

1) Presentation Type: Oral

Title: The Missouri Ecological Site Classification Project: a 2018 report

Authors: Douglas Wallace, Ecologist, NRCS, Columbia, Missouri and Alicia Struckhoff, Project Coordinator/GIS Specialist, MDC, Columbia, Missouri.

Affiliations: Natural Resources Conservation Service and Missouri Department of Conservation

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Abstract: Missouri is part of a nationwide effort to describe and map management-scale ecological sites. An ecological classification system is a framework that allows land owners and natural resource managers to identify, map, and describe land with similar physical and biological characteristics (ecological sites) at scales suitable for use in natural resource planning and management.

Development of ecological sites in Missouri was a multi-agency team effort. The Missouri Department of Natural Resources, Missouri Department of Conservation and USDA Natural Resources Conservation Service provided the majority of the total staff days that worked on the project.

Missouri now has a complete set of ecological sites, covering every acre of Missouri. This presentation will acquaint participants with the basic concepts of Missouri ecological sites, along with the structure of the ecological site system in Missouri, how ecological sites have been developed, and an overview of the project's outcomes and results.

2) Presentation Type: Oral

Title: Common carp recruitment five years after koiherpes virus outbreak in Blue Springs Lake.

Authors: Jake Allman, Haley Kokel and Cassandra Messer, Missouri Department of Conservation

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Abstract: In 2012 a massive fish kill occurred in Blue Springs Lake. The only species affected was common carp and analysis revealed the causative agent was koiherpes virus (KHV). Upwards of 30,000 carp died over a 26-day period. Electrofishing catch rates decreased by 75% immediately following the fish kill and have continued to decline. KHV is highly infectious and can cause up to 90% mortality in adults and is believed to be 100% lethal to fry and fingerlings. Once KHV is in a waterbody it persists as carp that were infected but did not die become carriers of the disease. In addition to a decrease in catch rates of adults we were interested in the effect KHV is having on recruitment. A five year period was allowed to elapse before attempting to document recruitment to allow carp to become vulnerable to our electrofishing gear. Common carp were collected during standard community sampling from May 8 through May 15. Additional carp only sampling occurred from May 26 through June 9 to capture the spawning period and post spawn when smaller individuals might be more vulnerable. Dorsal spines were collected from 88 carp and sectioned for age determination. Only one of the carp collected was aged as being five years old. All other carp were at least six years of age. Based on these findings and our continued decline in electrofishing catch rates it appears that carp recruitment is minimal in Blue Spring Lake.

3) Presentation Type: Oral

Title: Measuring and Modeling Suspended Sediment and Nutrient Yields from a Mixed-Land-Use Watershed of the Central U.S.

Authors names and Affiliations (Presenter underlined):

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Abstract: A nested-scale watershed study design was used to monitor water quantity and quality of an impaired 3rd order stream in a rapidly urbanizing mixed-land-use watershed of the central USA. Grab samples were collected at each gauging site ($n=836$ samples x 5 gauging sites) and analyzed for suspended sediment, total phosphorus, and inorganic nitrogen species during the four year study period (2010 – 2013). Soil and Water Assessment Tool (SWAT) estimates of monthly stream flow, suspended sediment, total phosphorus, nitrate, nitrite, and ammonium were validated. Total annual precipitation ranged from approximately 650 mm during 2012 (extreme drought year) to 1350 mm during 2010 (record setting wet year) resulting in significant ($p<0.05$) differences in annual pollutant yields (i.e. loads per unit area) ranging from 115 to 174%. Multiple linear regression analyses showed significant ($p<0.05$) relationships between pollutant loading, annual total precipitation (positive correlate), urban land use (positive correlate), forested land use (negative correlate), and wetland land use (negative correlate). Results from SWAT model performance assessment indicated calibration was necessary to achieve Nash-Sutcliffe Efficiency (*NSE*) values greater than 0.05 for monthly pollutant loads. Calibrating the SWAT model to multiple gauging sites within the watershed improved estimates of monthly stream flow ($NSE=0.83$), and pollutant loads ($NSE>0.78$). However, nitrite and ammonium loads were underestimated by more than four orders of magnitude ($NSE<-0.16$) indicating a critical need for improved nutrient cycling and routing routines. Results highlight the benefits of calibrating the SWAT model to multiple gauging sites in mixed-land-use watersheds.

4) Presentation Type: Oral

Title: Beating the Heat: Summer Tributary Use & Movement of Lake Sturgeon in the Missouri River Basin

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Abstract: In northern portions of its range, Lake Sturgeon often feed in lentic habitats and migrate up tributaries in the spring to spawn. However, southern populations are confined to lotic systems. Few studies in the Mississippi River basin have documented tributary use outside of the spawning season by Lake Sturgeon. Yet anecdotal evidence suggested that mid-sized tributaries are important year-round Lake Sturgeon habitat in the Missouri River basin. We implanted 54 Lake Sturgeon in two Missouri River tributaries with acoustic telemetry tags and monitored their movement from May-September 2017. The study area, which spanned over 1300 river km of the Missouri and Mississippi River basins in Missouri, was based off a network of 37 acoustic receivers. We divided our study area into 16 zones: nine in the Osage, two in the Gasconade, four in other Missouri River tributaries, one in the main-stem Missouri, and one in the main-stem Mississippi. All tagged Lake Sturgeon were present within a tributary at some point of the summer and overall tagged fish spent 70% of the study period in tributaries, and 20% remained in the tributaries during the entire summer. Lake Sturgeon congregated in two distinct holding areas in the Osage River July-August that were associated with tributary mouths and deepwater habitat caused by dredging. These areas may be important refugia as water temperatures exceed 30°C, which is near their thermal maximum. Information from this ongoing study on tributary use, habitat selection, and movement rates will aid in the recovery of Lake Sturgeon in Missouri.

5) Presentation Type: Oral

Title: Accurately and Precisely Measuring Body Composition of Alligator Snapping Turtles (*Macrochelys temminckii*) with Dual-energy X-ray Absorptiometry (DXA)

AUTHORS: BRANDON S. TAPPMAYER¹, DENISE M. THOMPSON², BRIAN M. FILLMORE³, KERRY GRAVES³, DAY B. LIGON¹

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Abstract: Assessing body composition of wild animals can reveal important information about fat stores, lean tissue mass, and bone density. Understanding these aspects of animals' biology is useful in a variety of contexts, including long-term longitudinal studies, post-reintroduction monitoring, and manipulative studies. A crude but often useful estimate of relative body composition can be obtained by calculating the residuals of mass regressed on body length. Positive residual values are typically interpreted as higher-than-average fat stores, and thus higher 'body condition', whereas negative values are interpreted as lower-than-average fat stores. The accuracy of regression-based body condition estimates varies among taxa; the precision, on the other hand is always consistently low because it assumes that fat is the only tissue that varies among individuals. To test the accuracy of this estimate, we conducted a study on three groups of alligator snapping turtles (*Macrochelys temminckii*) that were: 1) reared indoors, 2) reared in outdoor ponds, or 3) had been living in the wild for at least two years. We found that Dual-energy X-ray Absorptiometry (DXA) is able to accurately and precisely measure total body fat, lean tissue, bone mineral content, and bone density, but that mass-length residuals were a poor predictor of variation in any single tissue type. Therefore, we conclude that, while traditional body composition calculations are convenient, they may be difficult to interpret. DXA is non-invasive and therefore widely applicable to many species. Furthermore, the increased accuracy and quantity of data that it provides makes it a powerful tool for wildlife biologists.

6) Presentation Type: Oral

Title: Comparison of Omega 3 Fatty Acid Analysis and Chemical Contaminants in Mississippi River Fishes

Authors: Jeff Wenzel¹, Katrina Knott², [Tyler Ham](#)³ and [Larry Lawson](#)¹

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Abstract: Since 1980, Missouri has issued annual fish consumption advisories based on chemical contaminant concentrations in wild-caught fish; however, they did not consider potential health benefits of consuming fish. Such a strategy may discourage the public from consuming fish in general regardless of contaminant concentrations. Therefore, Missouri would like to expand its focus to balance risks from chemical contaminants with the health benefits of eating fish. Due to a lack of data on the nutritional quality of fish in Missouri, additional data collection was needed. The Department of Health and Senior Services partnered with the Department of Conservation to collect over 300 fish, consisting of more than 20 species from the Mississippi River, to test for both beneficial fatty acids and harmful chemical contaminants. Laboratory analysis provided detailed nutritional information for these common Missouri fish species. These results indicate that at least 15 fish species would provide the World Health Organization recommended 200 - 500 mg or more of EPA and DHA Omega 3 fatty acids per 8 ounce meal. Making healthy choices when consuming wild-caught fish should weigh the nutritional value of the fish against the potentially harmful effects of contaminants in the fish. We compared the fatty acid analysis and contaminant testing to recommend healthy fish consumption options. Although some species should be avoided, most fish in Missouri provide excellent nutritional benefits and contain limited contaminants. Additional testing will improve our knowledge of the nutritional quality of fish and help managers provide better fish consumption recommendations in the future.

7) Presentation Type: Oral

Title: Special Use Permit Project

Authors (Underline Presenter): Theresa Hyland and Amy Buechler

Affiliation: Missouri Department of Conservation

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Abstract (250 words maximum): The Missouri Department of Conservation owns or manages nearly 1,000 conservation areas totaling more than 1 million acres statewide. The primary public uses of Missouri Department of Conservation (Department) conservation areas are fishing, hunting, nature observation, and conservation education. As the Department continues to explore making conservation accessible and valuable for all Missourians, we must balance public desires with resource needs. We must also work to minimize conflicts between user groups. Information collected through a statewide collection and study of special use permits issued and denied on conservation areas is helping redefine how the Department approaches public use on conservation areas.

8) Presentation Type: Oral

Title:

Impacts of neonicotinoid seed-treatment use on native pollinator abundance and diversity in Missouri agroecosystems

Authors:

Anson R. Main^{1*}, Elisabeth B. Webb^{1,2}, Keith W. Goynes¹, and Doreen Mengel³

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Abstract: Neonicotinoid insecticides are widely applied as seed-treatments across North American agroecosystems. Due to their high water solubility, neonicotinoids are transported to adjacent field margins during precipitation events with potential accumulation of residues by non-target plants. Unlike honeybees, numerous wild bee populations nest in the ground in close proximity to cultivated fields and floral resources. To that end, it is unknown if native bee species are equally exposed to neonicotinoids through soil and non-target plants surrounding cropped fields (i.e., field margins). Few studies have evaluated neonicotinoid impacts on wild pollinator populations (e.g., solitary bees). To evaluate the effects of neonicotinoid exposure on native pollinator abundance and diversity, we sampled 24 agricultural fields (treated and untreated) on four conservation areas in central-north Missouri from pre-seeding to harvest (Year 2016). At each field, we collected field and field-margin soils, sampled herbaceous flowering species in margins, and collected a wide variety of native pollinators over time. Neonicotinoid residues were detected in field and field-margin soils during all sampling periods (frequency: pre-seeding, 58%; post-seeding, 67%; mid-growing, 69%; harvest, 58%). Clothianidin was the most-frequently detected active ingredient in soils with concentrations ranging from 0.16 to 55.7 µg/kg. Compared to untreated reference fields, native bee abundance was significantly less in both treated corn ($P = 0.002$) and treated soybean fields ($P = 0.005$). Here, we present our preliminary findings and discuss how this research improves our understanding of the potential impacts of neonicotinoid seed-treatment use on non-target native pollinator communities in agroecosystems.

9) Presentation Type (Oral or Poster): Oral

Title: Improved water system for Pallid sturgeon propagation at Neosho NFH

Authors (Underline Presenter): Justin Perkins

Affiliation: Fisheries Biologist Neosho NFH (USFWS)

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Abstract (250 words maximum): In February of 2016 the Neosho NFH was subjected to a technical review of its pallid sturgeon program. After the review, recommendations for improvement were made by pallid sturgeon recovery team members as well as the US army corp. of engineers. This presentation will discuss 3 of the major improvements made to the water system. Vacuum degassing system, an Air cooled water chiller and a 3 part water filtration and UV sterilization unit will be discussed from the design phase through installation and completion.

10) Presentation Type (Oral or Poster): Oral Presentation

Title: Freshwater Drum Population Dynamics Across Space and Time: How Resilient Are They?

Authors: Joshua K. Abner, Quinton E. Phelps

Affiliation: Southeast Missouri State University (Abner), West Virginia University (Phelps)

Presenter E-mail Address: jkabner1s@semo.edu

Abstract: The understanding of population dynamics is vital to population management. Population dynamics refers to the specific dynamic rate functions of recruitment, growth, and mortality. Each function is important to population management alone; however, studying all three at the same time paints the bigger picture and allows for more informed management decisions. Previous studies demonstrated variability in these functions across a few years, but patterns in long-term variability are unknown. This study explored both spatial (latitudinal) and temporal (25 years) effects on Freshwater Drum *Aplodinotus grunniens* population dynamics in the Mississippi River. Results demonstrated that the latitudinal gradient previously found along the Mississippi River still exists: greater recruitment variability, smaller maximum sizes, and lower mortality rates at higher latitudes compared to their lower latitude counterparts. These trends can be, at least in part, attributed to the increased thermal regime (i.e., potential climate change) experienced across the country. This research ties into previous latitudinal and temperature related research and supports the intimate relationship between latitude and temperature. While the dynamic rate functions have changed throughout the basin over the last 25 years, Freshwater Drum appear to thrive in the Mississippi River and are resilient to past as well as current biotic and abiotic changes. In addition, this study demonstrated how potential climate change can affect the population dynamics of a widely distributed riverine fish species.

11) Presentation Type (Oral or Poster): Oral/PowerPoint

Title: Beaver Dam Removal in Missouri Using Explosives

Authors (Underline Presenter): Micah Glover

Affiliation: USDA Wildlife Services

Presenter E-mail Address: Micah.F.Glover@aphis.usda.gov

Abstract: Beaver and human conflicts can be mitigated through the use of explosives. Beaver dams are as diverse as the habitat which they are built and the materials used in the construction of each dam. Beavers are the largest rodent in North America and their dams signify the alteration of an entire ecosystem to insure the species survivability. Over the last 40 years, beavers have caused over 40 billion dollars in associated economic damages and nuisance complainants across the United States. Research from the Smithsonian, estimate beaver populations in the United States at 12 million and the Missouri Department of Conservation 2016 Furbearer Annual Report shows trapping permits sales and harvest totals are low and on a downward trend. This will ultimately lead to an increase in damage for Missouri's number one offender of nuisance wildlife complaints. Obstructions or dams that beavers create to flood or raise water tables often produce conflicts that may threaten, restrict and inhibit natural and human development. The USDA Wildlife Services has a new tool, a safe binary explosive, to use within Missouri to mitigate these issues. Strict protocols for use ensure professionalism and safety before, during, and after each blast that may not be an option with other methods. Multiple detonation options are available when using explosives in the field to allow for accessibility and to maintain safety. Managing beaver populations and aquatic habitats is a necessity; dam removal with explosives is another tool for resource managers, with long term cost benefits for resource users.

12) Presentation Type: Oral

Title: Aquatic invertebrate response to neonicotinoid insecticide contamination of Missouri wetlands

Authors (Underline Presenter): Kyle Kuechle¹, Elisabeth B. Webb^{1,2}, Doreen Mengel³, Anson Main¹

Affiliation:

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3. Missouri Department of Conservation, Resource Science Division, Columbia, MO 65201

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Abstract (250 words maximum): Neonicotinoid insecticides are commonly used as seed-treatments on major agricultural row crops and can be readily transported in surface runoff into freshwater ecosystems. Previous field studies have documented neonicotinoid persistence in global surface waters as well as lethal and sub-lethal responses by aquatic invertebrates in laboratory settings; however, less is known about neonicotinoid occurrence in managed public wetlands of Missouri. We investigated the response of invertebrate communities to direct application of neonicotinoids in managed wetland ecosystems. In 2016 and 2017, 22 wetlands from nine conservation areas were sampled for water, sediment, and aquatic invertebrates during spring (pre-wetland drawdown), fall (post-wetland flood-up), and again during spring 2017. During the summer, portions of wetland areas were planted with either untreated corn (control) or corn treated with a neonicotinoid (i.e., thiamethoxam). Using a series of linear mixed effects models, we evaluate water quality parameters and pesticide concentrations on aquatic macroinvertebrate metrics. Water and sediment samples were analyzed for neonicotinoids with 68% of wetland water in spring having low, but detectable clothianidin residues (mean: 0.006 µg/L; max: 0.012), whereas 10% of wetlands contained imidacloprid. In addition, 30% of wetland sediment samples contained a neonicotinoid (mean: 0.22 µg/kg; max: 2.5). Preliminary results indicate an overall decrease in diversity as well as decreased abundance and size of benthic organisms with increasing concentrations of neonicotinoids in the water and sediment. This has important implications for aquatic invertebrates as well as wetland-dependant species (e.g., waterfowl) as some concentrations, although below regulatory limits, may be impacting these wetland ecosystems.

13) Presentation Type: Oral

Title: Landscape drivers of wetland sediment neonicotinoid concentrations in Missouri public wetlands

Authors (Underline Presenter): Kyle Kuechle¹, Elisabeth B. Webb^{1,2}, Doreen Mengel³, Anson Main¹

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Abstract (250 words maximum): Neonicotinoids are among the most widely applied and fastest-growing class of insecticides commercially available for agricultural use in North America. Neonicotinoid physico-chemical properties enhance its environmental mobility and have led to detection of neonicotinoids in global surface waters including streams and wetlands of North America. Despite increased water sampling efforts, little is known about neonicotinoid concentrations occurring in wetland sediments. Thus, in 2016, we sampled water and sediment from 40 public wetlands under different management practices across Missouri during three sampling periods (pre-plant, post-plant and following autumn inundation). Sediment samples consistently contained neonicotinoid active ingredients (e.g., clothianidin, imidacloprid) across all sampling periods. Clothianidin detection frequency and concentrations ranged from 31% (post-planting, mean: 0.39 µg/kg; max: 7.85) to 55% (pre-planting, mean: 0.44 µg/Kg; max: 9.37). By comparison, imidacloprid detection frequency and concentrations ranged from 32% (autumn, mean: 0.74 µg/kg; max: 6.71 µg/kg) to 44% (post-planting, mean: 0.85 µg/Kg; max: 9.77). Fall sediment concentrations show similar patterns with clothianidin and imidacloprid detected in 43 and 32% of samples respectively. Neonicotinoids across all sampling periods were found to be an order of magnitude higher in the sediment than associated water, indicating cross-seasonal persistence in wetland sediments. We evaluated the relationship between watershed land-use, wetland management variables (e.g. crop planting), and concentration variability among wetlands, and found neonicotinoid concentrations increased proportionately with associated agricultural land in production. Results of this study will be useful in determining both potential routes and levels of neonicotinoid exposure to aquatic wetland invertebrates.

14) Presentation Type: Oral

Title: Conservation from the inside: An introduction to the cooperative community conservationist position with the City of Columbia, MO.

Authors: Danielle Fox

Affiliation: Sustainability Office, City of Columbia, MO

Presenter E-mail Address: Danielle.Fox@como.gov

Abstract: The United Nations predicts that by the year 2030 more than 60% of the world's population will live in a city. As our population expands many natural ecosystems will be lost to urbanization. Additionally, the introduction of non-native plants and excessive use of pesticides by urban citizens can also adversely affect natural ecosystems as well as human health and safety. For the past few decades scientists, educators, and journalists have begun investigating the importance of cities to wildlife conservation and environmental stewardship. Many non-profit conservation organizations work toward improving urban environmental stewardship practices, but often lack the resources to make a large impact. Municipal governments have the greatest capacity to engage citizens and enforce policy to make "large-scale" habitat restoration a reality in a City. The City of Columbia, MO recognizes the importance of environmental stewardship that not only conserves habitat for wildlife but also meets the needs of citizens. In October 2016 the City of Columbia, MO partnered with the Missouri Department of Conservation to hire a Community Conservationist that works for the City to promote and install conservation at the local government level. This presentation introduces this new cooperative position and outlines the challenges and successes of having a community conservationist within the city.

15) Presentation Type: Oral

Title: The spatial ecology and microhabitat selection of the pygmy rattlesnake (*Sistrurus miliarius*) in Southwestern Missouri

Authors: Dylan Wallace Maag and Dr. Brian Greene

Affiliation: Missouri State University, Biology Department

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Abstract: Despite a wide distribution throughout the southeastern United States, pygmy rattlesnakes (*Sistrurus miliarius*) have received little research attention relative to other rattlesnake species. I captured a total of 33 pygmy rattlesnakes at the Drury-Mincy Conservation Area (DMCA) and retained 14 large individuals (mostly pregnant females) for a radiotelemetry study. Snakes were primarily encountered during evening road driving surveys and were rarely seen with any other technique. Pygmy rattlesnakes are widespread at DMCA where they were encountered in forest, savannah, and glade habitats. Snakes selected sites with more tree canopy and close to cover, such as small fallen logs and shrubs, while avoiding areas with sparse cover. All telemetrically monitored snakes were relatively sedentary and occupied very small (0 – 2.6 ha) home ranges. Pregnant snakes were especially immobile during gestation, often limiting all activity to a few m² area. Births occurred in mid-August with maternal attendance observed for several litters. An additional season of telemetry data is being analyzed to derive comparative data for males and non-pregnant females and assess variation in microhabitat selection among adult snakes differing in sex and reproductive condition.

16) Presentation Type: Oral

Title: Developing and Assessing the Accuracy of a Canopy Height Model (CHM) for Deriving Important Biophysical Forest Characteristics

Authors: Tyler Bradford, Dr. Michael Goerndt, Dr. Xin Miao, Dr. Wenping Qiu, Jim Peterson

Affiliation: Darr School of Agriculture, Department of Geospatial Science; Missouri State University, Springfield, MO

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Abstract (250 words maximum):

Photogrammetry is the art, science, and technology of obtaining reliable information about physical objects and the environment. The objective of this project is to develop an accurate canopy height model (CHM) of an area of Ozarks hardwood forest using innovative photogrammetry techniques for the purpose of deriving select biophysical variables. Realization of this goal will be determined by the successful completion of three critical phases: (1) Constructing a digital surface model (DSM) of the forest canopy from UAS-derived aerial imagery using intuitive photogrammetry software; (2) using *in situ* mensuration to validate the accuracy of the generated model; and (3) deriving biophysical characteristics from the validated model. If successful, this project will provide an effective methodology for developing an accurate CHM of temperate deciduous forest, and for deriving relevant biophysical metrics for the purpose of modeling seasonal vegetative growth response.

17) Presentation Type: Oral

Title: Assessing and Monitoring Stream Channels and Riparian Corridors Using LiDAR in the Grand River Grasslands

Authors (Underline Presenter): Ryan Wortmann and Dyan Pursell

Affiliation: Missouri Department of Conservation

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Abstract (250 words maximum): Missouri Department of Conservation is exploring the feasibility of using LiDAR to accurately model headcuts, sites of bank instability and riparian corridor condition, as well as document channel width within Priority Geographies. The goal of the project is to create a toolset for GIS users with limited experience. Leaf-off and leaf-on LiDAR was flown at USGS QL 0.5 for the Missouri portion of the Grand River Grasslands, achieving a horizontal accuracy of 6 inches and a vertical accuracy of 3 inches. Using eCognition, image objects were generated from the 2015 USGS leaf-off (4-band) DOQQ, and land cover (LC) classes were assigned by hand to the resulting 167,000+ objects. A center line stream layer was derived from a hydrologically sound .5 m DEM using a conditional flow accumulation statement that proved to be more accurate than the available 24k NHD. To accurately measure a 30m riparian corridor, it was necessary to define the stream channel. A custom program created bankfull channel polygons for second order and larger streams. This custom program also enabled the generation of potential headcut locations. Once channel polygons were defined, a tool was developed to calculate the percentage of shaded stream surface. In combination with existing data, this toolset will assist land managers in determining where to implement Best Management Practices along stream corridors by allowing them to effectively evaluate stream stability and riparian corridor condition.

18) Presentation Type (Oral or Poster): Oral

Title: Preliminary observations after a severe running crown fire in Missouri

Authors (Underline Presenter): Susan Farrington

Affiliation: MDC

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Abstract: Severe drought during the summer of 2012 created tinder dry conditions in Missouri. In early July, the 1200 acre Martin Wildfire in Christian County included a running crown fire, killing every tree in approximately 40 acres. Nothing but ash and blackened tree boles remained. Photo points were established after the burn and have been repeated several times since, showing the changes as the landscape recovers. Permanent vegetation monitoring plots were installed in 2016, including control plots in an adjacent site that did not burn. Preliminary data and lessons learned will be presented.

19) Presentation Type: Oral

Title: Estimating hydrology at fish sampling sites

Authors: Emily Tracy-Smith¹, Paul Blanchard², Matt Combes², Del Lobb², Craig Paukert³, Jason Persinger², and Nick Sievert¹

Affiliation: (1)University of Missouri, The School of Natural Resources, (2)Missouri Department of Conservation, (3)U.S. Geological Survey; University of Missouri; Missouri Cooperative Fish and Wildlife Research Unit

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Abstract: A limitation to ecologically informed water management is the lack of stream flow data that can be used to determine biotic responses to changes in river flow regimes. The ability to evaluate ecological responses to hydrologic alteration requires empirical information of hydrologic attributes for rivers across a gradient of natural to impaired flow regimes. We developed a method to estimate hydrology metrics (mean and median annual flow) at fish sampling sites to quantify flow alteration – ecological response relationships for Missouri streams. Reference (least disturbed) flow duration curves (FDC) were developed for gages that represent least altered conditions. These were synthesized for all Missouri stream reaches based on FDC groups and regressions of gaged discharge versus drainage area and percent zero flow days versus drainage area. Reach specific adjustments to flow estimates were based on accumulated springflow and losing stream factors within their drainage areas. Flow alteration metrics include basic attributes of impoundments and metrics for the hydrologic effect of withdrawals, using losing streams as a natural surrogate. Working downstream from each headwater segment, we used RivEX software to accumulate values of these metrics for every stream segment within Missouri. Accumulated flow alteration metrics were applied for every fish community sampling site of the Missouri Department of Conservation's Resource Assessment and Monitoring Program. The resulting datasets will help to identify gaps in existing data and to evaluate differences in fish communities as a function of flow alterations.

20) Presentation type: Oral

Title: Behavioral responses of cottonmouths to conspecific cloacal gland secretions

Authors: Alex Meinders and Dr. Brian Greene

Affiliation: Missouri State Biology

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Abstract: All snakes possess cloacal glands from which they secrete malodorous substances during predatory encounters. These secretions have been suggested to facilitate a variety of possible chemosensory communication functions. The two main hypotheses proposed for the function of snake musk gland secretions are predator deterrence and as a social alarm cue. However, experimental evidence addressing these hypotheses is limited. The recent discovery of cryptic sociality in pitvipers has sparked renewed interest in the alarm cue hypothesis. I tested the alarm cue hypothesis by examining behavioral responses of juvenile cottonmouths (*Agkistrodon piscivorus*) for evidence of threat sensitivity during both feeding trials and simulated predation events. Preliminary results are consistent with snakes being wary when exposed to musk as evidenced by elevated mean latencies to feed, time spent immobile, and tongue-flick rate, compared to control trials. A palatability test on mammalian carnivores will also be implemented in order to test the predator deterrent hypothesis. These experiments are currently underway and the data from these will be presented when trials have concluded.

21) Presentation Type: Oral

Title: The effects of public perception on forest management effectiveness and efficiency

Authors: Katie McGrath

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Abstract: Forest management practices in the United States are often surrounded by misunderstanding and controversy. Since the early 1900's, the argument of conservation versus preservation has persisted amongst environmentalists, politicians, and the public. Conservation provided the foundation for the United States Forest Service (USFS), and preservation for the National Park Service (NPS). Yet, since the early days of both agencies, the NPS has succeeded in capturing the attention and affection of visitors on a global scale, while the USFS often continues to spark controversy across political platforms. Both agencies strive to protect America's greatest natural resources and both are backed by some of America's greatest scientific minds. This paper explores the factors that determine the difference. I will examine how the US Forest Service's lack of public outreach affects its overall success as an agency and explore strategies that can help improve public awareness, inter-agency collaboration, and management efficiency. Additionally, I draw parallels to similar issues on a state level and address the vitality of updating public outreach measures in an ever-changing political arena. Support for this paper comes from both historical and modern-day examples, as well as from theories by policy analysts in the field of natural resources.

22) Presentation Type: Oral

Presentation Title: Missouri Water Resources Plan

Author and Presenter: [Sherri Stoner](#)

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Abstract: The Missouri Department of Natural Resources recently began updating the Missouri Water Resources Plan. During this process, estimates of current and future water use needs are being performed, and an updated evaluation of surface water and groundwater use and availability are being developed. Once completed, the water plan will provide a long-range, comprehensive strategy with an understanding of our water resource needs. The information collected for the water plan will help to ensure the quantity of Missouri's water resources will meet our future needs by identifying areas where developing new and more sustainable water sources, better infrastructure, and more integrated water supplies can help sustain water delivery in the face of stresses on supply, such as a drought and increasing demand. It is imperative that we look to the future and prepare for our water needs.

23) Presentation Type: Oral

Title: Fish Community Assemblages in the Ozarks of Southern Missouri

Author: Stephanie M. Sickler, Department of Biology, Missouri State University
Sean P. Maher, Department of Biology, Missouri State University

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Abstract: There are several potential mechanisms regarding fish community assembly, many of which can be related to habitat type. Within the three drainages in southwest Missouri, there are many habitat specialists, and some species are restricted to specific basins while others can be found in all three. Stream order also may be important because some fish typically live in smaller streams while others live in larger rivers. Surrounding land use is another likely mechanism in structuring fish communities as it impacts stream habitat structure and water quality. We sought to assess the mechanisms of fish community assembly by comparing fish diversity in the three basins in southwest Missouri, specifically asking 1) are fish communities structured by basin, 2) are they structured by stream order, and 3) if basin and stream order are not the structuring mechanisms, which mechanisms best explain the patterns we found at our sample sites? We sampled 44 streams in the summer 2016 using a combination of seines and electroshocking. A total of 58 species were collected, including hornyhead chubs and duskystripe shiners that were found only in specific drainages, and smallmouth bass and striped shiners that were found in all three basins. Bray-Curtis distances between sites were calculated and used to determine whether the assemblages were structured by basin, stream order, land use, or a combination of these mechanisms. The addition of historic data could shed light into long-term impacts that are affecting modern fish assemblage structure.

24) Presentation Type: Oral

Title: Population genetics of Missouri walleye (*Sander vitreus*)

Authors (Underline Presenter):

Leah Berkman¹, Chelsea Titus¹, Paul Cieslewicz², Dave Knuth², and Lori Eggert³

Affiliations: ¹Missouri Department of Conservation, Resource Science Division

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Abstract (250 words maximum): The Missouri Department of Conservation began managing walleye by the early 1950s. Arguably, the greatest alterations to the native walleye populations occurred during the early history of management due to the construction of impoundments and the subsequent stocking from non-local sources. More recently, managers have focused stocking programs to preserve the genetic integrity of Missouri's walleye while continuing to counter the negative effects of impoundments and provide angling opportunities. Genetic analyses conducted over 15 years ago provided 3 pieces of critical information that informed management plans: (1) the Black and Current Rivers harbor a unique strain of walleye and should only be stocked with that strain; (2) the remaining Missouri waterbodies may contain a mix of Great Lakes and endemic strains of walleye; and (3) walleye stocking in neighboring states may hinder MDC's attempts to preserve genetic integrity. Since then, molecular and computational techniques have become more streamlined, informative, and cost effective. Additionally, further information has emerged in the past few years regarding the genetic structure of walleye across their range. Thus, we revisited the conclusions and predictions from early analyses using microsatellite makers and mtDNA. Results indicate high diversity at nuclear markers which improves the power to detect genetic structure and identify non-native walleye and their hybrids. We confirmed the unique status of Black River walleye and their placement within the Eastern Highland clade of walleye, which are highly distinct from Great Lakes walleye both genetically and ecologically.

25) Presentation type: Oral

Title: Test-driving a newly developed fish sampling protocol to identify biodiversity hotspots in two Missouri mid-sized rivers

Authors: Corey G. Dunn¹, Craig P. Paukert^{1,2}

Affiliation(s): ¹Missouri Cooperative Fish and Wildlife Research Unit, School of Natural Resources, University of Missouri, Columbia, MO 65211; ²U.S. Geological Survey.

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Abstract (242 words):

Conservation planning depends on a clear and complete picture of species diversity patterns. Relatively little is known, however, about the distributions of the fishes inhabiting Missouri's mid-sized rivers due to the inherent difficulty surveying these large and complex systems. From 2014–2015, we developed a candidate set of sampling protocols capable of detecting all fish species inhabiting sites within mid-sized rivers. Then in summer 2016, we validated a single simplified and efficient protocol by surveying an additional 10 sites within the lower 200 km of the Grand River and 12 sites within the lower 250 km of the Meramec River. Our objective was to identify areas within each river supporting the highest fish species richness. Site-level richness was high, with sites on average supporting 33.8 ± 4.1 and 58.6 ± 7.2 species (\pm SD) in the Grand and Meramec rivers, respectively. Longitudinal richness patterns peaked in the mid-courses of both rivers, revealing consistent biodiversity hotspots at the transition between upland and lowland fish communities. When sites were aggregated by river, the total number of species detected included over 75% of all fishes ever recorded in either river drainage, revealing the wide diversity of species supported by mid-sized rivers. Overall, we demonstrate the possibility of rapidly inventorying the fishes within large rivers using streamlined protocols. If replicated in other rivers, distributional information would complement existing wadeable-stream fish inventories and better inform basin-wide approaches towards managing populations, prioritizing critical habitats, and monitoring fish communities.

26) Presentation Type: Oral

Title: A comparison between standard electrofishing and novel trawling techniques for assessing Silver Carp populations in backwater areas of the Illinois River, Illinois, with applications to the Missouri River system.

Authors, Affiliation: Christopher Brooke, U.S. Fish & Wildlife Service, Columbia Fish & Wildlife Conservation Office; Jeremy Hammen, U.S. Fish & Wildlife Service, Columbia Fish & Wildlife Conservation Office; Emily Pherigo, U.S. Fish & Wildlife Service, Columbia Fish & Wildlife Conservation Office; Jason Breeggemann, Wisconsin Department of Natural Resources; Pablo Oleiro, Missouri Department of Conservation; Jeena Credico, U.S. Fish & Wildlife Service, La Crosse Fish & Wildlife Conservation Office; Jason Goeckler, U.S. Fish & Wildlife Service, Columbia Fish & Wildlife Conservation Office; Wyatt Doyle, U.S. Fish & Wildlife Service, Columbia Fish & Wildlife Conservation Office

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Abstract: Silver Carp are an invasive species that were introduced to the United States in the 1970's and have expanded throughout the Greater Mississippi River basin. Management and monitoring of Silver Carp have been difficult due to the inability to effectively capture them, in part, because of their tendency to inhabit pelagic, open waters. In 2016 and 2017, two electrotrawling techniques (paupier and dozer trawl) were compared to traditional electrofishing methods currently being used for management and monitoring of Asian carp. The paupier and dozer trawl had 5x and 2x greater Silver Carp catch rates than traditional electrofishing, respectively. Small (<200mm) Silver Carp catch rates were greatest with the paupier compared to all other techniques. These results indicate that greater effort (sample size) is needed with traditional electrofishing to assess Silver Carp populations compared to the dozer trawl and paupier and that electrotrawling has the ability to efficiently sample a large size range of fish. As standard protocols are being developed for the management and assessment of Silver Carp, electrotrawling methods should be considered for their ability to assess Silver Carp populations with less effort. In the Missouri River and its tributaries the very nature of the river system can make it difficult to sample; it is essential to have a variety of techniques available to assess Silver Carp populations.

27) Presentation Type: Oral

Title: Finding suitable habitat in the historic range of the red wolf, a critically endangered large mammal, utilizing GIS and human dimensions components

Authors (Underline Presenter): Lauren Toivonen, Matthew Gompper, Hong He, Charles Nilon, Regina Mossotti

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Abstract (250 words maximum): The red wolf is a critically endangered species endemic to the southeastern United States. The world's only wild population resides on the Albemarle Peninsula of North Carolina. The goal of this study is to provide analysis of available data to identify and rank suitable habitat sites within the red wolf's expansive historic range. We used Geographic Information System to develop a habitat suitability model based on indices of landscape, road distance, and population distance. Because occurrence data has only been documented in the North Carolina population, we identified habitat used by red wolves from the published literature as well as from expert opinion. We incorporated human population and roads to create an initial weighted model of ranked suitability throughout their historic range. Next, human populations were surveyed to measure carnivore perception and interest of reintroduction. This information has been assessed in combination with the habitat suitability model to examine how site rankings change based on human perception.

28) Presentation Type (Oral or Poster): Oral Presentation

Title: The Protection Volunteer Program: Recruiting Tomorrow's Conservation Agent, Today.

Author: Kevin G. Eulinger

Affiliation: Conservation Agent, Missouri Department of Conservation

Presenter E-mail Address: Kevin.Eulinger@mdc.mo.gov

Abstract: The primary mission of the Protection Volunteer Program is to aid and assist division personnel with providing quality service to Missouri's citizens through a coordinated program of resource law enforcement, education, information and one-on-one contacts. The program also serves as a recruitment tool; allowing volunteers to gain knowledge and experience which will help prepare them for becoming a conservation agent in the future. This presentation will evaluate the effectiveness of the Protection Volunteer Program by examining the strengths, benefits, and cost savings that the Protection Volunteer Program provides to the Missouri Department of Conservation and the Protection Division.

29) Presentation Type: Oral

Title: Comparing native bee and grasshopper communities in reconstructed prairies to remnant prairies in Missouri

Authors: Joseph LaRose¹; Lisa Webb²; Deborah Finke¹

¹ Division of Plant Sciences, University of Missouri

² USGS Missouri Cooperative Fish and Wildlife Unit, University of Missouri

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Abstract: Tallgrass prairies and their obligate inhabitants once occupied a large swath of central North America, but now face the combined challenges of habitat loss and fragmentation. In Missouri, several hundred hectares of tallgrass prairie have been restored near patches of remnant native prairie. Typically, the success of reconstructed grasslands is assessed based on the extent to which native prairie plants have reestablished. Invertebrates are often assumed to colonize reconstructions if native vegetation returns. However, the limited mobility of many invertebrates and the isolation of many tallgrass remnants raises serious questions as to how prairie invertebrate communities in reconstructed prairies compare to those in remnants. To evaluate the effectiveness of prairie reconstructions in restoring grassland invertebrate communities, we sampled two guilds of terrestrial invertebrates: native bees (*Apoidea*) and grasshoppers (*Acrididae*). We sampled invertebrates from five conservation areas in Missouri containing tallgrass prairie habitat. Three areas contained prairie remnants adjacent to reconstructions, while the remaining two areas consisted of one remnant and one reconstructed prairie. We collected bees and grasshoppers in summers 2016 and 2017. We captured bees with bee bowls, and grasshoppers with sweep nets. Community analyses indicate that remnants and reconstructions may differ in composition for both taxa, particularly for grasshoppers. Reconstructed prairies were characterized by mobile species that are typically successful in agroecosystems. Although not statistically significant, bee species richness and diversity were greater on remnant prairies than on reconstructions. For bees in particular, pollen specialists and kleptoparasites may be less capable of colonizing and surviving in reconstructed prairies.

30) Presentation Type: Oral

Title: Survival and growth of 1-0 Shortleaf pine (*Pinus echinata*) seedlings relative to planted and natural hardwoods in forest restorations

Authors: John M. Kabrick¹, [Stephen J. Lyczak](mailto:stephen.lyczak@mail.missouri.edu)², Benjamin O. Knapp², Daniel C. Dey¹, and David R. Larsen²

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Abstract: Growing concern about forest species composition changes has renewed interest in restoring shortleaf pine in pine-oak forests to increase resiliency and heterogeneity. Establishing shortleaf pine across portions of its historical range has proven challenging due to shade intolerance, slow early growth, and poor competitive ability. Our objective was to determine the expected survival and growth rates of planted shortleaf pine relative to artificial and naturally regenerated hardwoods and identify barriers to restoration success. We used data from three long-term studies in southeastern Missouri to examine the survival and growth of over 4000, 1-0 *Pinus echinata* seedlings as a function of understory competition and overstory density in artificially and naturally regenerated stands. Growth of planted 1-0 shortleaf pine exceeded that of planted 1-0 white oak (*Quercus alba*) or red oak (*Q. rubra*) when grown without overstory competition during 8- and 20-year monitoring periods. However, planted pine had lower survival and growth where competing with oaks and other hardwood regeneration originating from advance reproduction than those established as monoculture plantations. Regression analysis indicated that survival and growth of shortleaf pine in natural stands was further reduced by retaining a hardwood overstory. Planted shortleaf pine grew faster than planted oaks in clearcut stands with few other hardwood competitors. However, most shortleaf pine restorations occur in mixed hardwood stands where large advance reproduction outcompetes planted shortleaf pine after harvesting. Although retaining a partial overstory reduces survival and growth, data show the importance of initially controlling understory competitors.

31) Presentation Type: Oral

Title: Identification of the cause of mussel population collapse, and current water quality and habitat suitability assessment in the Little Black River system, Carter, Ripley, and Butler Counties, Missouri

Author: Matthew Schrum¹, Amanda Rosenberger², Stephen McMurray³

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Abstract: Status surveys in known freshwater mussel beds in the Little Black River in the Current River drainage showed a precipitous decline in mussel richness and density in the late 1980s and early 1990's. Causes for this decline remain unknown, but may be related to water quality and habitat degradation. Our goal is to identify likely sources of ongoing water quality issues to determine if sites in the Little Black River are presently suitable for reintroduction efforts and, potentially, narrow down the causes of the precipitous decline in mussel assemblages in the river. From July 2016 to August 2017, we thermally characterized the stream by setting temperature loggers regularly along the length of the river, with particular attention to areas of known spring influx, tributary junctions, or other factors that could contribute to temperature change. We also conducted water quality assessments longitudinally along the system on a monthly basis during this same time period, specifically collecting pH, dissolved oxygen, ammonium, and conductivity. In fall 2016 and spring 2017, we conducted invertebrate sampling strategically along the length of the stream to determine if non-mussel macroinvertebrates communities indicate chronic poor water quality. We also researched records on the Little Black River to determine likely sources of spills and if any fish kills took place there. In summer of 2017, we sampled historic and new mussel beds to assess current population trends. The results of this study will inform future potential mussel reintroduction efforts in the Little Black River.

32) Presentation Type: Oral

Title: Practical considerations for long-term maintenance of oak woodlands

Authors: Benjamin O. Knapp¹; Michael C. Stambaugh¹; Daniel C. Dey²; John M. Kabrick²

Affiliation: ¹University of Missouri, School of Natural Resources; ²USDA Forest Service, Northern Research Station

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Abstract: Contemporary oak woodland management practices commonly focus on a restoration phase that transitions closed-canopy forests to the target structure and composition of woodlands. Managing oak woodlands over the long-term requires maintenance of that structure and composition, including a relatively low-density canopy, open vertical structure, and herbaceous ground flora. For most woodland sites in the eastern United States, maintaining open structural conditions and the desired herbaceous vegetation requires repeated, frequent prescribed burning. However, frequent prescribed burning can also damage hardwood trees, reducing the longevity of the canopy while limiting opportunities for canopy replacement through regeneration. We provide empirical examples from recent studies to highlight these points and discuss practical approaches to dealing with this paradox of oak woodland management in the context of traditional silvicultural concepts. These apparent challenges suggest consideration of operational limitations as well as trade-offs concerning management objectives when planning long-term oak woodland management.

33) Presentation type: Oral Presentation

Title: Evaluating Electrofishing Waveforms: A Critical Step in Developing Standardized Sampling Methods for Smallmouth Bass

Authors: Zach Morris, Missouri Cooperative Fish & Wildlife Research Unit; University of Missouri
Craig Paukert, U.S. Geological Survey, Missouri Cooperative Fish & Wildlife Research Unit; Univ of MO
Zach Ford, Missouri Department of Conservation
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Abstract: We compared electrofishing immobilization thresholds for 12 pulsed DC waveforms (30, 60, and 120 pulses per second (Hz) at duty cycles of 15, 25, 30, and 40%), including a commonly used waveform to collect Smallmouth Bass (60Hz/25%). A total of 310 Smallmouth Bass from two size groups (18-28; 35-43 cm) and three temperatures: 11 – 14°C, 17 – 20°C, and 22 – 26°C were collected via electrofishing, rested in a pen for >1 hr, and placed in a tank attached to a backpack electrofisher. Voltage was increased from one volt until immobilization was observed. A 3-way anova found interaction between temperature and fish size ($P=0.01$) and marginal interaction between temperature and waveform ($P=0.071$). For the coolest water temperature, waveform had a significant effect on immobilization threshold ($P<0.001$). The commonly used 60Hz/25% waveform was grouped with the waveforms that produced the lowest average thresholds. There was no effect of fish size in the lowest temperature ($P=0.830$). For the middle water temperature, waveform had a significant effect on immobilization threshold ($P<0.001$), with the 60Hz/25% waveform being grouped with the waveforms that produced the lowest average thresholds. Larger fish had lower immobilization thresholds (0.24 v/cm) than smaller fish (0.30 V/cm; $P<0.001$). For the warm water temperature, there was interaction between waveform and size ($P=0.031$). For small fish the effect of waveform was not significant ($P=0.074$). For larger fish, the effect of waveform was significant ($P=0.01$), and 60Hz/25% produced the lowest average thresholds, but 30Hz waveforms were also in the group of waveforms with the lowest thresholds.

34) Presentation Type: Oral

Title: Smallmouth Bass Population Demographics in Missouri Ozark Streams

Authors: Edward Sterling, Southeast Missouri State University; Dr. Quinton Phelps, West Virginia University; Dave Herzog, Missouri Department of Conservation; Sarah Tripp, Missouri Department of Conservation

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Abstract: In this study, five Ozark streams were sampled in southern Missouri. A representative sample of Smallmouth Bass (*Micropterus dolomieu*) were sampled from each system and aged by use of scales and sagittal otoliths. Age bias plots were constructed in order to determine the most precise aging structure for Smallmouth Bass. From the data collected, estimates of recruitment, growth and mortality were derived for each stream. These estimates were then used to produce models of yield, spawning potential, and number of preferred size fish in each system. This data helps to evaluate the sustainability and efficacy of Smallmouth Bass management within the State of Missouri.

35) Presentation Type: Oral

Title: Developing a Framework for the Management and Control of Asian Carp in the Missouri River Basin

Authors: Emily Pherigo and Jason Goeckler

Affiliation: U.S. Fish & Wildlife Service Columbia Fish & Wildlife Conservation Office

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Abstract: The U.S. Fish and Wildlife Service and the Aquatic Nuisance Species Task Force determined that Asian carp warrant active control by natural resource agencies and developed a national plan to address these species. The Missouri River Basin Asian Carp Control Strategy Framework (Framework) implements the national plan at the Missouri River sub-basin level. Six goals and associated strategies are identified in the Framework and relate to the national plan as well as other regional plans such as the Great Lakes, Ohio River Basin, Upper Mississippi River Basin and the Lower Mississippi River Basin. Implementation of the Framework will be coordinated through the Asian Carp Technical Committee (Tech Committee) of the Missouri River Natural Resources Committee with the intent to minimize the social, ecological, and economic impacts of these invasive fishes to the Missouri River Basin. The Tech Committee will be a multidisciplinary group of state and federal agencies, universities, and other partners. As an unfunded component of national Asian carp management and control, strong collaboration and coordination in the Missouri River Basin will be key for success.

36) Presentation type: Oral

Title: Validation of Annulus Formation in Rock Bass Otoliths

Authors: Kylie Sellers, Edward Sterling, Robert Snyder, and Quinton Phelps

Affiliation: College of the Ozarks, Southeast Missouri State University, University of West Virginia

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Abstract: In this study, five Ozark streams were sampled in southern Missouri between April and October 2016 and 2017. A representative sample of Rock Bass (*Ambloplites spp.*) were sampled via angling and aged by use of scales and sagittal otoliths. Age bias plots determined that age estimates from scales were less precise than age estimates from otoliths. Using the age estimates derived from the otoliths, estimates of recruitment, growth and mortality were formulated for each stream. To determine the validity of using otoliths as ageing structures, marginal increment analysis was performed with the sagittal otoliths from each Rock Bass collected. This analysis was used to determine the efficacy of using Rock Bass otoliths as a reliable ageing structure.

37) Presentation Type: Oral

Title: The value of partnerships in resource management

Authors: Paul M. McKenzie; Tom Aley, Ozark Underground Laboratory, Dave Woods, Missouri Department of Conservation

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Abstract: In today's society and environment, it is extremely important for various entities to reach resource management goals. This is especially true, regarding the conservation of threatened and endangered species or those of conservation concern. In Missouri we have three examples how partnerships have been able to obtain resource management goals that would not have been as effective through the efforts of one agency or entity. The Tumbling Creek Cavesnail Workgroup and Partnership was established in 2002 to coordinate the recovery of the species. The combined efforts Federal, State, and private partners were successful in preventing a local school from closing, restoring habitat, and reversing the decline in the population of the species. The Topeka shiner has been extirpated from all but two areas in Missouri. A partnership developed between the Service, MDC (fisheries staff and the Lost Valley Hatchery personnel), and the Neosho National Fish Hatchery staff facilitated the propagation of the species in captivity and the establishment of non-essential experimental populations that have improved the status of the species in Missouri. The Missouri Feral Hog Partnership was developed among Federal, State, and private entities to control the spread of feral hogs in Missouri. It is hoped that this partnership will facilitate the recovery of the federally listed Mead's milkweed on rhyolite glades in the Missouri Ozarks that is threatened by the spread of feral hogs.