their synergy will create an ideal platform for engaging future generations of environmentally aware citizens.

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Investigations into the life-history and genetic diversity of the Tennessee heelsplitter (*Lasmigona holstonia*)

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Freshwater mussels are one of the most imperiled faunas in North America, and current management efforts to support mussel populations require that key life-history information and genetic diversity of a mussel species be determined. The Tennessee heelsplitter (*Lasmigona holstonia*) is a headwater-dwelling species with a native range spanning Alabama, Georgia, North Carolina, Tennessee, and Virginia. Currently, *L. holstonia* is listed as endangered in Virginia, and is a candidate for listing under the U.S. Endangered Species Act. This species is critically understudied, with multiple key life-history traits and genetic diversity for this species still unknown. For this project, DNA samples from several populations of *L. holstonia* have been collected throughout the Clinch River (VA), New River (VA), and Ocoee River (TN) systems. Gravid female mussels from each river system were used to determine the naturally occurring host-fish relationships for *L. holstonia*. Our results suggest that Mottled Sculpin and Stoneroller are suitable hosts, which offers insight into the movement patterns of *L. holstonia* throughout its primary habitat of first and second order streams. Mitochondrial *ND1* markers were used to determine the degree of genetic diversity between *L. holstonia* populations for mussel recovery and management efforts. This is part of a larger project that will develop species distribution models for *L. holstonia* to assist resource managers in locating previously undocumented populations and to determine suitable habitat for reintroduction efforts. The project will provide data and recommendations to resource managers on the need for listing this species.

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Blue Catfish and Flathead Catfish Population Characteristics and Movement in Ohio and Lower Kanawha River, West Virginia

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The West Virginia Division of Natural Resources began reintroducing Blue Catfish into the Robert C. Byrd Pool of Ohio and Kanawha Rivers, beginning in 2004. Previous survey protocols produced insufficient data for monitoring population changes and making informed management decisions concerning this emerging fishery, along with a renowned Flathead Catfish fishery. Modified sampling schemes utilizing multiple gears to assess catfish populations were initiated to better manage this area of interest in 2017. Spring boat electrofishing surveys have been more efficient at capturing Flathead Catfish (mean CPUE 29.5±12.2 fish/hr) than Blue Catfish (2.4±.9 fish/hr). Catches represented all size classes for Flathead Catfish. Blue Catfish size distributions were highly variable between years, with quality fish being most common (38±15% of total catch). No trophy Blue Catfish have been collected so far using this gear. Fall trotline surveys have produced similar catch rates and size distributions for both species, while selecting larger fish than electrofishing. All Flathead Catfish collected have been quality-size or larger, and quality-size Blue Catfish have averaged 49±6% of the annual catch. A total of 21 Flathead and 24 Blue Catfish were implanted with acoustic transmitters in Fall 2018. Sex ratio, condition, size distribution, and spatial distribution were considered when selecting fish to tag. Data will be downloaded from acoustic receivers on a monthly basis, active tracking will occur quarterly to evaluate movement, behavior, and survival of these fish.

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Springtime Exploitation of Brook Trout by Anglers in Remote Headwater Streams of Central Appalachia

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In the central Appalachian Mountain, Brook Trout *Salvelinus fontinalis* are a popular target of anglers, but given the remoteness of many of these systems traditional creel methods of evaluating angling impact are impractical. We used a combination of angler surveys, fish population surveys, and motion activated cameras to determine the sizes and numbers of fish harvested, trout size structures, and angler effort in six streams in West Virginia. On average, anglers retained 3.7 fish ≥ 170 mm TL per trip. Between March 13 – May 29, we estimate anglers harvested 0.1 to 2.3 fish per 100 m in the six streams. Given these harvest rate estimates, we predicted a mean of 14.5 angler-days to deplete all Brook Trout ≥ 170 mm TL in 25 headwater streams of West Virginia. Anglers appeared knowledgeable of local fish populations and focused greater effort on streams with larger populations of harvestable-sized fish and easier access. While Brook Trout populations in low productivity streams may be particularly sensitive to harvest, anglers appear to use them less often. However, given the overall low abundance of harvestable-sized fish, with abundant under-sized fish in these streams, post-release stress may be an important source of mortality, particularly in low productivity streams.

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Long Term Variability in Brook Trout *(Salvelinus fontinalis)* Populations and Climate across a Large Spatial Extent in the Central Appalachian Mountains

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Examining variation in fish populations over time and space may be strengthened when climatic variations are understood and incorporated into analyses. We used a 15 year Brook Trout (*Salvelinus fontinalis*) dataset with samples across a ~4800 km² spatial area in the Central Appalachian Mountains and combined it with PRISM climate data at the subwatershed level to investigate temporal trends of each. Using regression, we found significant increases in air temperature ($p=0.04$) and precipitation ($p<0.01$) across our study area, with significant (negative and positive, respectively; both $p<0.01$) changes in variation of these variables also. Extreme rainfall events (# of days above 95% percentile for total daily precipitation in a given year) and consecutive dry days (# of consecutive days with >1mm precipitation in a given year) are both significantly increasing over time (both $p<0.02$). We also found significantly ($p=0.02$) increasing Brook Trout catch variability on public land sites across time. In a multi-model inference procedure, the best performing models to explain Brook Trout catch and variability contained the significantly model-averaged relationship between Brook Trout catch and coefficient of variation in a given stream across time. In a given year across all sites, the total precipitation model carried the greatest Akaike weight and showed a positive trend with Brook Trout catch. This work provides a starting point to understand the dynamics of these sentinel headwater fish populations as they experience a changing climate. Additional levels of analyses are needed that expand this work and illustrate more detailed relationships that influence population dynamics and recruitment across age classes. These results may indicate areas of concern across both space and time for managers to focus conservation efforts in those streams which indicate higher variability as they could experience greater risk of localized reduction or extirpation.

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Trout Angler Use and Trends at the Clinch Mountain Fee Area

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The Virginia Department of Game and Inland Fisheries (DGIF) catchable trout program provides outdoor recreation in many streams and lakes that otherwise do not provide trout fishing opportunities or, in some cases, any other fishing opportunities. Virginia's catchable trout program stocks trout from October 1st through May 31st into over 600 miles of streams and numerous ponds and small lakes. Unfortunately, summertime opportunities to fish for stocked trout are limited throughout Virginia. In order to expand trout fishing opportunities, DGIF operates three fee areas that allow anglers to fish for stocked trout during the warmer months. Clinch Mountain Fee Fishing Area in southwest Virginia is open from the first Saturday in April until September 30th and is stocked four times/week. Anglers are required to purchase a daily $8 permit in addition to a basic fishing license. In 2016, an access point angler survey was conducted from April through September (12 days/month). Total permits sales in 2016 were 11,844 permits. Total angler hours were estimated at 41,073 with a mean trip length of 4.2 hours. Anglers from ten states fished during 2016, with 95.4% residing in Virginia. Miles driven one way to fish ranged from 1-650 (Mean = 45.4). Angler fishing frequency averaged 14 days/season, and the Satisfaction (scale 1-5) averaged 4.4. Total trip expenditures from April – September were estimated at $275,467. Angler success was high with 1.25 trout caught/hr. In 2016, anglers reported catching 50,102 trout with 33,370 harvested.

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Population genetics of Brook Trout (*Salvelinus fontinalis*) in the southern Appalachian Mountains

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Brook Trout, a species important to sport fishing and conservation, is the native salmonid of the Appalachian Mountains and much of eastern North America. We characterized variation at 12 microsatellite DNA loci in 21,998 brook trout among 836 populations from Georgia to Quebec to the western Great Lakes region. Within-population diversity tended to be lower in the southern Appalachians relative to the mid-Atlantic and northeastern parts of their range. Effective population sizes of populations in the south were often very small, with many estimates less than 30. Genetic variation was pronounced among drainages (57.4% of overall variation), but was considerable at fine spatial scales (13% of variation among HUC12 drainage units); remarkably, 87.2% of individuals were correctly assigned to their collection of origin. Bayesian clustering and discriminant analysis of principal components showed that two major assemblages of populations differentiated at the eastern continental divide. Contemporary population genetic variation showed the signatures of geographic expansion of brook trout from Mississippian, mid-Atlantic and Acadian glacial refuges, as well as differentiation at the drainage basin scale. While some impacts were apparent at the population level, stocking did not overwhelm the signal of natural history upon large-scale patterns of population genetic variation. Our results show that much of the population structure in Brook Trout occurs at fine spatial scales (HUC-10 or smaller drainage basins), with additional structure at broader geographic scales. Additional work is necessary to provide managers with genetic information on a scale relevant to specific management activities.

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Variable Exploitation of Walleye and Saugeye in John W. Flannagan Reservoir

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A multi-year tagging study was initiated in early 2016 to estimate catch and exploitation rates of Walleye and Saugeye in John W. Flannagan Reservoir. Fish were collected with electrofishing gear in late winter – early spring in 2016 – 2018. A total of 582 Walleye and 156 Saugeye were collected and tagged with T-bar anchor tags. A $20 reward was offered for each tag returned by anglers and a total of 83 tags have been returned to date. Adjusted angler catch and exploitation was highest in the first year of the study with anglers catching 37% of tagged fish and harvesting 46% of legally harvestable fish. In 2017, angler catch and exploitation dropped to 6% and 11%, respectively. Angler catch remained low in 2018 at 9% as did angler exploitation (11%). Factors contributing to this substantial reduction in exploitation remain unclear. However, despite the lower estimates in the final two years of the study the mean exploitation rate (23%) at John W. Flannagan Reservoir is among the highest observed on stocked Walleye waters statewide.

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Egg Size Variation Among Walleye in Virginia

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Egg size is an important life history trait that may vary within a species in response to environmental conditions, genetics, or latitude. This study examined egg size variation across different populations of Walleye *Sander vitreus* in Virginia. We quantified egg size for over 50 Walleye from New River and South Fork Holston River. Differences in egg size between populations were statistically significant and not strongly associated with female length. Eggs of Walleye from the New River were 60.8% larger in volume than those from South Fork Holston River. These observations support the significance and uniqueness of the New River Walleye.

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Exploring Pathways of Atlantic Sturgeon DNA in Diets from a Tidal River Fish Assemblage using NextGeneration Sequencing

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A concern among managers during the Atlantic Sturgeon recovery phase is predation on early life stages (e.g., eggs and larvae) by other fish species. Fish collections occurred on known spawning grounds during prime spawning periods (September-October) on the tidal Pamunkey River in Virginia in 2016. Entire digestive tracts were extracted from 593 total fish samples (representing 23 fish species), 34 of which were from intact fish prey items to evaluate secondary predation. DNA metabarcoding techniques were used to amplify two markers for each sample: mitochondrial cytochrome c oxidase I (COI) and the nuclear 18S rRNA gene. Negative and positive control samples of known Atlantic Sturgeon DNA were included during each of six runs on an Illumina MiSeq platform to verify proper amplification. Genetic sequences were compared to custom and online genetics databases (i.e., SILVA 128 and BLAST). Overall, the presence of Atlantic Sturgeon DNA was detected in two Blue Catfish (0.3% of total samples; 1.5% of total Blue Catfish samples) and no other fish species. We conclude that the two Sturgeon detections were from Blue Catfish consumption and not other pathways; however, it is impossible to elucidate whether Sturgeon were directly preyed upon or scavenged. Predation studies on several sturgeon species have shown varied results. The recruitment bottleneck within the Pamunkey River Atlantic Sturgeon population is likely not mediated by consumption of early life stages, and other biotic and abiotic factors should be explored (e.g., flow regime, water quality, and suitable spawning habitat). We recommend amplifying multiple genetic markers and analyzing the entire digestive tract to maximize the ability to detect target prey items in future DNA-based diet studies.

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Comparative Analysis of Two Genetic Markers Used Separately and in Conjunction for DNA Metabarcoding Diet Studies

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DNA barcoding techniques have revolutionized our ability to conduct comprehensive diet studies. These innovative techniques can identify diet items that were previously unidentifiable by traditional methods. Most molecular studies generally focus on utilizing a single genetic marker to identify diet items. We collected entire digestive tracts from 593 total fish from a tidal section of the Pamunkey River in Virginia for DNA metabarcoding analysis. Twenty-three distinct fish species were represented, and 34 of the samples analyzed were taken from intact fish prey items to evaluate secondary predation. NextGeneration DNA sequencing was used to amplify two markers for each sample: mitochondrial cytochrome c oxidase I (COI) and the nuclear 18S rRNA gene. Genetic sequences were compared to custom and online genetics databases (i.e., SILVA 128 and BLAST). Generally, 18S was more effective at identifying to the species level and vertebrate prey. We found higher species richness in a given sample using COI, but this gene was frequently only capable of identification to a higher taxonomic level than 18S (usually order or family). Both markers consistently detected distinct prey items not detected by the other. By analyzing multiple genetic markers, we obtained a snapshot of fish diets, which would have been less comprehensive if using a single marker. We recommend utilizing multiple genetic markers to enhance future diet studies, and increase detection of target DNA.

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Competition and Predation: Interactions between American eels (*Anguilla rostrata*) and brook trout (*Salvelinus fontinalis*) in Virginia mountains streams

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The native range of American eels (*Anguilla rostrata*) and brook trout (*Salvelinus fontinalis*) overlap historically; however, this relationship has been altered by anthropogenic modifications to rivers. Their populations have been declining overall, but the removal of dams and construction of eel ladders has likely increased the co-occurrence of these two native fish in Virginia. The purpose of this study was to investigate the degree of competition and predation between American eels and brook trout, as these are two of the most influential interactions acting on the structure of natural communities. The study was conducted at Crabtree Falls in Nelson County, Virginia, which acts as a natural barrier to eels migrating upstream. Eels and brook trout live sympatrically below the falls (treatment) and brook trout live in the absence of eels above the falls (control). Eel and trout diets (n = 33 and 120, respectively) were sampled via gastric lavage, three times between May and August 2017, along with benthic and drifting invertebrates. Brook trout abundance was higher above the falls, but size and body condition did not differ significantly between sample reaches. Both fish species had low rates of empty stomachs (7-8%) and there was zero observed predation. Over the course of the study brook trout mostly preferred terrestrial invertebrates of the 12 available prey groups with no significant difference in diet where they co-occurred with eels, and eels preferred crayfish. Diet overlap between trout and eels below the falls was 73% overall; however, this does not directly indicate competition. Invertebrate communities had lower abundance below the falls, but both sample reaches had similar diversity, and there was no significant difference between invertebrate communities overall. As conservation efforts increase the co-occurrence of brook trout and American eels, it appears there is limited potential for adverse competition.

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Virtual reality meets fish biology: introducing Project eTrout

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Virtual reality (VR) provides new opportunities for ecological research and education. Here we introduce a new initiative to apply VR for fish abundance and habitat use estimation in headwater streams (Project eTrout). We provide preliminary analysis comparing fish abundance estimates from 360-degree video samples, backpack electrofishing, and diver counts for a series of headwater stream pools in Shenandoah National Park. We highlight current opportunities and limitations for VR in fish ecology using crowdsourcing and citizen science platforms.

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A Fisheries Management Perspective: Public Versus Private Sector Approaches

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Solitude Lake Management

Fisheries management is the process of planning and taking actions to manipulate fish populations, fish habitat, and people to achieve specific human objectives. Generally, fisheries managers use adaptive management to address specific fisheries concerns for particular resources. However, management strategies likely differ for biologists managing private and public waters. For example, when improving habitat in lentic systems, private-sector biologists traditionally focus on managing aquatic plants, liming and fertilizing, and aeration. Biologists managing public lakes often create artificial reefs to improve angling success, and manage hydrology associated with outflows and water level fluctuations. Managing stakeholders in public waters is often a complex process involving diverse interests whereas for most private waters, biologists deal with a single owner making the process more simplistic. In terms of fish stocking, biologists managing private waters tend to focus on enhancing the forage base (focus on growth of sportfish) while public-sector manager's stock catchable-size fish to improve angling success or fingerlings to supplement recruitment in more dynamic environments. Both private and public sector management can learn a lot about fisheries management from each other by applying different techniques in the lakes they manage.

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Restoration of Beneficial Native Vegetation in the Presence of Herbivores

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Compared to natural lakes, reservoirs are young and lack the seed banks for aquatic vegetation. Often, this void is filled by invasive species such as hydrilla (*Hydrilla verticillata)*. Therefore, reservoir managers often seek to establish native aquatic plants to improve habitat and preclude establishment by invasive species. Lake Monticello is a 352-acre reservoir in Fluvanna County, Virginia. The Lake Monticello Owners Association periodically stocked triploid Grass Carp (*Ctenopharyngodon idella)* from 1988 – 2006 to control hydrilla. Grass Carp successfully controlled hydrilla, but left the reservoir devoid of any aquatic plants. In this study, we constructed wire mesh enclosures to establish 90 founder colonies of pickerelweed (*Pontederia cordata)*, soft stem bulrush (*Schoenoplectus tabernaemontani)*, water willow (*Justica americana)*, spatterdock (*Nuphar lutea)*, and eelgrass (*Vallisneria americana)*. We chose these aquatic plants due to their aesthetics and resistance to Grass Carp herbivory. This study was conducted as part of a three-phase approach to introduce native plants to Lake Monticello. In the first phase, we planted all plant species in enclosures at nine sites throughout the reservoir and monitored survivability and growth over the following four months. Preliminary results from phase one indicate that the emergent and floating species survived and grew well whereas eelgrass did not. Phase two will involve adding more enclosures to the sites and species that did well and attempt to find an alternative submersed plant. During phase three, the plant enclosures will be removed and monitored for survivability and growth.

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Lighting Up the Black Box: Discovery of Novel Viruses that Infect Fish Using Massively Parallel Sequencing Approaches

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Understanding disease ecology is a critical, yet often under acknowledged component of fisheries management. Managing disease in the hatchery setting is perhaps the most familiar application. The management of disease in natural ecosystems is often less straightforward. These management strategies typically focus on efforts that minimize the introduction and spread of known pathogens. This approach, however, assumes that all relevant disease-causing organisms are known. Fish mortality events or lesions that cannot be ascribed to a known disease organism are still often observed in managed fish populations. Advances in sequencing technologies during the past decade have facilitated disease investigations for which classical approaches have fallen short. Here we discuss the identification of several fish viruses that have been identified using deep sequencing methodologies in tandem with bioinformatic pathogen discovery pipelines. At present we have identified novel viruses that infect the endangered fountain darter, brook trout, white sucker, alewives and smallmouth bass. Some of these viruses are associated with overt disease while others are not. Here we discuss the application of this approach to identify novel emerging viruses associated with idiopathic fish diseases. We will focus on examples of virus discovery in white sucker that inhabit the Great Lakes Region and introduce a candidate virus associated with blotchy bass syndrome. While often referred to as next generation sequencing, massively parallel sequencing methods are in fact "now generation". Coupled with appropriate sampling and analysis, it is a promising tool to address unexplained disease in fishes. As aquatic ecosystems change due to natural and anthropogenic influences, disease thresholds are likely to fluctuate and emerging pathogens may become more frequent. Managers cannot responsibly manage aquatic diseases within a black box. Adopting available discovery technologies provides a means to light up this black box, enhance informed disease management strategies, and better educate the public.

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A Tale of Two New Catfishes from Oz

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*Presenting

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Two new species of *Tandanus* (eel-tailed catfishes) were recently described from tributaries of the east coast of Australia. *Tandanus tropicanus* (Wet Tropics Tandan) is found in coastal tributaries of the Wet Tropics Region of northeast Queensland, Australia. *Tandanus bellingerensis* (Wilang or Bellinger Catfish) is found in four river drainages of the mid-northern coast of New South Wales, Australia. Previously, only two species of *Tandanus* catfishes were recognized from Australia: *Tandanus tandanus* (Freshwater Catfish) of the Murray-Darling drainage and coastal streams of central-southern Queensland and New South Wales, and *Tandanus bostocki* (Freshwater Cobbler) of southwestern Western Australia. Descriptions of the two new species add to the recognized fish diversity of Australia, and inform natural resource agencies relative to the management of Australia's eel-tailed catfishes. Both new species are valuable food fishes, as well as recreationally import to anglers.

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2019 VA-WV-VT Joint Meeting Poster Abstracts

Tuesday, February 19th to Thursday, February 21st, 2019

Blacksburg, VA

VDGIF Northern Snakehead Citizen Science App.

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Citizen science is an approach to incorporate citizens into biological data collection and analysis. The VDGIF Northern Snakehead Citizen Science App allows the general public to document Northern Snakeheads throughout Virginia. These data can be combined with verified reports from research/monitoring studies, and the VDGIF phone hotline to develop distribution maps which highlight spatial and temporal patterns. There have been 132 observations to date following its launch in 2014. Reports range across the state from the Potomac River down to the Northwest River and as far west as the Thornton River. Of those 132 observations, VDGIF biologists could only consider 55 reports because of proper evidence provided. Unsubstantiated reports were due to misidentification of the fish or lack of adequate photograph. Misidentified fish include bowfin (3.6%), American Eel (3.6%), and minnow spp. (1.8%). The overall distribution of verified reports looks similar to the statewide distribution pattern from all available data sources. This poster highlights the current state of the citizen science app, applications, improvements, and the authenticity of the citizen-collected data.

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Identification of larval darters of the upper Roanoke River drainage

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Accurate identification is a fundamental prerequisite for any study of larval fishes. However, little information exists for identification of larval darters known from the upper Roanoke River drainage (URR), including the federally endangered Roanoke Logperch (*Percina rex*). We are assessing differences in external morphometric traits and pigmentation patterns between taxa (two genera, six species) of approximately 800 URR larval darter specimens. Identification to species will be confirmed by genetic barcoding based on mitochondrial DNA sequencing. Preliminary multivariate analyses of morphometric data reveal distinct clusters corresponding to genus (*Percina* versus *Etheostoma*) and some clustering within genera. Distinguishing traits include relative (to total length) pectoral fin length, eye diameter, preanal length, preanal myomere count, and pigmentation patterns. If externally visible traits can be used to identify URR darter larvae, this will expedite future identification of wild-caught larvae in the URR and other river drainages across Virginia.

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Modeling the Predation Dynamics of Invasive Blue Catfish *Ictalurus furcatus* in the Chesapeake Bay Tributaries and Subestuaries

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Blue catfish *Ictalurus furcatus* have been introduced to many Atlantic and Pacific drainages in the United States, and have invaded the largest estuary in the contiguous U.S.A – the Chesapeake Bay. Despite being widespread and abundant, little is known about the feeding behavior of this large, predatory catfish. We used a stratified random sampling design to collect stomach contents from 14,488 blue catfish in three major tributaries of the Chesapeake Bay. Canonical correspondence analysis (CCA) was used to identify key drivers of blue catfish diet, while generalized additive models (GAMs) were used to explore trends in blue catfish predation rates of depleted or commercially-valuable native species, including American shad *Alosa sapidissima*, river herring, *A. aestivalis* and *A. pseudoharengus*, American eel *Anguilla rostrata*, and blue crab *Callinectes sapidus.* CCAs revealed that diets were significantly correlated with season, salinity, and catfish total length (LT), while our GAMs revealed the circumstances that cause greater predation rates of at-risk or commercially valuable species. For example, we found that American shad and river herring were most susceptible to predation by large catfish (600 –1000 mm LT) in freshwater areas during the month of April. This paper provides methods for identifying times, locations, and other circumstances that are associated with maximal predation rates of target species. The information gained from these approaches can be used to reduce the predatory impact of invasives on at-risk native species, by informing management strategies such as increased harvest or targeted removals of the invader.

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Using fishers' knowledge of catch rates to conserve Brazilian fisheries

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Tropical fisheries produce about a third of the world's capture fisheries production, but suffer from severe lack of data on catch and fishing effort, which inhibits fisheries management. An alternative source of data is fishers' knowledge. Previous studies have shown that when biases associated with fishers' knowledge are minimized, it is possible to reliably assess historical changes in catch rates for up to 30 years in the past. Despite the potential for fishers' knowledge to fill data gaps, there are few established criteria for identifying "knowledgeable" fishers, which makes it difficult to know which fishers should be selected to provide such information. In addition, empirical research on the memory bias of fishers' memories is rare, making it difficult to know which variables should be asked of fishers. This study is part of a larger effort to develop an approach to use catch rate data based on fishers' knowledge in fisheries assessment. We have documented catch rates based on fishers' knowledge for a total of 61 fisheries along the coast of Brazil, including artisanal and industrial fisheries in mangrove, reef, coastal and pelagic environments. Data from interviews with more than 500 fishers in these fisheries showed a number of trends. Fishers' catch rates for some fisheries showed sharp declines, particularly in the South and Southeast regions, while for others they remained stable, especially in the Northeast and North regions.

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Bluegill (*Lepomis macrochirus*) exhibit distinct morphology, but not gonad mass, in reservoirs *versus* streams

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Human-made reservoirs account for the great majority of lentic habitat in Virginia. Fish living in streams that become reservoirs face radical changes to their environmental conditions and biological interactions, creating an opportunity for strong selection and rapid phenotypic change. We compared the body morphology and reproductive investment of bluegill (*Lepomis macrochirus*) in reservoirs *versus* the streams that fed them. Stream samples represented a "space for time" control, providing an estimate of the bluegill phenotypes that were present when the reservoirs were built. We hypothesized that reservoir bluegill would have (1) a more "steady swimming" body shape, due to the reduced flow velocity, and (2) earlier and greater investment in gonad tissue, due to greater predation threat for adults. Reservoir bluegill had deeper bodies and narrower caudal peduncles than stream bluegill, consistent with hypothesis (1). However, the timing of gonad growth and mass of gonad tissue did not differ between reservoir and stream bluegill. Together, these results suggest that morphology has responded more strongly to the change in environment than gonad mass has. We would need to determine the fitness and plasticity of different body shapes to know the relative contribution of genes and environment to the consistent changes in morphology that we observed.

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Bluegill Habitat Use in the Upper Mississippi River

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Anthropogenic modifications to the environment have had damaging effects on the wildlife that depend on those natural ecosystems. Specific to Upper Mississippi River fishes, channelization, dams, and loss of floodplain connectivity have all been purported as deleterious. In the face of these habitat modifications, understanding habitat requirements of individual species is needed in order to help guide management and restoration efforts. Furthermore, bluegill (*Lepomis macrochirus*) are an important indicator species that may provide insight to habitat needs of the broader fish community (e.g., "canary in a coal mine"). Prior research suggests bluegill require a mosaic of habitats throughout all life stages (e.g., main channel to backwater connection). As such, the objective of this study was to identify the habitat needs of bluegill in the Upper Mississippi River. We evaluated bluegill habitat use via electrofishing conducted by the United States Army Corps of Engineers' Long-Term Resource Monitoring Program (LTRMP). Electrofishing events (n=2,124) were conducted at three field sites (Pool 4 in Lake City, MN, Pool 8 in Onalaska, WI, and Pool 13 in Bellevue, IA) throughout the Upper Mississippi River from 1993 to 2017. Our results suggest that bluegill prefer backwater channels with shallow water (0.5-1.5m), low flows (.01-.19m/s), sandy substrates, and areas with woody debris. Management efforts that focus on the preservation of backwater habitat and connectivity to main channel should help to sustain bluegill populations in the Upper Mississippi River. The information garnered in this study can be used to help direct management efforts that not only favor bluegill, but also other members of the Upper Mississippi River fish community.

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Urban Stream Restoration: Material Processing and Conveyance Channels

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Restoration is often defined as the reestablishment of pre-disturbance functions, processes, and related chemical, physical, and biological links between aquatic and riparian ecosystems. Stream restoration is gaining popularity in the Mid - Atlantic region to offset impacts from urbanization, such as increased levels of impervious surfaces and decreased vegetation along stream banks, changing the flow patterns of the water. Due to these changes, urban stream systems tend to have high erosion rates resulting in increased sedimentation into the Chesapeake Bay. Different restoration practices such as conveyance channels and material processing channels can play a large role in the amount of nutrients leaving a stream system. Conveyance channels are constructed to protect existing utility and infrastructure placed adjacent streams (e.g., sewer) from erosion. This restoration practice prioritizes channel stability and may result in reduced other stream functions (e.g., habitat, nutrient uptake, etc.). Material processing channel design techniques developed after the use of wood in Pacific Northwest restoration. These streams are supposed to help meet the TMDL (Total Maximum Daily Load) levels and provide fish and wildlife habitat, as well as support a reduction of instream energy and associated erosion. They work to retain nutrients, sediment, and organic matter and raise the water level so it can connect with the floodplain. This study evaluated these two restoration practices in terms of macroinvertebrate diversity and abundance and organic retention to help professionals and citizens gain awareness for the different restoration practices and see the benefits that material processing channels can provide to the ecosystem.

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Pitt Springs Run: A Tale of Two Water Chemistries

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Pitt Spring Run is a small stream (8000 m) that discharges from the Massanutten Mountain in Page Co, VA. The upper reach of the stream has extremely low pH (< 4.5), no alkalinity and toxic (> 400 ppb) aluminum concentration values. At the confluence with Cub Run, however the water quality has changed to circumneutral pH (> 7.0), high alkalinity (> 15 ppm) and low aluminum (< 25 ppb). The lower reach of the stream supports a viable native trout population, while trout and other fish are absence in the upper reach. The reason for this dramatic difference in water chemistry and associated aquatic biota is due to watershed geology. The upper reach discharges from hard Silurian orthoquartzite sandstone which has no natural carbonate to offset atmospherically derived acid rain. When the stream meets the discharge of Pitt Spring about 2300 meters upstream of the mouth, the geology has changed to Devonium Group post-Tonoloway limestone, Needmore Formation and Millboro (Martinsburg) Shales which are soluble rocks that provide plenty of carbonate. In 2010, the US Forest Service began an experimental limestone treatment strategy to enable trout survival upstream of the spring. There has been limited success due to access limitations and other issues since that time. The results of water chemistry monitoring by JMU for this cooperative project from 2010-2018 will be presented in this poster. Problems that have occurred and recommendations will be discussed in the context of how water chemistry values tie to practicalities of management in the field.

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Lake Keokee: Physical – Chemical Parameters, Fish Populations and Management Issues

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The Virginia Department of Game and Inland Fisheries owned Keokee Dam impounds a 98 acre reservoir near the headwaters of the North Fork Powell River in Lee County, Virginia. Lake Keokee's purpose is to provide public recreational fishing in a rural mountain setting. It provides a warm water environment for fish species such as largemouth bass, bluegill sunfish, red-ear sunfish and channel catfish. However, over the fifty years since its construction, fish recruitment and growth have not met the expectations of fisheries managers and anglers. Lake Keokee has been drained and refilled for various reasons, treated with limestone to control iron floc and fertilized with a nitrogen-potassium-phosphorous mix to enhance productivity. The goals of this project were to analyze Lake Keokee water chemistry and sediments, watershed characteristics, geology and lake morphology to provide data for fisheries managers. Inductively coupled plasma-mass spectrometry (ICP-MS) was used to measure trace elements: iron, aluminum, magnesium and arsenic. Major ions were determined by ion chromatography (IC). Total phosphorous and chlorophyll a were measured colorimetrically and by fluorimetry, respectively. Total phosphorous, chlorophyll a and Secchi disk measurements were used to calculate the Trophic State Index (TSI). Sediment samples were taken at multiple locations in the lake and dam and analyzed for iron, aluminum, magnesium, zinc and lead. Chief findings to date include the lake being nitrogen limited and the iron floc is under control. The lake has very low alkalinity values (< 10 ppm). Recently the lake pool was dropped for removal of tree stobs that were a significant navigation hazard. Other results of the analyses and fish surveys from 2012 to 2018 will be presented along with recommendations for future lake management.

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Can you see the rainbow: Assessing the genetic diversity of a common and ubiquitous freshwater mussel species, *Villosa iris*

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Current management practices for freshwater mussel species include a genetic analysis of populations, which provides useful data to determine which populations are genetically diverse, and which ones are good source and receiving populations for propagation and translocation efforts. Most genetic studies conducted on freshwater mussels have focused on species that are considered threatened or imperiled, or are listed as endangered under the U.S. Endangered Species Act. To date, few common and widely dispersed species have been assessed. However, with numerous habitat alterations occurring in streams and the recent die-offs of species that were once considered stable, common species should be investigated before the information that can be gained from them becomes difficult or impossible to obtain. The Rainbow Mussel (*Villosa iris*), inhabits small to large streams throughout the Tennessee, Cumberland, and Ohio River systems, the Upper Mississippi River, and part of the St. Lawrence River. Currently, this species is considered to be stable in Kentucky, Missouri, Ohio, Tennessee, and Virginia. *Villosa iris* was chosen because it is abundant and is found in a variety of habitats, including streams that are generally considered good mussel habitat (i.e., good flow, small cobble substrate, etc.) and streams that are considered poor mussel habitat (i.e., silt and mud substrate, low flow, lots of organic input). DNA samples were collected from Copper Creek and Cavitts Creek in Virginia. Mitochondrial *ND1* markers were used to determine the genetic diversity of these isolated populations, with the goal of comparing the genetic diversity of these populations to populations of *V. iris* in Indian Creek (VA) and in major tributaries of the Clinch River (VA and TN). The genetic data will be used along with observed variations in shell morphology within and among populations of *V. iris* to assess presence of cryptic species and management units for this species.

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Fragmentation and Genetic Diversity in Clinch Dace *Chrosomus* sp. cf. *saylori*

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The Clinch Dace (*Chrosomus* sp. cf. *saylori*) is a headwater specialist minnow first discovered in Tazewell County, Virginia in 1999. Since 1999, Clinch Dace were found in only 16 streams in eight tributaries to the upper Clinch River in Russell and Tazewell counties. Because it is listed as 'very high conservation need' in Virginia's Wildlife Action Plan, we aim to inform management actions by delineating management units using estimates of population genetic structure and assessing the influence of road crossings fragmenting Clinch Dace populations. Three-pass electrofishing depletions were conducted at 19 sites in Russell and Tazewell Counties in 2017. Most sites consisted of a reach upstream and downstream from a midpoint, usually a road crossing. Population estimates of Clinch Dace in each reach were standardized to 100 meters of reach length to make them comparable for analysis. Estimates of instream canopy cover, woody debris abundance and stream width were made at spaced transects, specific conductance was measured at the most downstream point, and maximum depth was recorded for each reach. Logistic regression and quasi-Poisson regression analysis of habitat variables and fish density on Clinch Dace presence and abundance showed that only conductivity was significantly related to Clinch Dace abundance and no variables were related to presence. {no variables were sign related to presence?} To test the effects of road crossings on Clinch Dace presence, we conducted paired *t*-tests on Clinch Dace abundance in upstream and downstream reaches. Road crossings did not seem to influence Clinch Dace abundance. The effects of road crossings on gene flow will be analyzed by means of variations in microsatellite DNA and mitochondrial DNA. While some streams are good candidates for habitat restoration to improve and safeguard currently robust populations, other streams have suitable habitat but low abundance and are candidates for introductions and barrier removal.

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Patterns of larval darter catch in the upper Roanoke River drainage

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Population dynamics of riverine fishes are typically driven by early life stages, yet basic information on most larval fishes is lacking. We sought to identify areas and periods crucial to recruitment of the endangered Roanoke logperch (RLP) *Percina rex* and to compare effectiveness of methods for sampling larval darters in general. We sampled larval darters and monitored water temperature and river stage during the 2018 RLP spawning season (April–June) at 16 sites in the upper Roanoke River system (URR) where RLP likely occur. We collected larval darters from mid-channel flowing water using drift nets, and from channel-edge slow water using light traps (quatrefoil- and funnel-type). Overall, we collected 1,909 larval darters, including 1,133 *Etheostoma*, 620 *Percina*, and 156 unknowns (all larvae will be identified to species using DNA barcoding). We caught darter larvae from early April through late June; however, 90% of larvae were caught after May 8 (*Percina*) and May 11 (*Etheostoma*). 50% of *Percina* larvae were caught during May 8–18, which followed a rapid increase in mean daily water temperature from 13.3 degrees C on April 30 to 18.9 on May 4 (in the mainstem Roanoke River). Two-thirds of *Percina* larvae were collected from four sites, including three mainstem Roanoke River sites and one on Big Chestnut Creek. The two Pigg River sites accounted for <1% of *Percina* larvae. Most *Percina* (56%) were collected in the early (soon after sunset) drift net set, with 26% caught in the later drift net set, 10% by quatrefoil trap, and 8% by funnel trap. In contrast, funnel traps caught the greatest proportion (33%) of *Etheostoma.* These results will help establish more effective protocols to sample larval darters in the URR and elsewhere in Virginia and inform managers regarding RLP restoration and protection actions.

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HABITAT UTILIZATION AND IMPACT OF FLOODING ON THE JAMES SPINYMUSSEL (*PARVASPINA COLLINA*) POPULATIONS IN VIRGINIA STREAMS.

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Considering the ecosystem services that mussels provide and their high percentage of threatened species, specifically over half the freshwater mussels in Virginia, one avenue for future research could prioritize upstream mussels in downstream conservation plans. This project will provide information that could be applied to recovery plans for mussels in the James River watershed. In addition, the results will help bridge the gap between studies in freshwater and coastal systems through informing the release of propagated mussels to high survival habitats. Thus, increasing nutrient retention before reaching coastal systems. The objectives of the proposed research are: determine the relationship between flood disturbance and mussel population dynamics (abundance and variation through time), compare a stream with flood disturbance to a dammed stream without flooding to determine if flooding drives a source-sink dynamic, and identify habitat preferences for *Parvaspina collina.* Analysis will use a four-year mark-recapture data set for sites in the James River watershed. Including a comparison of immigration and emigration between flooding events. A population viability analysis will be conducted to quantify extinction to determine if transiency is resulting in a source-sink dynamic. Furthermore, habitat preferences will be determined between two streams through a comparison and analysis of substrate, base-flow, water depth and velocity, and distance to the stream bank in areas where mussels have persisted. Our observations suggest that many mussels are temporarily occupying unstable habitats, understanding where mussels are most likely to survive and reproduce is crucial to identifying potential habitat and determining where propagated mussels should be released. Understanding the effect flooding has on *P. collina* populations can be vital in restoring the diminishing population and other endangered mussels in flood prone streams. Restoring populations will have positive ramifications for the filtration capacity of the populations of mussels in upland waters, benefiting nutrient retention downstream.

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Smallmouth Bass Habitat Use in the Upper Mississippi River

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Smallmouth bass are an economically important sportfish across the United States. Smallmouth bass can be seen as an indicator species due to their effects on the entire fish community. Yet smallmouth bass have received little interest in the Upper Mississippi River. Understanding habitat needs of smallmouth bass could lead to improved management practices. Data from the United States Army Corps of Engineer's Long-Term Resource Management Program was evaluated to assess the smallmouth bass habitat use. From 1993 to 2017, a total of 10,941 smallmouth bass were caught using day electrofishing in pool 4 (Lake City, Minnesota) and pool 8 (LaCrosse, Wisconsin). Macrohabitat and mesohabitat use were assessed. In regard to macrohabitat, main channel borders had the highest catch rates of smallmouth bass; this includes unstructured channel borders and wing dams. Smallmouth bass exhibited intermediate use in side channel borders, while backwaters were infrequently occupied. More specifically smallmouth bass tend to concentrate in areas with large substrate, moderate velocities across a range of depths. Information provided in this project can promote a better understanding of the smallmouth bass habitat use, ultimately enhancing management of the fish.

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Ichthyochory in omnivorous fishes of the Amazonian floodplain

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Ichthyochory is an important process driving the high diversity of plant species in the Amazon basin, mainly in the annually flooded forest adjacent to the rivers and lakes. Environmental changes potentially modifying or preventing frugivorous fish species from accessing the flooded areas, such as hydroelectric dams, or reduce fish stocks such as overfishing could disrupt this relationship. Human activity's effects on ichthyochory remain sparsely studied and the species-specific interactions between fish and seeds are poorly understood. We sampled fish from six floodplain lakes on the lower stretch of the Solimões River: Sacambú, Preto, Poção, Piranha, Cacao and Baixo during the high water season for three consecutive days,10-13 July 2018. Fish were collected twice from each lake, using gillnet batteries with standardized dimension of 15m long by 2m high, consisting of 10 nets of different mesh sizes in 10mm increments from 30-120mm. Collected fish were identified on site and dissected stomachs were kept on ice until returned to the laboratory for examination of stomach contents. Seeds were identified to the level of highest confidence. Principal component analyses were performed to identify relationships between fish species and seeds. We collected a total of 416 fish, representing 50 species. Fifteen species, consisting of 43 individuals, were identified as omnivorous and 11 contained fruit material in their stomachs. Nine different seed species were identified in the stomachs of fish from among the 26 confirmed fruit bearing tree species that occurred in the immediate vicinity of our study site. We found a high preference of seeds of the family Arecacea by *Pristigaster cayana*, *Pterodoras lentiginosus*, *Nemadoras humeralis* and *Trachelyopterus galeatus* and an association between Arroz sp. with two species of Triportheus, as an indication of a relationship between these species.

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