



## **2017 Meeting of the Virginia and Virginia Tech Chapters of the American Fisheries Society**

### **“Applied Fish Health”**

Tuesday, February 21st - Thursday, February 23rd, 2017

Washington and Lee University  
Elrod Commons – Stackhouse Theatre  
Lexington, VA 24450

Hampton Inn.  
401 E Nelson St  
Lexington, VA 24450

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2017 Meeting of the Virginia and Virginia Tech Chapters of the American Fisheries Society

Tuesday, February 21<sup>st</sup> - Thursday, February 23<sup>rd</sup>, 2017p9

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<b>Program at a glance</b>	
<b>Tuesday 21 February</b>	
12:00 PM – 5:00 PM	Registration for Joint AFS Meeting
1:00 PM – 5:00 PM	Applied Fish Health Symposium
6:00 PM – 10:00 PM	Informal social – Hampton Inn. Rockbridge Room
<b>Wednesday 22 February</b>	
7:45 AM – 3:45 AM	Registration for Joint AFS Meeting
8:00 AM – 8:15 AM	Opening remarks
8:15 AM – 10:00 AM	Contributed papers
10:00 AM – 10:15 AM	BREAK
10:15 AM – 11:55 AM	Contributed papers
11:55 PM – 1:30 PM	LUNCH – on your own Student/Mentor Lunch
1:30 PM – 2:30 PM	Contributed papers
2:30 PM – 2:45 PM	BREAK
2:45 PM – 3:50 PM	Contributed papers
3:50 PM – 4:00 PM	BREAK
4:00 PM – 5:00 PM	Virginia Chapter AFS Business Meeting
6:00 PM – 7:00 PM	Poster session and social – Hampton Inn. Rockbridge Room
7:00 PM – 10:00 PM	Dinner and raffle – Hampton Inn. Rockbridge Room
<b>Thursday 23 February</b>	
8:30 AM – 9:45 AM	Contributed papers
9:45 AM – 10:00 AM	BREAK
10:00 AM – 11:15 AM	Contributed papers
11:15 AM – 11:30 AM	Closing remarks / Awards

Program Committee: Mike Isel (VA Chair), Skylar Wolf (VT Chair), Craig Roghair, Scott Smith, Aaron Bunch, and Hae Kim

**Wednesday, February 22 - Morning Session**

**8:00am – 8:15am**

**Opening remarks**

**8:15am – 8:25am**

**Getting beneath the surface with freshwater snorkeling education programs**

C. Roghair\*, K. Williams, D. Kirk, A. Dolloff, C. Krause

\*Presenting

U.S. Forest Service Southern Research Station, Blacksburg, VA

NorthBay, North East, MD

George Washington & Jefferson National Forests, Natural Bridge Station, VA

The George Washington & Jefferson National Forests (GWJ), the nonprofit NorthBay environmental education program, and the Forest Service Southern Research Station Center for Aquatic Technology Transfer (CATT) recently hosted GWJ's inaugural Freshwater Snorkeling Toolkit implementation event. The toolkit and related curriculum developed by the U.S. Forest Service Nature Watch Program in partnership with environmental education specialists at NorthBay are modeled on the nationally recognized Cherokee National Forest snorkeling education program. Organizers welcomed 25 students and instructors from a local elementary school to the Lion's Tale accessible trail along Passage Creek to participate in snorkeling, aquatic insect collection, and other activities intended to convey a "forests to faucets" message. Over the next several years NorthBay and the CATT will seek additional partners to introduce and expand snorkeling programs to additional National Forest sites and beyond.

**Type:** Lightning talk

**Is the presenter a Student or a Professional?** Professional

**8:25am – 8:35am**

**The abyss explained: What happens to the data in your DGIF collection permit report after submission?**

K.M. Horodysky

Virginia Department of Game & Inland Fisheries, Henrico, VA

Researchers and educators who obtain a collection permit from the Virginia Department of Game and Inland Fisheries (DGIF) to collect aquatic wildlife for scientific or educational purposes are required to submit their collection data each year. The often tedious process of entering data on the DGIF permit reporting website may cause some to wonder why these data are required and who reviews the data after the report is submitted. An overview of the post-submission process is provided including who reviews the data, common data entry errors, incorporation of permit data into DGIF datasets, and how permit data are used to fulfill important agency objectives.

**Type:** Lightning talk

**Is the presenter a Student or a Professional?** Professional

**8:35am – 8:50am**

**Identifying Sampling Efficiencies in Fisheries Monitoring: Examples from Virginia**

A. Bunch\*<sup>1</sup>, D. Goetz\*<sup>2</sup>, D. Martin<sup>3</sup>

\*Co-Presenting

<sup>1</sup>Virginia Department of Game & Inland Fisheries, Charles City, VA

<sup>2</sup>Virginia Department of Game & Inland Fisheries, Farmville, VA

<sup>3</sup>Virginia Department of Game & Inland Fisheries, Henrico, VA

Monitoring studies aimed at assessing status and trends are imperative for addressing fisheries management goals and objectives because of the dynamic nature of fish populations. However, routine surveys often overlook sample size considerations needed for statistical validity in making fisheries management decisions. We evaluated three datasets using bootstrap techniques to determine how coefficient of variation (CV) of catch per unit effort (CPUE; fish/hr) estimates respond to sample size (e.g., total number of sites, or sample days depending on survey type). Datasets were obtained from a variety of monitoring studies across Virginia, which included electrofishing and creel surveys from lakes, rivers, and small streams. Typically, CV curves will show a negative relationship (i.e., exponential decay trend) as sample size increases. We found this to be true with the number of sites needed to accurately estimate Largemouth Bass *Micropterus salmoides* CPUE in a large impoundment. However, the opposite trend occurred with angler CPUE for Largemouth Bass and Blue Catfish *Ictalurus furcatus* from James River creel surveys. In this case, despite high and increasing trend in CV, there was still a point of diminishing returns for added sampling effort above eight creel days for estimating CPUE of those target species. When determining adequate sample size biologists should consider overall study objectives, time and budget constraints, and the distribution of the experimental unit in question. Lastly, periodic evaluation to determine sampling efficiencies is essential for maintaining data integrity and standardization, and should become standard practice.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

8:50am – 9:05am

**A Monumental Removal of a Hazel River Mill Dam**

A. Weaver\*<sup>1</sup>, L. Finger<sup>2</sup>, M. Pinder<sup>3</sup>, J. Howren<sup>1</sup> and B. Watson<sup>4</sup>

A. Spells<sup>5</sup>

\*Presenting

<sup>1</sup>Virginia Department of Game & Inland Fisheries, Henrico, VA

<sup>2</sup>Virginia Department of Game & Inland Fisheries, Verona, VA

<sup>3</sup>Virginia Department of Game & Inland Fisheries, Blacksburg, VA

<sup>4</sup>Virginia Department of Game & Inland Fisheries, Forest, VA

<sup>5</sup>U.S. Fish & Wildlife Service, Charles City, VA

In Culpeper County, Virginia Monumental Mills Dam was removed in October 2016 reopening 45 km of the Hazel River and a total of 459 Upstream Functional Network kilometers. Restoration goals were to provide fish passage, reduce upstream sedimentation and downstream scour, increase instream habitat complexity and aquatic species diversity, and to restore riverine-channel hydraulics, sediment transport and continuity to headwaters. The dam was in Tier 1 and ranked 6<sup>th</sup> overall in the Chesapeake Fish Passage Prioritization tool. No barriers exist between Monumental Mills Dam and the Bay. American Shad (*Alosa sapidissima*) and Blueback Herring (*A. aestivalis*) have been documented in the Rappahannock within 16 km of the Hazel confluence since the removal of Embrey Dam in 2005. Extensive fish community sampling in 2012 confirmed American Eel (*Anquilla rostrata*) and Sea Lamprey (*Perimyzon marinus*) as fish passage targets. A total of 11 fish species found below the dam were absent from the first three km upstream. VDGIF conservatively avoided summer instream work to protect Green floater (*Lasmigona subviridis*) that has occurred in the Hazel although was not found during a 2012 mussel survey near the dam. Working with the Office of the Attorney General, and an independent title research firm, VDGIF did not find evidence supporting a king's grant claim to the river bottom by the opposing landowner across the river. Subsequently, VDGIF acquired the dam and construction easements from the cooperating owner in order to proceed. Surveying and removal design was done by VDGIF. USFWS provided funding from the National Fish Passage Program. Permits and authorizations were acquired from the USACE, VMRC, VDEQ, VDOF, VDGS, and VDHR. A cultural resources firm conducted assessments before and during the removal to satisfy historical MOA Section 106 requirements. An experienced stream restoration contractor removed the 3 m tall dam in one week.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**9:05am – 9:20am**

**Harvell Dam Removal: Preliminary Analysis**

R. D. Willis\*<sup>1</sup>, L. A. Weaver<sup>2</sup>, M. Pinder<sup>3</sup>

\*Presenting

<sup>1</sup>Virginia Department of Game & Inland Fisheries, Charles City, VA

<sup>2</sup>Virginia Department of Game & Inland Fisheries, Charles City, VA

<sup>3</sup>Virginia Department of Game & Inland Fisheries, Blacksburg, VA

Harvell Dam was removed from the Appomattox River in the summer of 2014 providing migratory fish access to 127 miles of spawning and nursery habitat upstream. Several upstream dams are passable via breaches and Brasfield Dam (Lake Chesdin) has a FERC required fish lift. Sampling goals were to document the presence of target Alosines upstream of the removal to satisfy Tier 1 monitoring requirements under the NOAA removal grant and to evaluate any effects of removal on the full fish community. Spring results indicated that three of four target Alosines and Striped Bass are passing upstream of the removed dam. Community sampling resulted in a total of 50 species collected representing 15 families and a slight increase in species richness upstream post-removal. The most dramatic habitat change occurred just upstream of the dam (Harvell pool) post removal. Located just upstream of the influence of the former dam pool, the control station showed the least amount of change in fish community structure post-removal. Future plans include continuing annual spring sampling for anadromous species including finding additional upstream access, expanding eDNA sampling to aid in documenting upstream range of river herring, and possibly using video at the Brasfield lift. Additional full community sampling will also be conducted in three to five years to further evaluate the fish assemblage post-removal.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**9:20am – 9:30am**

**Fishes of the Upper New River, Virginia.**

Hae H. Kim <sup>\*1</sup>, Caitlin S. Carey<sup>2</sup>, and Donald J. Orth<sup>1</sup>

\*Presenting

<sup>1</sup>Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA

<sup>2</sup>Conservation Management Institute, Virginia Tech, Blacksburg, VA

Dams significantly alter the natural hydrological and geomorphological river processes that can lead to changes in fish assemblages over time. Dams serve as barrier to upstream species dispersal. The reservoir serves as a sediment trap and creates sediment-starved reaches directly below. These altered habitats support a distinct fish assemblage. The Upper New River extends 83 RM from the North Carolina border downstream to Claytor Dam. Four dams bisect the Upper New River, of these, Fries Dam is currently up for Federal Relicensing. Fries Dam is a 41-foot high and 610-foot long rock masonry dam located in Southwest Virginia. Federal relicensing prompted a need for biological surveys of the area around Fries Dam. Our objectives were to assess the impact of the dam on fish assemblages. In recent years, extensive fish surveys have not been conducted in this area. We utilized both standardized quantitative and qualitative sampling methods. Six endemic species to the New River were of particular interest during our sampling. Three of the six endemic species commonly encountered, Bigmouth Chub *Nocomis platyrhynchus*, New River Shiner *Notropis scabriceps*, and Appalachia Darter *Percina gymnocephala*. A total of 41 species were collected, representing five orders and seven families. We present one of the first extensive fish surveys conducted in this part of the Upper New River.

**Type:** Lightning talk

**Is the presenter a Student or a Professional?** Student



**9:30am – 9:45am**

**Age and Growth of Largemouth Bass in Lake Monticello**

H. S. Jenkins\*<sup>1</sup>, V. DiCenzo<sup>2</sup>

\*Presenting

<sup>1</sup>The Virginia Tech Chapter of the American Fisheries Society, Blacksburg, VA

<sup>2</sup>SOLitude Lake Management, Blacksburg, VA

Age and growth information is a prerequisite to successful fisheries management and provides insight into population dynamics. On Lake Monticello, Virginia, a 6' by 20' net was used to hold the Largemouth Bass (<15 inches) caught by anglers. These fish were taken to the lab where their sagittal otoliths were removed and aged. They ranged in age from 0.5 to 6.5 years, with only 3% of the fish being over the age of 2. The proportional size distribution (PSD) was found to be 83—well above the 40-60 range—and the mean length of the fish at ages 1.5 and 2.5 were 10.6 and 12.4 inches respectively. Relative weights were low. Because these young fish proved to be a little skinnier than anglers would hope for, we recommend that the fisheries managers at Lake Monticello use methods to encourage growth in weight. Some methods could include fish feeding, forage fish management, and continued harvest of Largemouth Bass.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student

**9:45am – 10:00am**

**Development of a Fisheries Management Plan at Long Pond, Virginia – a Case Study**

V. DiCenzo\*, D. Beasley, and A. Cushing

\* Presenting

SOLitude Lake Management, Charlottesville, Virginia

Private pond owners often seek intensive management strategies to enhance their fishing experiences. Long Pond is a 7-acre eutrophic impoundment located near Winchester, Virginia that has been under management since 2014. Initially, the pond lacked structural cover for Largemouth Bass and had dense coverage of Curly Leaf Pondweed and Watermeal. Additionally, the Largemouth Bass population had a size structure skewed toward smaller individuals and condition was poor. In fall 2014, we lowered the pond eight feet and applied rotenone to reset the fishery. We improved habitat by eliminating nuisance aquatic vegetation, installing aeration, constructing spawning beds, and creating fish cover using trees from the property. We also established the forage base by stocking Bluegill, Redear Sunfish, Golden Shiners, and Fathead Minnows and installed four feeders to support these forage fish. In spring 2015, we restocked forage fish as well as added Threadfin Shad. Also, in May 2015, we stocked three strains of female-only Largemouth Bass (15/acre total). These fish grew 1.2 to 2.0 pounds in the first six months at large. After 18 months in Long Pond, Largemouth Bass grew 2.9 – 3.6 pounds and relative weights improved from 79 prior to resetting to 120 in the fall of 2016. Our results indicate that within 18 months, size structure and condition improved and the pond now has trophy fish potential. Future plans include continued forage fish stocking, plankton management, selective harvest of wild Largemouth Bass, and establishing crayfish. Intensive management of habitat and predator-prey ratios can produce quality fisheries in small ponds.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**10:00am – 10:15am**

**Break**

**10:15am – 10:30am**

Modeling Contact Rates Based on Population Density and Resource Aggregation

P. McElmurray\*<sup>1</sup>, S.R. Hopkins<sup>1</sup>, T.E. Layton<sup>2</sup>, J.M. Wojdak<sup>2</sup>, L.K. Belden<sup>1</sup>

\*Presenting

<sup>1</sup> Department of Biological Sciences, Virginia Tech, Blacksburg, VA

<sup>2</sup> Biology Department, Radford University, Radford, VA

Many terrestrial and freshwater species contract parasitic infections when they contact infected individuals, so contacts are a central component of parasite transmission models. But what determines the number of infection-relevant contacts that a given host has? Ecological models often contain simple assumptions about how animals move around their environment and interact with each other, with the most common assumption being that animals move randomly and therefore contact each other randomly. However, agent-based (or individual-based; ABMs) models offer an opportunity to break from this paradigm. ABMs allow us to model individual behavior and view how it affects contact rates for the population. Additionally, as anthropogenic changes to the environment continue to affect animal behavior and resource availability on a wider scale, models that can account for both behavior and the state of the environment can help us better model contact patterns, and subsequently parasite transmission. We created an ABM that models the contact rates among individuals in a population for different foraging behaviors and resource distributions, and found that simple nonrandom foraging behaviors can change how density and resource distribution affect contact rates. We then used aquatic snail, *Helisoma trivolvis*, to explore these patterns in a real animal system. Snail foraging behaviors resulted in contact rates that were different from those expected based on random foraging models. We suggest that ABMs are useful tools for exploring how realistic behaviors influence parasite transmission.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student

**10:30am – 10:45am**

**Applying a Bayesian spatiotemporal model to CPUE to inform management unit appropriateness: an example based on Lake Erie Yellow Perch (*Perca flavescens*)**

Rujia Bi\*, Yan Jiao

\*Presenting

Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA

Understanding the spatial and temporal distribution of fish is useful for an efficient fisheries management. In order to identify potential spatiotemporal patterns, a solid knowledge of species-environment relationships is needed, as well as a spatial identification analysis. Here I established integrated nested Laplace approximations (INLA) and stochastic partial differential equations (SPDE) as two powerful tools for modeling patterns of fish catch through time and space. These computational fast approaches were applied to fit a Bayesian hierarchical spatiotemporal hurdle model to catch occurrence and catch rate of Lake Erie yellow perch (*Perca flavescens*) from yellow perch gill net surveys. Results indicated that yellow perch catch rate was clustered in space, which was consistent with the four management unites (MUs). Except substantial random spatial effects, environmental factors including water depth, gear depth and water temperature at gear depth also showed significant impacts on yellow perch catch rate. The method explicitly could model the spatiotemporal correlation structure inherent in catch data at a very reasonable computational cost, such that the forecasting of catch patterns and simulating management strategies become more accessible.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student

**10:45am – 11:00am**

**Prioritizing Fish Habitat for American eel (*Anguilla rostrata*) in the Chesapeake Bay Watershed**

N.J. Walker\*<sup>1</sup>, P.M. Gillevet<sup>1</sup>, K. de Mutsert<sup>1</sup>, C.A. Dolloff<sup>2</sup>, A.A. Aguirre<sup>1</sup>

\*Presenting

<sup>1</sup> George Mason University, Fairfax, VA.

<sup>2</sup> Virginia Polytechnic Institute, Blacksburg, VA.

The American eel *Anguilla rostrata* was once one of the most abundant fish in Atlantic coast streams but are now at less than 1% of historic levels. No specific cause is responsible of the decline; however, overfishing, parasites, habitat degradation, pollution, barriers to migration, and global environmental change have been incriminated on the decline. The Atlantic States Marine Fisheries Council (ASMFC) considers this species as depleted. The objective of this work is to determine the current distribution, density and relative abundance of American eel throughout the Chesapeake Bay watershed. We use weighted metrics representing habitat factors and GIS mapping in our analysis of over 1 million individual eels captured within the Chesapeake Bay watershed. These data include presence, density, relative abundance, distribution, length, life stage and gender overlaid with environmental factors including temperature, salinity, contaminant type and load, parasite and disease infection, presence and type of riparian buffers, barrier type, and fishing pressure. The effects of environmental factors across temporal and spatial scales will be evaluated using metrics based on the Fish Habitat Decision Support Tool (Erik Martins, The Nature Conservancy). Hypotheses about American eel distribution and abundance will be evaluated based on specific metrics and combinations of metrics. We also will develop a null model using environmental factors known to be associated with suitable habitat for American eel. Model outputs will be used to create maps (using ArcGIS 10.4 and Python) of potential American eel habitat. These results will be used to inform policy proposals and suggest conservation management actions.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student

**11:00am – 11:15am**

**Temporal and Longitudinal Mercury Trends in Burbot (*Lota lota*) in the Russian Arctic**

Alexander R. Pelletier,<sup>\*1</sup> Leandro Castello,<sup>1</sup> Alexander V. Zhulidov,<sup>2</sup> Tatiana Yu. Gurtovaya,<sup>2</sup>  
Richard D. Robarts,<sup>3</sup> Robert M. Holmes,<sup>4</sup> Daniel A. Zhulidov,<sup>2</sup> and Robert G. M. Spencer<sup>5</sup>

\*Presenting

<sup>1</sup>Virginia Tech, Blacksburg, Virginia 24061, United States

<sup>2</sup>South Russian Centre for Preparation and Implementation of International Projects, Rostov-on-Don, Russia

<sup>3</sup>World Water and Climate Foundation, Saskatoon, Saskatchewan, Canada

<sup>4</sup>Woods Hole Research Center, Falmouth, Massachusetts 02540, United States

<sup>5</sup>Florida State University, Tallahassee, Florida 32306, United States

Current understanding of the dynamics of biological mercury (Hg) in the Arctic is limited by a lack of data in the eastern Arctic (i.e., Russia). This study quantified temporal and longitudinal trends in Hg concentrations in burbot (*Lota lota*) muscle in eight eastern Arctic rivers between 1980 and 2001, encompassing an expanse of 118 degrees of longitude. Burbot Hg concentrations declined by an average of 2.6% annually across all eight rivers during the study period, decreasing by 39% from 0.171  $\mu\text{g g}^{-1}$  w.w. in 1980 to 0.104  $\mu\text{g g}^{-1}$  w.w. in 2001. Burbot Hg concentrations also declined by an average of 1.8% per 10° of longitude from west to east across the study area between 1988 and 2001. These results provide clear support to previous findings showing that biological Hg concentrations in the western Arctic (i.e., North America) have been mostly increasing while those in the eastern Arctic have been mostly decreasing. It is suggested that Hg trends in Arctic animals may be dominantly influenced by the deposition of anthropogenic Hg emissions from temperate latitudes.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student

**11:15am – 11:30am**

**A new method of estimating life history parameters of blackbelly rosefish (*Helicolenus dactylopterus dactylopterus*)**

K.S. Kirch<sup>1\*</sup>, C.M. Jones<sup>2</sup>, N. Diawara<sup>3</sup>

\*Presenting

<sup>1</sup>Center for Quantitative Fisheries Ecology, Norfolk, VA

<sup>2</sup>Center for Quantitative Fisheries Ecology, Norfolk, VA

<sup>3</sup>Old Dominion University, Norfolk, VA

The predictive ability of fishery models relies heavily on good data collection. Small fisheries that are not financially lucrative tend to have data that is severely limited or nonexistent. Computer simulations can be used with data poor models to gain parameter estimates that are more biologically accurate. Blackbelly rosefish (*Helicolenus dactylopterus dactylopterus*) are a deep sea demersal species found along the entire United States coast as well as coastal areas of Europe and Africa. Life history parameters of the blackbelly rosefish population off the coast of the United States have never been calculated. The estimates produced from the simulations have lower variance and are better approximations to the putatively true value. A probability distribution of weights will lead to better maximum harvest estimates. These parameter estimates will be used to enhance current data poor models.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student

11:30am – 11:45am

**Linear Mixed-Effects Models to Describe Length-Weight Relationships for Yellow Croaker (*Larimichthys Polyactis*) along the North Coast of China**

Q. Ma\*<sup>1, 2</sup>, Y. Jiao<sup>2</sup>, Y. Ren<sup>1</sup>

\*Presenting

<sup>1</sup>Fisheries College, Ocean University of China, Qingdao, Shandong, China

<sup>2</sup>Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA, USA

In this study, length-weight relationships and relative condition factors were analyzed for Yellow Croaker (*Larimichthys polyactis*) along the north coast of China. Data covered six regions from north to south: Yellow River Estuary, Coastal Waters of Northern Shandong, Jiaozhou Bay, Coastal Waters of Qingdao, Haizhou Bay, and South Yellow Sea. In total 3275 individuals were collected during six years (2008, 2011 - 2015). One generalized linear model and nine linear mixed effect models that applied the effects from regions and/or years to coefficient  $a$  and/or the exponent  $b$  were studied and compared. Among these ten models, the linear mixed effect model with random effects from both regions and years fit the data best, with lowest Akaike information criterion value and mean absolute error. In this model, the estimated  $a$  was 0.0192, with 95% confidence interval 0.0178~0.0308, and the estimated exponent  $b$  was 2.917 with 95% confidence interval 2.731~2.945. Estimates for  $a$  and  $b$  with the random effects in intercept and coefficient from Region and Year, ranged from 0.013 to 0.023 and from 2.835 to 3.017, respectively. Both regions and years had effects on parameters  $a$  and  $b$ , while the effects from years were shown to be much larger than those from regions. Except for Coastal Waters of Northern Shandong,  $a$  decreased from north to south. Condition factors relative to reference years of 1960, 1986 and 2007 revealed that the body shape of Yellow Croaker became thinner in recent years. Furthermore relative condition factors varied among months, years, regions and length. The values of  $a$  and relative condition factors decreased, when the environmental pollution became worse, therefore, length-weight relationships could be an indicator for the environment quality. Results from this study provided basic description of current condition of Yellow Croaker along the north coast of China.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student



**11:45am – 11:55am**

**Symbiont Dispersal Across a Crayfish Landscape**

S. S. Bell\*<sup>1</sup> and B. L. Brown<sup>1</sup>

\*Presenting

<sup>1</sup>Department of Biological Sciences, Virginia Tech, Blacksburg, VA

The application of metacommunity frameworks has helped explain biodiversity dynamics in landscapes of real world complexity. Through comparisons of dispersal rate, habitat heterogeneity, and species equivalencies; this theory explains how spatial dynamics and species interactions shape community structure and biodiversity. Historically metacommunity research has focused on systems with stationary, non-living patches. By observing symbiotic systems though, we know this description of patches is not always true in nature. In symbiotic systems, symbionts exist in a landscape of host patches connected by symbiont dispersal. The crayfish-Branchiobdellida symbiosis represents a model system for examining metacommunity dynamics. In this symbiosis, crayfish host diverse assemblages of symbiotic worms (Branchiobdellida). These worms are obligate cleaning symbionts with no free-living life stage. Symbiont assemblages vary significantly based on crayfish community makeup due to different tolerances of symbionts by *Cambarus* and *Orconectes* crayfish. As a first step in exploring the utility of this system in studying metacommunity dynamics, dispersal studies were carried out in artificial streams using one species of worm. Worm dispersal and survivorship were examined in relation to *Cambarus* host density as well as *Cambarus* displacement by *Orconectes*. Early results show optimum dispersal to occur at intermediate *Cambarus* host density. Symbiont survivorship increases with increased host density. As displacement of *Cambarus* crayfish by *Orconectes* crayfish occurs, both worm survivorship and dispersal are reduced. Future research on this system will include dispersal studies involving multiple worm species (both individually and as an intact symbiont community) with both *Cambarus* and *Orconectes* host in the environment to better model metacommunity dynamics of symbiosis in nature.

**Type:** Lightning talk

**Is the presenter a Student or a Professional?** Student

**11:55am – 1:30pm**

**Lunch**

Wednesday, February 22 - Afternoon Session

1:30pm – 1:45pm

**The Proposed Atlantic Coast Pipeline and the Risk to Mountain Streams**

J.W. Webb\*<sup>1</sup>, T.L. Belinsky<sup>1</sup>, M.C. Cameron<sup>1</sup>, D.J. Shaffer<sup>1</sup>, D.W. Sligh<sup>1</sup>

\*Presenting

<sup>1</sup>Dominion Pipeline Monitoring Coalition, Monterey, VA

[www.pipelineupdate.org](http://www.pipelineupdate.org)

Dominion's proposed construction of the Atlantic Coast Pipeline (ACP) has raised concerns about impacts to high-quality headwater streams associated with forested mountain watersheds in Virginia and West Virginia. The risk for stream degradation is significant both due to the difficulty of pipeline construction across steep mountains and due to the scale of excavation required for the ACP project, which will involve hundreds of miles of pipeline corridor and access roads and hundreds of stream crossings. Damage may be reduced to some degree by the development and implementation of erosion and sediment control plans, stormwater management plans, and slope-stabilization plans. The ultimate effect of the project on the physical and biological integrity of surface waters, however, will be determined by the practical limits of available control technology. Regulatory oversight is uncertain and may not be protective, given deferral of critical analysis until after permitting and given Dominion's request for expedited project review and authorization under general permits. The risk is further compounded by Dominion's intention to seek exemption from critical environmental standards, including waivers of open-trench limits that are essential for runoff control and waivers of time-of-year restrictions on construction that are essential for protection of brook trout (*Salvelinus fontinalis*) and other aquatic species during sensitive early-life stages.

In response to these concerns and uncertainties, the Dominion Pipeline Monitoring Coalition has undertaken a Critical Zone Analysis (CZA) to identify sections of the proposed pipeline corridor and access road system that present the greatest hazard for stream and watershed damage. The CZA will be published as an online interactive map and made available to the public, the regulatory decision makers, and the ACP developer.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**1:45pm – 2:00pm**

**Impacts of coal mining on stream fish diversity and distribution in the Clinch River and Powell River watersheds**

Zachary Martin<sup>1</sup>, Serena Ciparis<sup>1</sup>, Paul Angermeier<sup>1,2</sup>, and Don Orth<sup>1</sup>

\*Presenting

<sup>1</sup>Department of Fish and Wildlife Conservation, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061

<sup>2</sup>U.S. Geological Survey, Virginia Cooperative Fish and Wildlife Research Unit, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061

Mining coal in Appalachia has drastically changed landscapes and impacted >1,900 km of headwater streams via physicochemical alterations. Common shifts in water and habitat quality include elevated concentrations of total dissolved solids and increased sedimentation above tolerances of stream fishes. We are evaluating responses of fish communities and populations to these stressors in the upper Clinch River and the upper Powell River watersheds. Water quality, physical habitat, and fish samples were collected in 2014 and 2015 at 83 2<sup>nd</sup>- to 4<sup>th</sup>-Strahler order streams that represent a gradient of mining extent within the coalfields region of southwestern Virginia. We expected conductivity and fine sediments to be elevated in streams on the high-impact end of the gradient. We expected fishes to exhibit intolerance thresholds of diversity, occurrence, and density to increased conductivity and siltation. Water and habitat metrics exhibited weak correlations with deep mine, surface mine, and valley fill extents in watersheds; the strongest relationship was between valley fill and conductivity (Pearson's  $r$ : 0.41). We analyzed the response of Shannon-Weiner diversity, along with occurrence and density of the eight most prevalent species, to landscape and stream conditions using boosted regression trees. Diversity of fishes and occurrence and density of *Etheostoma flabellare* all showed a negative threshold response at approximately 330  $\mu\text{S}/\text{cm}$ , which aligns with conductivity regulations proposed by the U.S. Environmental Protection Agency. *Campostoma anomalum* was the only other species to show a response to conductivity, albeit in a slightly positive direction. Other species distributions were influenced by variables such as watershed area and stream depth. Although *E. flabellare* is generally regarded as a widespread, tolerant species in southeastern U.S. streams, our findings suggest it may be a useful indicator of stream quality in the Appalachian coalfields.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student

**2:00pm – 2:15pm**

**Revealing the Current Relationship between Stream Acidification and Fish Species Richness in Shenandoah National Park: What is the Status after Two Decades?**

<sup>1</sup>Pat Harmon\*, <sup>2</sup>Dr. Christine May

\*Presenting

<sup>1</sup>MS Candidate, James Madison University, Harrisonburg, Va.

<sup>2</sup>Associate Professor, James Madison University, Harrisonburg, Va.

Prior to limitations placed on atmospheric emission of sulfur dioxide, Shenandoah National Park streams were heavily impacted by acid deposition. Acidification of these streams resulted in a depletion of acid neutralizing capacity (ANC) and a loss of fish species diversity. Differences in bedrock composition of park watersheds produce variation in stream response to acidification such that siliciclastic watersheds provide the lowest ANC, basaltic-carbonate watersheds provide the highest ANC, and granitic watersheds provide an intermediate ANC. Previous results by Bulger et al. (1995) indicated a significant relationship between ANC and fish species richness in thirteen park streams, such that low ANC streams in siliciclastic watersheds support less fish species diversity than relatively higher ANC streams in granitic and basaltic-carbonate watersheds. Given the potential for acidification recovery in the past two decades, has the relationship between fish species richness and ANC changed? The current study investigated changes in this relationship from 1995 to 2016 in the same thirteen park streams distributed among the three major bedrock regions of the park. Increases in fish species richness primarily occurred in well-buffered streams underlain with granitic and basaltic-carbonate bedrock while minimal increases in fish species richness were observed in siliciclastic watersheds. The strong correlation between fish species richness and ANC observed in 1995 still exists in 2016, indicating that park streams may still be experiencing legacy effects of past acidification.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student

**2:15pm – 2:30pm**

**Atmospheric Acid Deposition Reduction and Stream Water Chemistry Response in Three Virginia Trout Stream**

K. M. Pyszka\*<sup>1</sup> and D. M. Downey<sup>1</sup>

\*presenting author

<sup>1</sup>James Madison University, Harrisonburg, VA

Fossil fuel combustion has delivered large amounts of SO<sub>x</sub> and NO<sub>x</sub> gases into the atmosphere where sulfuric and nitric acids have formed. These acids have been delivered to the landscape in precipitation and have caused acidification of streams that drain base poor watersheds. The decreased stream pH and acid neutralizing capacity (ANC) have resulted in loss of acid sensitive aquatic life. To address this problem, the U. S. Congress passed the Clean Air Act to reduce power plant emissions. Between the years 1990 and 2015, SO<sub>x</sub> and NO<sub>x</sub> gases have been reduced by 76% and 68%, respectively. We have intensively collected water chemistry data on three acid sensitive streams in the George Washington National Forest: Little Stony Creek, Mill Creek, and Mountain Run monthly since 1987. The purpose of this project was to assess how the reductions in acid deposition are being realized in stream water chemistry response. All three streams are experiencing a positive response to the reductions in atmospheric acid but have not yet returned to pre-industrial age values. Little Stony Creek has 25% reduction in sulfate with a corresponding decrease in hydronium ion of 58% (4.07 µeq/L to 1.70 µeq/L) and an ANC increase of 400% (-2.0 µeq/L to 6.0 µeq/L). For Mill Creek there is a 26% reduction in sulfate with a corresponding decrease in hydronium ion of 52% (14.45 µeq/L to 6.92 µeq/L) and an ANC increase of 54% (-14.2 µeq/L to -6.6 µeq/L). Mountain Run has a 39% reduction in sulfate and a corresponding decrease of hydronium ion of 17% (26.92 µeq/L to 22.39 µeq/L) and 20% (-33.7 µeq/L to -27.0 µeq/L). All three streams are experiencing a positive response to the reductions in atmospheric acid but have not yet returned to pre-industrial age values. Differences in response are dependent on watershed geology and soils.

**Type:** Oral presentation

**Is presenter a student or professional:** Student

**2:30pm – 2:45pm**

**Break**

**2:45pm – 2:55pm**

**Real-time GIS Reporting—Successful Use of ESRI’s Collector App During Watershed Assessments**

Jackson Ayers\*<sup>1</sup>, Kirk Smith<sup>2</sup>

\*Presenting

<sup>1</sup> James Madison High School, Vienna, VA

<sup>2</sup>Environmental Science and Policy George Mason University Fairfax, Virginia 22030

Logistical complexities of watershed assessments--field testing, land use surveys, laboratory coordination, data compilation and reporting—are time consuming, often requiring many months before information is available to interested parties. One volunteer group, backed by Trout Unlimited and Fairfax Water, has streamlined the process. Utilizing a state-of-the-art brook trout watershed assessment protocol and ESRI’s Collector App to log instantly accessible georeferenced data points, students from James Madison High School, Vienna, VA, can report field assessment results while onsite. Headwaters of four watersheds (South River, Greene County; Wildcat Hollow and Fiery Run, Fauquier County; Catharpin Creek, Prince William County) have successfully been assessed by the students. Activities have been coordinated and results shared with DGIF professional biologists. Procedures for quality control and assurance are routinely followed in order to produce accurate, verifiable data. While land use information is compiled offsite, dissolved oxygen (mg/L), water temperature (°C), and riffle-run quality (0 – 20) is collected from a randomly selected 75 meter stream reach within each watershed and recorded within the Collector App. Upon returning to data service or Wi-Fi service, cached data is uploaded to a shared web map within ESRI’s Arcgis Online portal. Collected data fields may be modified and designed by any group in any study. Academics and professionals can instantly access data for research or natural resource management.

**Type:** Lightning talk

**Is the presenter a Student or a Professional?** Student

**2:55pm – 3:05pm**

**Virginia's State Fish Surviving in Suburban Waters of Our Nation's Capital—A  
Lofty Dream or a Scientifically Sound Possibility?**

Emily Garcia\*<sup>1</sup>, Kirk Smith<sup>2</sup>

\*Presenting

<sup>1</sup>James Madison High School, Vienna VA

<sup>2</sup>Environmental Science and Policy George Mason University Fairfax, Virginia 22030

Utilizing state-of-the-art science and technology, students of James Madison High School, Vienna, Virginia, have identified a subwatershed possessing attributes favorable for sustaining brook trout (*Salvelinus fontinalis*). Beginning in 2014, Madison students embarked on a mission to locate new release sites for fingerling brook trout raised in the classrooms of over 20 Northern Virginia schools. In coordination with the Department of Game and Inland Fisheries (DGIF), Trout Unlimited and other entities, students assessed the headwaters of Catharpin Creek (Prince William County, VA) and found the subwatershed possessed qualities conducive to sustaining brook trout. Watershed assessment included instream water quality measurements: dissolved oxygen (11.8 mg/L), water temperature (10.6 °C), riffle run quality rating (11 out of 20) and land use evaluation (percent in agriculture—0%), distance to the nearest road (29.3 m). To date, assessments have not incorporated any biological information. Future assessments will now include an additional water quality index rating utilizing the results of stream biomonitoring; a macroinvertebrate species richness index developed specifically for citizen monitoring. Biological information will further expand a multimetric approach. Preliminary measurements of macroinvertebrates in Catharpin Creek indicate the stream harbors a notable amount of macroinvertebrates intolerant of pollution. Unfortunately, protocol did not allow for an official index rating due to an insufficient sample size. In the spring of 2017, Madison students will conduct macroinvertebrate assessments at several locations in the headwaters of Catharpin Creek to establish an overall baseline rating. In late spring, brook trout will be introduced. Post brook trout introduction watershed surveys will be conducted yearly, every spring.

**Type:** Lightning talk

**Is the presenter a Student or a Professional?** Student

**3:05pm – 3:20pm**

**To BRT or Not To Be? Summertime Stream Temperatures and Brook Trout in Virginia**

Thomas R. Benzing <sup>\*1</sup> and Brad Fink <sup>2</sup>

\*Presenting author

<sup>1</sup> James Madison University, Harrisonburg, VA

<sup>2</sup> Virginia Department of Game & Inland Fisheries, Verona, VA

Summertime stream temperatures are an important factor limiting the extent of brook trout (BRT) habitat in Virginia. During 2011-2015, the Department of Game & Inland Fisheries (DGIF) deployed HOBO Pro v2 data loggers to monitor water temperatures in over 100 locations on streams throughout Regions II, III, and IV. These stream temperature datasets were analyzed to identify daily maximum values during June to September as well as the number of days exceeding 21 degrees Celsius, a temperature commonly used to delineate coldwater streams. Using historic DGIF survey data, each location was characterized as supporting BRT or not. In our analysis, streams without BRT were found to experience a 14-day maximum temperature greater than 22 degrees and typically registered at least 20 days with a maximum water temperature exceeding 21 degrees. So, if Shakespeare were a fisheries manager, he would conclude that BRT were “not to be” in these streams. During summer 2016, more DGIF data loggers were placed in reaches of several streams that support BRT in their headwaters and transition to warmer waters downstream. These additional locations were selected to further explore how summertime temperature limit BRT habitat. A preliminary analysis of these data supports the conclusions from previous years.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional



**3:20pm – 3:35pm**

**The role of fish personality during formation of linear dominance hierarchies in brook trout**

Emily Sprague\*<sup>1</sup> and Charles Gowan<sup>1</sup>

\*Presenting

<sup>1</sup> Biology Department, Randolph-Macon College, Ashland VA

Brook trout in streams often move among habitats in search of energetically-profitable foraging locations called focal points. Fish defend these points aggressively, leading to the formation of linear dominance hierarchies. In other social animals, ‘personality’ plays a role in social interactions, but personality in brook trout has not been studied. In particular, nothing is known about how personality influences the processes that occur as a newcomer integrates itself into an existing dominance hierarchy. We evaluated the reliability of different behavioral tests for assessing brook trout personality, and then evaluated the role that personality played in the formation of dominance hierarchies. Open field and latency-to-exit tests were used to determine personality for 39 fish, and then 29 of those fish were used as the newcomer to an established three-fish hierarchy (the ‘rivals’). We tested for effects of fish size and personality on behavior by recording all agonistic interactions involving the subject and rivals for a five hour period. We found that repeated open field tests with the same fish provided personality scores that were repeatable within individuals and variable among them. However, scores from open field tests did not correlate with those from latency-to-exit tests, indicating that different tests do not provide equal measures of personality. In tests with rivals, we found that the relative size of the subject, along with its score from the open field tests, were both positively correlated to the total number of agonistic interactions among subjects and rivals during the observation period.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student

**3:35pm – 3:50pm**

**Movers and Stayers: Can We Predict Movement Behavior in Brook Trout?**

Shannon White\*<sup>1</sup> and Tyler Wagner<sup>2</sup>

\*Presenting

<sup>1</sup> Pennsylvania Cooperative Fish and Wildlife Research Unit, Pennsylvania State University

<sup>2</sup> U.S. Geological Survey, Pennsylvania Cooperative Fish and Wildlife Research Unit,  
Pennsylvania State University

Despite decades of research, the cause of individual differences in trout movement behavior remains unknown. In particular, models characterizing movement as a function of habitat quality or fish phenotype fail to fully explain the leptokurtotic distribution that describes the movement behavior of many salmonid populations. This suggests that movement may be a physiological property with genetic control. We completed a multi-season movement study of native brook trout populations in the Loyalsock Creek watershed to determine whether movement can be predicted by fish genotype. Using radio telemetry, we tracked the movements of 166 brook trout in the three tributaries to Loyalsock Creek in 2016. A blood sample and gill biopsy were taken from each tagged fish multiple times throughout the study for genomic sequencing and to measure temporal variation in gene expression. We found high individual variability in movement behavior with the majority of fish remaining sedentary during summer, but some individuals dispersing several kilometers after spawning. We will continue exploring genetic correlates to movement and quantify environmental variables that many influence movement. As mobile individuals are less susceptible to the lethal effects of local habitat loss and maintain population connectivity, this study could have implications for trout conservation and management.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Student

**Wednesday, February 22 – Poster Social  
6:00pm – 7:00pm**

**Water Quality Improvement Plan for Montebello Fish Cultural Station**

K. J. Kulzer\*<sup>1</sup>, S. J. Johnston<sup>1</sup>, T. Teears<sup>2</sup>, D. M. Downey<sup>1</sup>

\*presenting author

<sup>1</sup>James Madison University, Harrisonburg, VA

<sup>2</sup>VDGIF, Montebello Fish Hatchery, VA

Montebello Fish Culture Station in Nelson County Virginia operated by Virginia Department of Game and Inland Fisheries (VDGIF) is the oldest state owned facility in the Commonwealth for trout production. Initially constructed in 1929, the fish production facility consists of thirty four concrete ponds in a raceway that utilize a large spring as the main water source. The spring originates from a granite rock formation and discharges water that is low in pH, calcium and alkalinity. To improve water quality and increase trout production at the hatchery, it is hypothesized that the addition of limestone could increase the pH and enhance other water quality parameters. Preliminary tests were conducted in the laboratory to study the dissolution rate of limestone in de-ionized and tap water. These trial experiments were conducted with old rain gutters filled with limestone of varying sizes and qualities. Metrics included particle size, geometry, temperature, flow rate, bed length and depth. Assays included measurement of pH, alkalinity, dissolved calcium, conductivity, and other components of water discharged from the troughs. Results showed that Frazier # 8 (0.625", 35.6% calcium) limestone was the best quality product based on dissolution rate. The second stage of this research (currently in progress) is pilot scale tests at Montebello using spring water fed into a 30' trough, then into a 350 gallon tub with rainbow trout. If successful the treatment will be put in place as an integral part of the operation of the facility. Phase I of this project was funded with a JMU environmental sustainability grant. Phase II is being funded by the 4VA program.

**Type:** Poster

**Is presenter a student or professional:** Student

## **Impacts of Light on Survival of Brook Trout (*Salvelinus fontinalis*) Eggs**

J. A. Studio\*<sup>2</sup>, T. D. Tears\*<sup>1</sup>, C. L. May<sup>2</sup>

\*Presenting

<sup>1</sup>Virginia Department of Game and Inland Fisheries, VA

<sup>2</sup>James Madison University, Harrisonburg, VA

Anthropogenic impacts such as urbanization and agricultural operations have reduced the riparian buffer around many of Virginia's streams. Vegetation is vital to the health of a stream by reducing light penetration and water temperature as well as providing important terrestrial and aquatic interactions for the ecosystem. Light penetration could directly impact the survival of brook trout eggs during these early stages of development. Understanding light's effect on brook trout eggs also has implications for hatchery and reintroduction approaches. It was hypothesized that brook trout egg survival would decrease with increasing intensities of ultraviolet (UV) light. Brook trout eggs were fertilized and hatched in high and low levels of UV light, fluorescent light, and complete darkness at the James Madison University vivarium. Results indicated that freshly fertilized brook trout eggs (pre-eyed) were more severely impacted by light than post-eyed eggs. Furthermore, the highest levels of UV light had the highest percent mortality (100% pre and post-eyed), low levels of UV light (100% pre and 84% post-eyed), fluorescent light (97% pre and 78% post-eyed), and complete darkness had lowest rate of mortality (28% pre and post-eyed). High mortality for the UV treatments (relatively high UV but low light intensity) and the fluorescent treatment (no UV but high light intensity) indicates that UV light and light intensity both have an effect on egg development. Eggs were also fertilized and hatched at the Montebello Fish Culture Station spring in natural light and dark conditions. The natural light treatments had a higher rate of mortality (10-day avg.) than the dark treatments (35-day avg.); however, all treatments eventually reached complete mortality, which was likely due to factors such as low flow rate or low conductivity. Results of this study indicate that hatching boxes should be completely covered throughout egg development to increase survival.

**Type:** Poster

**Is the presenter a Student or a Professional?** Student

**Assessing Longitudinal Patterns in Freshwater Mussel, Crayfish, and Other Benthic Macroinvertebrate Assemblages and Distributions Above and Below a Hydroelectric Dam in the Upper New River, Virginia.**

C. Carey\*<sup>1</sup>, H. Kim<sup>2</sup>, D. Orth<sup>2</sup>

\*Presenting Author

<sup>1</sup>Conservation Management Institute, Virginia Polytechnic Institute and State University, Blacksburg, VA

<sup>2</sup>Department of Fish and Wildlife Conservation, Virginia Polytechnic Institute and State University, Blacksburg, VA

Dams can significantly alter aquatic habitats and community assemblages by modifying natural hydrological and geomorphological river processes and blocking upstream species dispersal. Bisected by four dams, the Upper New River flows northward through southwest Virginia, 83 RM from the North Carolina border to Claytor Lake. Knowledge of species' distributions and population statuses across these sections of the Upper New River is often patchy or limited, as relatively few comprehensive biological assessments have been conducted. Of the four dams, Fries Dam is currently undergoing relicensing, prompting the need for a review of the biological resources in the vicinity of the hydroelectric project area. In order to determine longitudinal patterns in freshwater mussel, crayfish, and other benthic macroinvertebrate assemblages and distributions, we designed a spatially-explicit study to survey five distinct reaches surrounding the dam. In 2016, we began conducting surveys in each reach of interest: the impoundment, the bypass, an 800 m reach extending downstream from the bypass, and two reference reaches—one above and below the project footprint. Species of particular interest included pygmy snaketail dragonfly, New River crayfish, and several imperiled mussels (pistolgrip, elktoe, green floater). We employed standardized qualitative searches by snorkel and SCUBA to assess mussels and crayfish and kick-net and seine-haul sampling for aquatic insects and crayfish. To date, we have documented two mussel species (purple wartyback and state threatened green floater), spiny stream crayfish, and several Orders of aquatic insects. Several species within the pygmy snaketail Genus (*Ophiogomphus*) were collected and final identification confirmations are underway. Additional sampling will be conducted in 2017 to complete species surveys. This study will provide a better understanding of the legacy effects of dams in the Upper New River and valuable data for effective resource management plans and operational recommendations that balance power and environmental interests during future relicensing processes.

**Type:** Poster

**Is this presenter a Student or a Professional?** Professional

## **Establishing Tiger Muskie Fisheries in Private Virginia Impoundments**

By Aaron Cushing<sup>\*</sup>, Dave Beasley, and Vic DiCenzo

<sup>\*</sup>Presenting

SOLitude Lake Management, Charlottesville, Virginia

Fisheries management in small private impoundments allows for the use of unique management methods and strategies enabling greater control over an aquatic ecosystem. This high level of control allows biologists the ability to lay the foundation for a successful trophy fishery and push the natural limits to achieve objectives. Though not often thought of in small water bodies, Tiger Muskies offer a unique fishing experience rarely found in ponds and small lakes in the mid-Atlantic. In an attempt to establish their populations in several small impoundments, we stocked (10/acre) 6-month old fish averaging 10.6 inches (270 mm) in three small impoundments in central Virginia in the fall of 2013. We again stocked in 2015 and 2016 (5/acre). We tagged each fish with a PIT tag to identify age class and estimate growth rates. We assessed these stockings by electrofishing each lake in the fall of 2015 and 2016 as well as the winter of 2016. One year following stocking, Tiger Muskie grew 8-12 inches and by age-3.5, fish averaged 26.5 inches. Future sampling should seek to estimate annual survival and abundance but results here suggest that Tiger Muskie may be a viable alternative sportfish in small Virginia impoundments.

**Type:** Poster Presentation

**Is the presenter a Student or a Professional?** Professional

**Fish species diversity and interactions at varying classes of *Acropora palmata* and *Acropora cervicornis* in Bonaire**

Danielle Goldberg

Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA

One structurally important genus of coral, *Acropora*, has declined roughly by 80- 98% in the Caribbean alone. In the recent decade, active reef restoration efforts have been implemented through the Coral Restoration Foundation to help lessen declining patterns and enhance recovery for two important species of *Acropora*: *A. palmata* and *A. cervicornis*. Previous studies have examined its role as a well-established habitat provider; however, previous research has not addressed fish species diversity at varying morphological classes of *Acropora* spp. This *Acropora* spp. restoration has provided a unique platform to investigate fish species community dynamics at various classes including Coral Tree Nursery® fragments (class 1), bar method fragments (class 2), natural crops of *Acropora* spp. (class 3), and dead *Acropora* spp. piles (class 4). To address this, visual snorkeling surveys were conducted over a five-week study period assessing fish species diversity and interaction time and level. Fish species diversity was greatest among smaller, less complex corals (class 1), which was contradictory to past studies. The highest interaction time and amount of indirect interaction occurred among larger, more complex corals (class 3), where the highest amount of direct interaction level occurred among smaller, less complex corals (class 1). These results demonstrate and provide merit for continued active *Acropora* spp. restoration projects to improve the declining coral reef ecosystem. Further, dead *Acropora* spp. piles (class 4) had a high fish abundance (n = 1820) that mainly exhibited high interaction time (> 95%), which greatly demonstrates and supports *Acropora* spp. as indispensable reef habitat providers.

**Type:** Poster

**Is the presenter a Student or a Professional?** Student

**Influence of *Bacillus* Probiotic Candidates on Growth Performance and Immunity in Nile Tilapia (*Oreochromis niloticus*)**

Oscar A. Galagarza\*<sup>1</sup>, David D. Kuhn<sup>1</sup>, Stephen A. Smith<sup>2</sup> and Joseph D. Eifert<sup>1</sup>.

<sup>1</sup>Department of Food Science and Technology and

<sup>2</sup>Department of Biomedical Sciences and Pathobiology

Virginia Polytechnic Institute and State University

Blacksburg, VA

Tilapia is an important animal protein source around the world. Output of tilapia continues to increase, yet, intensification of aqua-farming is generally accompanied by several problems, for instance, bacterial diseases that translate into reduced productivity, and ultimately financial losses in millions of US dollars. Traditionally, antibiotics have been utilized in efforts to control bacterial diseases, yet their use is undesirable from the human food safety and development of antibiotic resistance standpoints. This has led to the scrutiny of probiotics as alternative agents in management of diseases. The health promoting effects of probiotics have gained interest from the aquaculture industry in the last decade. Among commonly used probiotic strains, bacteria of the genus *Bacillus* are regarded as probiotic candidates. Application of *Bacillus* spp as feed additives has resulted in enhanced growth and immune stimulation in multiple fish species, yet their mechanisms of action are not fully understood. This study was designed to assess the effects of three *Bacillus subtilis* probiotic candidates on growth performance and multiple parameters of the immune system of Nile tilapia over a period of 51 days. For that comparative purpose, 80 fish were split evenly and stocked in four separate 300L tanks in one recirculating aquaculture system. Each tank pertained to the corresponding individual strain treatments and one non-treatment control. Twelve fish ( $165 \pm 14$  g) per treatment were randomly tagged intramuscularly, and followed individually during the trial. Fish were fed either a basal diet without spores (control), or a basal diet supplemented with the corresponding spores of one of the three probiotic candidates during the 51 days. The experiment included sampling of blood for lysozyme activity, blood leukocyte differentials, myeloperoxidase activity and alternative complement evaluation; collection of immune organs for multiple leukocyte activities via flow cytometry; and intestines were collected to determine spore germination.

**Type:** Oral Presentation

**Is the presenter a Student or a Professional?** Student



**Thursday, February 23 – Morning Session**

**8:30am – 8:45am**

**Freshwater Mussels Exposed to Arsenic and Sulfate Show Contrasting Patterns of Gene Expression**

Pawel Michalak<sup>1</sup>, Lin Kang<sup>1</sup>, Serena Ciparis<sup>2</sup>, William Henley<sup>2</sup>, Jess Jones<sup>2,3</sup>,  
Andrew Phipps<sup>2</sup>, and Eric Hallerman<sup>2,\*</sup>

\*Presenting

<sup>1</sup>Virginia Biocomplexity Institute, Blacksburg, VA

<sup>2</sup>Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA

<sup>3</sup>U.S. Fish and Wildlife Service, Blacksburg, VA

Freshwater mussels of the Clinch and Powell river systems have been heavily impacted by runoff, leachates or spills of materials related to coal extraction, processing, and combustion. Assays assessing the sublethal impacts of coal-related wastes on freshwater mussels are yet to be developed and validated. We assessed the utility of gene transcriptional markers in a laboratory study, focusing upon arsenic (arsenate, As(V)) and sulfate (SO<sub>4</sub><sup>2-</sup>), two contaminants related to coal mining and processing. Pheasantshells *Actinonaias pectorosa* collected from the Clinch River were subjected to a 28-day chronic exposure to relatively high, but environmentally relevant -concentrations of each compound. We employed the RNAseq approach using the Illumina HiSeq platform to make quantitative comparisons of gene expression in digestive gland among parasite-free, female, toxin-challenged and control pheasantshells. We assembled 61,774 sequence reads into the putative transcripts of 34,019 genes, with an average length of 1,012 base-pairs. Statistically significant differential expression of particular genes was observed among control mussels and those exposed to either arsenate or sulfate. Chemical stress was as likely to cause under-expression as it was to cause over-expression of particular genes relative to levels observed in control mussels. Contrasts also were observed among mussels exposed to the respective pollutants, indicating that arsenate and sulfate induced up- or down-expression of different suites of genes. From 50 to 100 differentially expressed genes were found for each comparison. The proportion of genes to which we were able to annotate function was relatively low (63%), as mollusks are non-model organisms and hence are underrepresented in genomic databases. Results of this project provide proof-of-principle for using RNAseq technology to approach issues of toxicogenomics in freshwater mussels.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**8:45am – 9:00am**

**Leveraging Existing Fish Collections and Museum Data for Improved Conservation Decisions**

Emmanuel A. Frimpong\*<sup>1</sup>

\*Presenting Author

<sup>1</sup>Virginia Tech, Blacksburg, VA

Multispecies approaches to environmental assessment and species conservation have proven more statistically robust and cost-effective, relative to single-species approaches. The robustness of such approaches derive from the fact that information about the distribution and abundance of all species in a community is inherent in the known distribution and abundance of any one species observed in that community. Consequently, monitoring data accumulated over space and time provide a rich resource for assessing trends in populations of species and the potential impacts of environmental changes. In this paper, I introduce *IchthyMaps*, a spatially high resolution database of historical distribution of freshwater fishes of the United States, compiled from published fish distribution atlases and online agency collections reports, and verified for its utility using field sampling of wadeable tributaries throughout the New River basin (VA, NC, and WV). I also introduce a temporally high resolution compilation of a similar database for the upper and middle New River basin covering over 70 years of collections and museum data starting in 1938. Several studies that have used these data, including 1) predicting the current distribution of endemic species of the New River, 2) predicting the future distributions of New River fish species under warmer climate scenarios, and 3) modeling trends in ranges of native and introduced species of the New River, illustrate the enormous potential of exiting data. I suggest a number of additional applications for species' status assessments and habitat management in Virginia, and extension of the multispecies assessment concept to other taxa of high conservation interest such as freshwater mussels and crayfishes.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**9:00am – 9:15am**

**Floodplain deforestation effects on fisheries yields in the Amazon**

Leandro Castello<sup>1,\*</sup>, Victoria J. Isaac<sup>2</sup>, Ram Thapa<sup>3</sup>, Laura Hess<sup>4</sup>, Caroline C. Arantes<sup>5</sup>

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<sup>5</sup> Department of Fisheries & Wildlife, Texas A&M, College Station, TX

Floodplains are among the most threatened ecosystems on the planet, with 90% of them in Europe and North America being functionally extinct. Floodplains dominate fish production rates among freshwater ecosystems largely because their vegetated habitats provide fish populations with important nursery and feeding opportunities. Yet, the extent to which escalating changes on floodplain land-cover affect fisheries productivity is unknown. We evaluated the effects of floodplain land-cover change on fisheries productivity in a region of the Amazon Basin where 56% of the forests have been converted into agricultural and cattle ranching lands. We used linear regression methods to model multispecies fish capture per unit effort (CPUE) in 107 floodplain lakes as a function of the amount of herbaceous, shrub, aquatic macrophyte, and forest habitats surrounding them. The floodplain lakes were distributed along a gradient of surrounding habitat conditions, from forested to highly-deforested. We tested the degree to which each floodplain habitat type influenced CPUE. We found that forest and herbaceous habitats affected multispecies CPUE. Forest amount directly affected multispecies CPUE at a significance of  $p = 0.000005$ , and herbaceous amount inversely affected multispecies CPUE at a significance of  $p = 0.01$ . The coefficients of both these parameters indicate that a one-unit change in forest or herbaceous percent causes a five-unit change in untransformed multispecies CPUE. These results indicate that removal of floodplain forests causes decreases in fish biomass available for harvesting and associated productivity of multispecies fisheries. The herbaceous habitats that usually develop in deforested areas exacerbate deforestation effects by decreasing multispecies fisheries productivity even further. These results constitute the first empirical evidence concerning floodplain deforestation effects on fisheries, and they illustrate the fishery potential that is being lost as floodplains worldwide continue to be degraded.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**9:15am – 9:30am**

**A length-based age-structured Bayesian hierarchical model of tag-recovery data, with a case study of Lake Erie yellow perch**

Can Zhou<sup>1\*</sup>, Yan Jiao<sup>1</sup>, Rujia Bi<sup>1</sup>

\*Presenting

<sup>1</sup>Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA, 24061

Tagging studies have been widely conducted to study the movement pattern and mortality of wild fish populations. In this study, we present a set of length-based and age-structured Bayesian hierarchical models to explore the variabilities and uncertainties in modeling tag return data. These models fully incorporate the uncertainty in the age classification of the tagged fish based on length and sex, and the uncertainty in the estimated population structure based on available data. A tagging experiment conducted by the Ontario Department of Natural Resources (ODNR) on yellow perch in Lake Erie was analyzed as a case study. The study area was divided into three spatial units according to yellow perch management units (MU). A total of 13,694 yellow perch were tagged with PIT tags from 2009 to 2015, and 322 of them have been recaptured through the Ontario commercial gillnet fishery and recorded by ODNR personnel. A total of 7 movement configurations and 3 background mortality configurations were used to model the tag return data. Results indicate substantial variation in yellow perch cross management units' movement among years and individuals of different ages. Individuals in MU1 exhibited relatively strong site fidelity, but age 4 fish have a larger tendency to move from MU1 to MU2. Individuals from MU2 and 3 move between these two units, but their movement to MU1 appears restricted. The estimated commercial gillnet selectivity is consistent with previous studies. The estimated fishing mortalities were higher than the stock assessment level, indicating imperfect mixing of tagged fish. This model is applicable to other tagging studies to explore temporal and age-class variations while incorporating uncertainties in age classification.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**9:30am – 9:45am**

**Yellowfin Madtom Reintroduction into the North Fork Holston River**

Mike Pinder\*<sup>1</sup>, J.R. Shute<sup>2</sup>, Pat Rakes<sup>2</sup>

<sup>1</sup>Virginia Department of Game and Inland Fisheries, Blacksburg, Virginia

<sup>2</sup>Conservation Fisheries, Inc., Knoxville, Tennessee

Species reintroduction is a prominent task in many recovery plans. Here we highlight the six year effort to reintroduce the Yellowfin Madtom (*Noturus flavipinnis*) into the North Fork Holston River (NFHR) of southwestern Virginia. Because the river was known historically for the species, the US Fish and Wildlife Service (USFWS) designated it as Non-essential/Experimental for Yellowfin Madtom in 1988. However, no effort was made to reintroduce the species until the formation of a Yellowfin Madtom Conservation Committee in 2010. The purpose of the committee was to provide guidance on a reintroduction strategy. Before any releases could be considered, the committee determined the need for habitat, threat, species presence, and genetics assessments. Because reintroduction involved the propagation of an endangered species, the USFWS required the development of a controlled propagation plan. Administratively, an intensive effort was made to inform federal, state, and local government officials and agencies of our intent. Finally, we were able to incorporate an education/outreach component by involving local school children to assist in the release.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**9:45am – 10:00am**

**Break**

**10:00am – 10:10am**

**A comparison of Methods for Evaluating the Presence of F<sub>1</sub> Intergrade Largemouth Bass**

A. Bunch<sup>1</sup>, B. Donovan<sup>1\*</sup>, C. Lim<sup>2</sup>, E. Peatman<sup>3</sup>

\*Presenting

<sup>1</sup>Virginia Department of Game & Inland Fisheries, Charles City, VA

<sup>2</sup>Virginia Department of Game & Inland Fisheries, Ashland, VA

<sup>3</sup>School of Fisheries, Aquaculture, and Aquatic Sciences, Auburn University, AL

Understanding the fate of stocked fish is essential for stocking evaluations. Growth and mortality of stocked fish has been studied using various marking methods including internal and external tags, fin clipping, use of oxytetracycline (OTC), and genetic markers. The Chickahominy River was stocked with F<sub>1</sub> intergrade Florida *Micropterus salmoides floridanus* X northern *M. s. salmoides* Largemouth Bass in mid-2000s and recently in 2015. All F<sub>1</sub> intergrade Largemouth Bass were exposed to OTC prior to each stocking event. We used two independent evaluations to determine the presence of F<sub>1</sub> intergrade Largemouth Bass in 84 paired samples collected in fall 2015 during standardized long-term monitoring. Otoliths and pectoral fins were collected from each specimen, and labelled and stored accordingly. Otoliths were evaluated for the presence of a fluorescent band indicative of an OTC mark. Genetic samples were analyzed to determine strain-specific allele frequency and heterozygosity. The threshold to which we determined F<sub>1</sub> intergrade was >90% heterozygous due to 5-10% variation in purity of brood stock. All available stocked cohorts (2005, 2006, 2007, and 2015) were represented in the sample. We found strong agreement between the two methods at 93%. Based on these preliminary findings, DNA analysis could be used in lieu of OTC for future evaluations. Trade-offs exist for both methods as DNA analysis does not allow for determination of age, and OTC requires sacrificing the specimen. Study objectives should dictate the method of evaluation. An acceptable level of inherent error exists in both methods, and OTC marking may have a systemic level of error due to differing mark quality among batches or mark degradation. Further investigation is planned for fall 2017 as a larger number of F<sub>1</sub> intergrades should be present due to recent stockings.

**Type:** Lightning talk

**Is the presenter a Student or a Professional?** Professional

**10:10am – 10:20am**

**Angler Usage and Exploitation of Muskellunge in the Upper James River: First Year Results**

J. T. Young\*<sup>1</sup>, G. Palmer<sup>1</sup>, D. B. Goetz<sup>2</sup>

\*Presenting

<sup>1</sup>Virginia Department of Game & Inland Fisheries, Forest, VA

<sup>2</sup>Virginia Department of Game & Inland Fisheries, Farmville, VA

In the past decade the Muskellunge population in the upper James River has grown exponentially and created a popular fishery. However, very little is known about angler usage and exploitation. In January 2016 the VDGIF began a multiple year tagging study to (1) estimate angler catch and exploitation, (2) quantify Muskellunge movements, and (3) estimate Muskellunge population densities throughout the upper James River. From January to April 2016 a total of 211 Muskellunge were tagged with dart style Floy tags and implanted with Passive Integrated Transponder (PIT) tags at seven different sites on the upper James. Sixty-two Muskellunge were marked with two Floy tags to quantify tag retention. Anglers were offered a US\$20 reward for each tag returned and as of December 2016 tags from 60 Muskellunge (28%) were returned. Unadjusted catch rates ranged from 7%-46% between study sites and tag retention measured 92%. Anglers reported releasing 93% of Muskellunge caught and 88% of tags returned were from anglers targeting Muskellunge at the time of capture. Muskellunge movements away from tagging sites ranged from 3 to 27 kilometers, with a mean of 12 kilometers. Mark-recapture population estimates for the Lynchburg site was 73 Muskellunge.

**Type:** Lightning talk

**Is the presenter a Student or a Professional?** Professional

**10:20am – 10:35am**  
**Comparisons of Striped Bass Growth and Gizzard Shad Abundance**

Dan Wilson

Virginia Department of Game & Inland Fisheries, Forest, VA

Striped bass *Morone saxatilis* has been introduced primarily into southwest and western United States reservoirs to take advantage of underutilized pelagic forage and provide additional game fish opportunities. Difficulties in assessing pelagic forage and their relationships with striped bass in reservoirs have made it challenging for managers to measure supply-demand relationships that would indicate striped bass populations remain within acceptable levels for both optimum striped bass growth and competing piscivores. Gizzard shad *Dorosoma cepedianum* were monitored with fall nighttime electrofishing gear to determine catch per unit effort (CPUE) and percent of the population that were adults ( $\geq 150\text{mm}$ ) with striped bass growth at Smith Mountain Lake, Virginia. Additional clupeid species occupy Smith Mountain Lake; threadfin shad *Dorosoma petenense*, alewife *Alosa pseudoharengus*, and blueback herring *Alosa aestivalis*. These additional species were not included in the analysis due to vulnerability of fall electrofishing but impacts from predation were expected to be similar. Gizzard shad CPUE were highly variable within sample years based on sample locations; upper reservoir areas received the most nutrient input and produced the highest CPUE which declined as sampling progressed downstream. Upper reservoir samples were used for analysis due to higher and more consistent catch rates but did mirror trends for the entire reservoir. Comparisons showed little correlation for overall gizzard shad abundance and striped bass growth but showed strong correlation with adult gizzard shad abundance ( $\geq 200\text{fish/hr}$ ) and percent of the gizzard shad population that were adults ( $\geq 50\%$ ) when compared to striped bass growth of ages 3 and 4. Years when striped bass growth was slowest, gizzard shad recruitment was highest but very few young-of-year (YOY) persisted to adults. Each reservoir has its own unique hydrological parameters, physical characteristics, and biotic factors dictating forage production but this study demonstrated a simplistic approach to a density dependent relationship for pelagic predator and prey species. Annual monitoring of multiple forage species can require more resources than most managers have available. However, this approach of monitoring gizzard shad populations by comparing adults and YOY, may provide a tool to determine if striped bass populations are balanced with a reservoirs existing forage base.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional



**10:35am – 10:45am**

**Using a Non-traditional Method for Conducting an Angler-Creel Survey for Three Stream Fisheries**

\* Stephen J. Reeser and Dustin Martin

\*Presenting

Virginia Department of Game and Inland Fisheries, Verona, VA

Reaches on three separate streams flowing through private property are managed by the Virginia Department of Game and Inland Fisheries (VDGIF) for public fishing. Each stream is stocked with hatchery-reared trout and managed under special fishing regulations. Anglers are required to obtain an annual permit (no fee) to fish these streams. The majority of permits were obtained online through VDGIF's website. An online survey was e-mailed to 2,041 anglers who had acquired a permit in 2015 and granted access to using their e-mail address. Nine-Hundred-two (902) anglers responded to the online survey (44% response rate). Information was collected to estimate overall angling pressure, catch, harvest, angler economic expenditure, and angler satisfaction for each stream. Respondents were also asked their level of support for a Virginia Trout License being required to fish these waters. This project highlighted how effective this inexpensive and low effort technique compares to more traditional angler-creel survey methods.

**Type:** Lightning talk

**Is the presenter a Student or a Professional?** Professional

**10:45am – 11:00am**

**Development of a Trophy Wild Trout Fishery**

Steve Owens

\*Presenting

Virginia Department of Game and Inland Fisheries, Marion, VA

Southwest Virginia offers anglers a plethora of trout fishing opportunities for wild trout in headwater as well as large valley floor streams. However, low productivity in many area streams limits growth leading to populations dominated by adult fish that seldom exceed 254 mm. The Buller Fish Cultural Station located in Smyth County offers anglers a roughly 1.6 km special regulation catch and release trout fishery that is limited to single hook artificial lures. Historically, this section was dominated by wild rainbow trout (*Oncorhynchus mykiss*) that seldom reached 254 mm in addition to the occasional brown trout (*Salmo trutta*). A supplemental feeding program was initiated by Virginia Department of Game and Inland Fisheries in March of 2015 in hopes of significantly increasing growth rates. This limited feeding program quickly improved growth with in the first year to include 31% of the rainbow trout in the population in excess of 305mm. Two years (2016) after the program began 42% of the rainbow trout collected exceeded 305mm. Relative weight ( $W_r$ ) shifted from 0% of the population  $>100 W_r$  in 2014 prior to the supplemental feeding program to 24% and 20% of the population  $>100 W_r$  in 2015-2016, respectively. Angler utilization and attitudes towards this fishery have dramatically changed as a trophy fishery develops.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**11:00am – 11:15am**

**Trends in Abundance of Brown Trout and Brook Trout in an Appalachian Stream**

John Odenkirk\*, and Mike Isel

\*Presenting Author

Virginia Department of Game and Inland Fisheries, Fredericksburg

A self-sustaining Brown Trout *Salmo trutta* population was discovered coexisting with Brook Trout *Salvalinus fontinalis* in the Conway River, Madison County, Virginia in 1987. These populations were monitored through 2016 along with a Brook Trout population in the nearby Rapidan River where no Brown Trout were present. Brook Trout biomass in both streams changed little over time and appeared stable but was greater in the Rapidan River (Conway River Brook Trout mean kg/ha=38.0 [ $n=13$ ;  $SD=13.4$ ]; Rapidan River Brook Trout mean kg/ha=87.9 [ $n=12$ ;  $SD=44.0$ ]). However, Brown Trout numbers in the Conway River increased dramatically from 0.4 kg/ha in 1987 to 59.9 kg/ha in 2016 ( $r^2=0.59$ ;  $P=0.002$ ;  $n=13$ ), while proportion of Brown Trout biomass in this stream increased from less than 1% to 56% over the same period ( $r^2=0.74$ ;  $P<0.001$ ;  $n=13$ ). Assumptions that the increase of a nonnative would occur at the expense of a native coexisting salmonid may not be valid in this case, as potential differences in trophic guild and/or habitat partitioning may allow both species ample access to forage and spawning substrate. Continued monitoring is needed, as Brown Trout biomass may have reached (or could reach) critical levels and begin to impair this Brook Trout fishery.

**Type:** Oral presentation

**Is the presenter a Student or a Professional?** Professional

**11:15am – 11:30am**

**Closing remarks**