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Session 2B

Kentucky Water Resources Research Institute, University of Kentucky

DEVELOPING A VEGETATION-BASED INDEX OF BIOTIC INTEGRITY FOR ASSESSING THE ECOLOGICAL CONDITION OF WETLANDS IN KENTUCKY

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To enforce the Clean Water Act, a number of ecological assessment techniques have been developed to quantify the ecological quality of streams and wetlands across the United States. However, Kentucky is currently lacking in this area and has no state-wide means to assess the ecological quality of its wetlands. Ohio has a state-wide applicable vegetation-based index of biotic integrity (VIBI) for assessing wetlands that has undergone multiple testing iterations and years of refinement. Due to the geographic and vegetative similarities between Ohio and Kentucky, Ohio's VIBI was used as a model for the development of a state-wide applicable vegetation-based IBI for Kentucky (KY VIBI). The Ohio VIBI metrics were tested for performance in riverine wetlands in two of Kentucky's watersheds, the Green River and Upper Cumberland River. Using a stratified random selection approach, a total of 39 sites were intensively sampled between the two watersheds over the growing seasons of 2011 and 2012. Preliminary analysis suggests certain metrics (e.g. the number of seedless vascular plants, number of hydrophytes, percent invasive graminoids) from the Ohio VIBI are not performing in a way that correctly reflects wetland condition in these two watersheds. Our next step is to make slight modifications to the existing metrics from the Ohio VIBI in order to properly reflect wetland condition in these two watersheds. These modified metrics will become candidate metrics for the KY VIBI. Additionally, we will also develop new and simpler metrics as possible candidate metrics for the KY VIBI. These candidate metrics will then be validated against an independent method of calculating disturbance (Landscape Development Index or LDI) using correlation analysis.

NOTES

USING VEGETATION AND LANDSCAPE ANALYSIS TO VALIDATE A WETLAND RAPID ASSESSMENT METHOD FOR KENTUCKY'S FORESTED RIPARIAN WETLANDS

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Within the past few decades, Rapid Assessment Methods (RAMs) have been employed as a quick and qualitative approach to determine ecological integrity across various ecosystems. From an ecological and regulatory perspective, wetlands are a model system for using and testing RAMs. In terms of total wetland loss, Kentucky is among the nation's highest with losses exceeding 80%. Of those wetlands remaining, the vast majority are forested floodplains. Kentucky is currently in the process of developing and evaluating a Kentucky Wetland Rapid Assessment Method (KYWRAM) to be used in regulatory processes and scientific research. The goal of this study was to validate the KYWRAM using the Environmental Protection Agencies' 1-2-3 level framework. Level 1 methods are landscape-scale assessments; Level 2 methods are rapid assessments typically requiring no more than a half day in the field. Level 3 methods are intensive assessments surveying biotic communities.

This study was conducted within the Green River and Upper Cumberland River basins of Kentucky. Sites were sampled between 23 May and 26 September, 2012 (n = 20). Wetlands were selected by the US Environmental Protection Agency using a generalized random tessellation stratified sample design. To validate our method, we quantified the vegetation communities and landscape intensity at each site to be compared against scores from the KYWRAM. At each site, a Vegetation Index of Biotic Integrity (VIBI) and KYWRAM were conducted. A Landscape Development Intensity Index (LDI) was also used to calculate landscape disturbance for each site. VIBIs were conducted using ten 10x10-m plots, composed of ten forest metrics and is scored from 1 to 100 (100 being reference and 1 being very poor quality). KYWRAMs were completed by individual raters, were composed of 6 disturbance metrics and scored from 1 to 100 (100 being reference and 1 being very poor quality). Scores for the KYWRAM were averaged for each site. LDIs were calculated using the 2005 National Land Cover Dataset in ArcGIS v. 10 within a 1000m buffer around each VIBI point and was scored from 1 to 10 (1 being reference and 10 being completely disturbed).

Our initial results show that scores ranged from 25 to 80 (VIBI), 30.5 to 87 (KYWRAM), and 1.36 to 5.95 (LDI). Linear regression showed similar relationships between all three levels of assessment, however, only significant relationships exist between the VIBI and the LDI ($R^2 = 0.219$, $P < 0.05$). Of all three methods, only the VIBI

showed a statistically significant difference between basins ($t_{18} = 5.231$, $P < 0.001$) while the KYWRAM and LDI were not statistically significant ($t_{18} = 1.940$, $P < 0.068$ and $t_{18} = -1.365$, $P = 0.189$, respectively).

Since scoring ranges did not encompass the entire gradient of disturbance, we cannot yet validate this method. Since random sampling did not pick up very low or high quality sites, we will likely have to locate these sites with the help of state agencies. Because this method is still being developed, we will review which metrics best reflect intensive surveys and landscape analysis to modify the KYWRAM. Future analysis will utilize model selection to determine which variables are best explaining each KYWRAM metric. In addition, multivariate techniques to determine which variables are scoring similarly. This will give us a better framework for developing and adapting these methods for regions specific to Kentucky. The results from this research will be used towards the development of a KYWRAM and to influence wetland management practices within Kentucky.

IMPROVING OVERALL STREAM FUNCTION BEYOND THE CHANNEL (OPPORTUNITY MEETS NECESSITY)

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Working for the Tennessee Stream Mitigation Program, Stantec and Jen-Hill teamed on the Middle Fork Stream Restoration Project to expand the ecological footprint of a restoration project in Western Tennessee by incorporating a variety of oxbow ponds, wetlands and vernal pools. The oxbows wetted areas were designed and constructed in a manner that provided an array of ecological opportunities including variable depths, hydrologic regimes, vegetation, woody debris and substrates. The project, located in Huron, TN., was primarily a Priority 1 design and included, among the oxbows, a 0.5 ac pond designed to intercept sub-surface drainage tiles installed sometime prior to 1985 to convert wetlands to farmable land. The combination of hydrology and sandy silt soils made it difficult, and in some cases too costly, to fill certain areas of the old channel and floodplain, which created the opportunity to incorporate oxbows and wetlands to balance material on site using landform grading techniques. The oxbows and wetlands created adjacent to valley slopes intercept, reduce the velocity, and provided storage for overland flow on the highly erodible soils. The water-filled oxbows, wetlands, and vernal pools then gradually supply the adjacent stream with longer sustained stream flows through the year and pool habitat through the summers due to groundwater flow. Multiple oxbows were created adjacent to the stream channel, many of which were hydraulically connected with shallow swales creating a network of oxbow lakes. These oxbows were generally created to maintain existing springs and seeps encountered during construction. The network of oxbows allowed these springs and seeps to slowly move water through the wetlands and then become part of the groundwater hydrology. The flow networks facilitate the controlled runoff of storm water while the addition of woody debris creates natural wood-type structures. Root wads and other woody debris generated from construction were used to ecologically augment the oxbows while creating natural check dam type structures for larger runoff events. Depths were varied throughout the oxbows while trees that were present were incorporated into the design as well. The result is a functioning system of oxbows with vernal pools and adjacent wetlands that support and enhance the natural channel design both ecologically and hydraulically.

About the Speakers: **Oakes Routt** P.E. is a Stream Restoration Construction Manager with Stantec who has been working on stream restoration projects the last 5 years across the United States. Mr. Routt holds Bachelors and Masters of Engineering degrees from the University of Kentucky. **Wanda Lawson** P.E**.** is a Stream Restoration Designer with Stantec who has been working on stream restoration projects for over 9 years across the United States. Mrs. Lawson holds a Bachelors of Engineering degree from the University of Kentucky.

NOTES

THE EFFECTS OF PRESCRIBED FIRE RESTORATION ON AMPHIBIAN AND REPTILE DIVERSITY

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Restoration ecology is an expanding field with great potential. The benefits of fire restoration have been well documented for a number of plant and animal species, yet the impact of fire on amphibians and reptiles is not fully understood. I tested whether fire restoration measures, specifically controlled burns, had any effect upon amphibian and reptile abundance, diversity and community composition. This study was performed after one managed burn event within Land Between the Lakes National Recreation Area (LBL). I employed three methods (dip-netting, drift fences and minnow traps) to sample herpetofauna at eight control and eight restoration sample sites. I also measured environmental variables including forest characteristics and water quality at each sample site. Individual species abundances did not differ significantly for any reptile or amphibian. The restoration area had significantly higher herpetofauna diversity, but only one environmental variable, leaf litter depth, corresponded to this result. Control and restoration areas had significantly different species assemblages. Differences in species assemblage and diversity can be attributed to a higher number of species documented in the restoration area including many that occurred in low numbers. The presence of these additional species in the restoration habitat suggests that fire disturbance has promoted a redistribution of the available niche space. This study is one of the first in the southeastern U.S. to document overall increased diversity of herpetofauna corresponding with fire restoration techniques. The changes in reptile and amphibian diversity and community composition observed in this study are likely due to both the specific fire prescription used by LBL land managers and my sampling methodology. Comparisons with previous studies indicate that the long burn regimes implemented at LBL benefit herpetofaunal diversity and that thorough sampling is necessary to detect changes in herpetofauna community structure and diversity after fire management.

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QUANTIFYING BENTHIC MACROINVERTEBRATE COMMUNITY STRUCTURE AND BIOMASS IN A RECENTLY RESTORED STREAM IN EASTERN KENTUCKY

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Channelization is the process of straightening, widening, and deepening existing stream and river channels (1). Studies have shown that stream alteration and channelization results in degraded stream habitat and loss of hydrologic function. These changes have negative impacts on the aquatic biota (2). From the late 19th century through the middle of the 20th century, stream alteration and channelization was so expansive that many streams nation-wide are impacted by this anthropogenic disturbance. In the Appalachian Highlands physiographic region of the US, nearly 99% of the streams have been potentially modified as a result of channelization (3).

Our study sites, Slabcamp Creek and White Pine Branch, are good examples of channelized headwater streams in Kentucky. Many years ago, sections of these streams were straightened and moved to the base of a mountain to support farming in their respective valleys. As a consequence, the channels eroded to bedrock and developed unstable habitat for aquatic biota. Furthermore, the streams became disconnected from their natural floodplains and aquifer, which resulted in intermittent annual flow patterns. (4). The USDA Forest Service decided to restore Slabcamp Creek and repair the damage that resulted from past channelization and historical land-use. The major goals of the restoration were to improve habitat for wildlife and fish, reduce erosion and downstream flooding, restore the hydrologic function, and increase the flow during summer and dry fall periods (4). The restoration practices at Slabcamp Creek involved the removal of post-settlement alluvium in order to reconnect the channel to its original aquifer and floodplain in the center of the valley. The restoration has been complete since October 2011. Stream restoration is becoming increasingly common and various restoration practices are well underway in the United States. Although stream restorations are occurring throughout Kentucky, post-restoration studies that quantify aquatic community responses to restoration practices are rarely performed. The goal of this study is to quantify macroinvertebrate community structure and biomass during the first post-restoration year at Slabcamp Creek and to compare those responses to a pre-restoration reference condition represented by White Pine Branch**.**

Because there was not an opportunity to sample Slabcamp Creek prior to its restoration, White Pine Branch was selected as a pre-restoration reference site. Seasonal sampling (fall 2011, winter 2012, spring 2012 and summer 2012) occurred within a 150 m representative reach at each study site. Benthic samples were collected systematically (*i.e.*, every 30 m along each stream reach) from predominant habitats (*i.e.*, riffles and pools) with a quantitative Hess sampler. The sampling design resulted in five replicates from riffles and five replicates from pools in each stream during each sampling period.

During the summer 2012 sampling period, White Pine Branch was dry and surface flow in Slabcamp Creek was too low for benthic collections from riffles, so only pools in Slabcamp Creek were sampled during that sampling period. Sixty-five benthic samples were collected for the entire study. Benthic samples were preserved in ethanol and transported to the laboratory where they were sorted to their entirety (*i.e.*, no subsampling) under a dissecting microscope. All individuals were identified to genus, except Chironomidae, enumerated and measured to the nearest 0.5 mm in order to estimate standing stock biomass from published length-mass regressions (5). Reach-scale habitat measures were taken during the spring and summer sampling periods and hydrologic variables were monitored at each site during summer 2012 (August through October), which is the typical season that surface flow subsides at our study sites.

Thus far, all benthic samples from riffles have been analyzed. Preliminary analysis of macroinvertebrate community structure from riffles show that Slabcamp Creek had higher total taxa richness (Slabcamp creek = 52 taxa, White Pine Branch = 45 taxa) and a higher proportion of EPT taxa (Slabcamp Creek %EPT = 54, White Pine Branch %EPT = 47). Macroinvertebrate densities from riffles were significantly different between streams only during the winter sampling period ($t_{2,4}$ = 3.117, p = .005). However, significant differences in total biomass were detected during every sampling period: fall ($t_{2,4}$ = 2.487, p = 0.020), winter ($t_{2,4}$ = 4.074, p < 0.001), and spring ($t_{2,4}$ =3.576, p = 0.002). Results from reach-scale habitat measures and hydrologic monitoring show that Slabcamp had more wetted riffle habitat during the critical summer flow period. Our preliminary findings suggest that the new perennial flow pattern and stable riffle habitat in the restored channel at Slabcamp Creek has resulted in a macroinvertebrate riffle community that can persist through high winter/spring flows and low summer flows. Further analysis will include macroinvertebrate data from pool samples, habitat-weighted biomass estimates, and multivariate analysis of community structure.

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