ABSTRACTS

15th Annual Meeting of the American Ecological Engineering Society
Stillwater, OK, June 3-5, 2015

Wednesday, June 3, 2015

Session A1 (Room 108): 10:30 – 12:00

DEVELOPMENT OF THE TENNESSEE RUNOFF REDUCTION ASSESSMENT TOOL
**Andrea Ludwig1, John Buchanan1, Tim Gangaware2, John Tyner1, and Daniel Yoder1; 1 Biosystems Engineering & Soil Science Department, University of Tennessee Institute of Agriculture, 2 Tennessee Water Resources Research Center, University of Tennessee Knoxville.* In 2014, the Tennessee Runoff Reduction Assessment Tool, or RRAT, was developed to provide designers and plan reviewers a transparent and quantitative evaluation tool for determining whether their design meets the requirements of the general municipal separate storm sewer system permit under the unique combination of climate, soil, flow patterns, land uses, and special conditions on the site. The tool uses a time-mass balance approach to calculate water movement through a site for the duration of a representative storm event given that unique combination of controlling factors. The designer may model different scenarios using various stormwater control measures and routing pathways to optimize the hydrologic and functional layout of a site design. A case study was used to evaluate whether a curve number approach or RRAT modeling best represented field measurements of runoff in two nested basins within a typical residential development in east Tennessee using 72 individual storm samplings. Results indicated that runoff trends were best represented through the infiltration-based RRAT model, and that is was not possible to select a representative curve number for small-storm hydrologic design from the data.

LOOKING BEYOND ECOLOGICAL FUNCTIONS TO THE VALUE OF ECOSYSTEM SERVICES IN THE URBAN REGIONS OF HOUSTON
**Deborah January-Bevers1, Courtney Hale1,2, Taylor Britt1, Lindsey Roche1,2; 1Houston Wilderness,2Rice University.*
Natural landscapes and organisms serve our wellbeing in a great variety of ways: water purification, flood protection, recreation, recharging of aquifers, protection from damage by hurricanes and tropical storms, pollution reduction, carbon sequestration and more. Identifying and understanding the services provided by ecosystems can lead to impressive, cost-effective success in using ecosystem services to solve infrastructural and environmental issues. The Greater Houston region, which encompasses 10 distinct ecoregions, is a huge and diverse assemblage of forests, prairies, bottomlands, wetlands and bays and receives a tremendous amount of benefits (economic and social value) from the natural world in the form of ecosystem services. Without the ecosystem services provided by these 10 ecoregions, the Greater Houston Region would economically and environmentally suffer in trying to provide equivalent services to its residents and industries. Incorporating the value and benefits of ecosystem services into infrastructure and policy decisions in the Greater Houston Region is still evolving but a few best management practices now exist. For an expanding urban core such as the Houston Area, there is a critical need to: (1) Provide more opportunities for regional recognition and support of the 10 unique ecoregions in the Greater Houston Region; (2) Engage in more region-based research on ecosystem services to better understand natural benefits and the cost-effective infrastructure solutions that this understanding will enable; (3) Compare the economic value of ecosystem services to other alternative approaches when making public policy decisions regarding land-use and infrastructure; and (4) Incorporate ecosystem services into infrastructure decisions.

RESILIENCE OF ECOLOGICALLY ENGINEERED SYSTEMS BASED ON EMERGY INFORMATION THEORY
**David R. Tilley1, Rhea Thompson2; 1 Environmental Science & Technology, College of Agriculture & Natural Resources, University of Maryland, College Park, Marine Estuarine and Environmental Sciences Program, University of Maryland.*
A singular, ecologically engineered system is intimately and distantly connected with natural environments and human-managed, complex socio-economic systems via energy, mass and information flows. The resiliency of the system thus depends on the resiliency of the systems supporting its metabolism and functioning, as well as its capacity for contributing “tribute” to other systems. We describe how emergy systems principles were adapted to develop indices to characterize and measure the

complexity and resiliency of ecologically engineered systems. We support our theory with a case study of a built environment that was designed with multiple living architecture features. The new resiliency metrics could foster society's appreciation for the ecological, environmental, social and economic benefits garnered from ecological engineering.

Session B1 (Room 109): 10:30 – 12:00

CONSTRUCTION AND PERFORMANCE OF GREEN ROOFS IN NORTH TEXAS

**Michelle Wood-Ramirez1; Fouad H. Jaber2; 1Texas A&M University; 2Texas A&M AgriLife.* Urbanization is altering the composition of landscapes nationwide, with urban areas characterized by a high proportion of impervious surfaces that adversely impact the water cycle of the region. Increased surface runoff, velocity and pollution - all byproducts of rainfall on impervious surfaces - impede urban waterways tremendously. Increase in volume of runoff can lead to flooding, with receiving water bodies exhibiting stream bank erosion and channelization. Low impact development (LID) is considered to be a way to mitigate the adverse effects of increasing impervious cover, using decentralized measures to retain stormwater runoff on-site, and thereby seeking to mimic the natural pre-development hydrology of a site. Green roofs are vegetated roof tops that offer an alternative to conventional impervious roofing systems. Also known as 'living roofs', they retain and reduce stormwater runoff, as well as delay the time of peak runoff so that there is a reduced chance of flooding. Green roofs are known to intercept between 15 and 90% of rooftop runoff. However, type of growth medium, thickness and plant cover variability can cause differences in runoff of 50-60%. The objectives of this study were to design, construct and demonstrate the effectiveness of green roofs in Dallas, TX. The findings of a three-year study on the stormwater and pollutant retention in a green roof experiment will be presented.

WATER AND ENERGY BENEFITS OF A THIN SLOPED GREEN ROOF ON A SUSTAINABLE HOME

**Rhea Thompson, Marine Estuarine and Environmental Sciences Program, University of Maryland, College Park and David Tilley, Department of Environmental Sciences and Technology , University of Maryland, College Park.* Despite the accelerated use of green roofs, few studies have simultaneously researched stormwater retention and potential energy saving in residential settings. This is of concern as residential application of green roofs is projected to increase, thus many new green roofs could likely be sloped, light-weight and shallow. This study researched the effect that storm characteristics (size, intensity and frequency) had on the retention of a 10o sloped, 2.5 inch green roof located on a sustainable home in Maryland (USA). Furthermore, since previous studies showed that substrate moisture impairs water retention and heat conduction (i.e., u-value), we aimed to determine the trade-offs of retention on u-value given the thin depth and slope. A total of 76 storm events between July and December of 2014 were analyzed. Average retention was 23.3 % (±5.5). Larger storm events produced more absolute retention but less as a percent of precipitation ($p<0.0001$). Additionally, higher antecedent water content suppressed retention ($p<0.0001$). Substrate moisture correlated to reduced thermal performance, as greater substrate water content was linked to increased u-value ($R^2 = 0.6994$). Despite decreased thermal performance, saturated green roof insulation value (R-67) is well below Maryland's minimum requirement (R-35). Evapotranspiration was greater when soil water content was greater ($p<0.0001$), indicating plants play an intimate role in reducing water content between storms for improved thermal performance. The strong links between the water content of the green roof media, plant evapotranspiration rates, stormwater retention and roof heat flux indicated that there are trade-offs to be considered for irrigating green roof's.

A COUPLED ANALYSIS OF SOIL MOISTURE AND THERMAL HEAT TRANSFER WITHIN A THIN GREEN ROOF SYSTEM

**Scott Tjaden1, David R. Tilley2; 1Pepco Holdings, Inc., 2University of Maryland.* As we try to mimic nature with human designed living systems the realization that they are highly complex and naturally interconnected in their functionality is becoming more of a reality. Given their various benefits for installation in urban areas, green roofs are becoming a more desirable system to integrate into buildings. With the desire to put green roof in areas were both water is becoming a limiting natural resource and excess resource, the connections between water and thermal heat transfers is fundamental for green roof justification given the influence in building performance. A net zero energy home in the Mid-Atlantic region named WaterShed has an integrated data monitoring system, installed in a thin green roof system, which would allow this analysis to be compared through different seasons. The overall performance findings can be related to the irrigation of green roofs in helping to increase the overall performance and plant survivorship.

Session C1 (Auditorium): 10:30 – 12:00

FLOATING WETLANDS IN EUCHA RESERVOIR: COST-BENEFIT COMPARISONS

Paul Koenig, Oklahoma Water Resources Board. Floating wetlands were installed in the upper end of Eucha Lake to demonstrate the effectiveness of intercepting inflowing nutrients prior to entering the main reservoir. This application highlighted a multipurpose function and documented a modest nutrient removal rate compared to other mitigation methods. Comparatively, these floating wetlands cost ten times more than hypolimnetic treatment and 150 times more than litter transport on a per unit phosphorus basis. As a floating breakwater floating wetlands cost 2 times more than a tire breakwater. As fish and wildlife habitat these floating wetland units met the breakeven point after 15 years deployment. The primary influence on cost comparisons was the choice of floating wetland media. The capability of floating wetlands to provide habitat for diverse biota under conditions of high water level fluctuation is a niche uniquely suited for floating wetlands. Although the phosphorus removal rate was low, floating wetlands can provide a cost effective, multi-use solution for systems providing both public water supply and recreational opportunities to a community.

ENHANCEMENT OF PERIPHYTIC COMMUNITY COLONIZATION AND PRODUCTIVITY USING 3D PRINTING TECHNOLOGIES

**David Blersch1, Andres Carrano2, Kamran Kardel2, Manjinder Kaur1; 1Biosystems Engineering Department, Auburn University 2Department of Industrial and Systems Engineering, Auburn University.* While controlled algal biofilm cultivation has been proposed for production of valuable biomass from aquatic pollutant nutrients, large-scale product yields can be limited because of competitive exclusion by low-quality algal species, and few approaches exist to control this dynamic. Substratum surface engineering, however, promises to revolutionize biofilm cultivation technology by controlling for types and quality of the colonizing algal community. The goal of this research is to optimize substratum surfaces for functionally specific algal biofilms using additive manufacturing (3-D printing) technologies. The objective is to understand the micro-topographical surface characteristics that control species recruitment and growth from a mixed algal community. Our approach is to employ high-resolution polyjet 3-D printing to engineer substratum surfaces with varying roughness morphologies, reverse-engineered from natural substrata, thereby determining the qualities of the algal biofilm that. Three experiments were designed to test the selective colonization of a mixed algal biofilm community on various printed surface and shape designs. Preliminary results demonstrate the feasibility of using printed material as experimental substrata for algal growth, and show a direct effect of surface roughness on algal cell recruitment, colonization, and growth rates. Future work will focus on species-specific colonization interactions and community biochemical responses to surface roughness.

LOW TO NO ENERGY NITRIFICATION AND DEAMMONIFICATION IN INTENSIFIED TREATMENT WETLANDS

David Austin, CH2M HILL. Intensified wetlands technologies have proven effective at nitrification and deammonification (anammox). Recent advances have demonstrated practicable nitrification rates in treatment wetlands are three to four orders of magnitude greater than current textbook values, removing nitrification as a sizing constraint for these treatment wetlands. Un-nitrified secondary effluent of approximately 25 mg/L ammonia can nitrify to 1 mg/L at a hydraulic loading rate of approximately 4 m/d, rather than 5 to 10 mm/d in a conventional surface flow wetland. Deammonification also appears to be native to certain subsurface flow wetland technologies through relatively simple changes to design specifications at similar hydraulic loading rates to nitrifying wetlands. Tidal flow methods make it possible for nitrification and deammonification to operate from gravity alone at zero process energy. These advances in wetland technology tend to integrate it into mainstream wastewater treatment technologies. This presentation will present data from projects, review underlying process microbiology, and look toward future technology development.

Session A2 (Room 108): 1:30 – 3:00

EXPLORING LAND COVER CHANGE IN THE OKLAHOMA CROSS TIMBERS

**Emma L. Kuster (1,2), Renee A. McPherson (1,2); 1South Central Climate Science Center, 2University of Oklahoma - Department of Geography and Environmental Sustainability.* Since the time of the Industrial Revolution, increasing carbon dioxide levels have resulted in shifts of temperature and precipitation patterns across the globe and are expected to continue to do so over the next century. Changes in climatic factors (e.g., drought, fire, etc.) have been shown to have various impacts on vegetation,

with some being quite detrimental. Human-induced land use practices (e.g., urbanization, etc.) also have been shown to result in changes in ecosystem vegetation. Understanding what factors predominately drive vegetation change will allow decision-makers to generate well-informed land management decisions. However, very few studies have explored climate and human-induced impacts on vegetation within the Cross Timbers ecoregion of Oklahoma. We intend to determine if the effects of various climate factors can be detected in a highly anthropogenically modified transitional boundary in Oklahoma and attempt to determine which variable(s) (i.e., climatic or land-use land-cover factors) has the strongest influence on grassland coverage within over 200 HUC12 watersheds across the boundary. Grassland change over a 19-year time period (1992-2011) will be determined via satellite imagery. Anthropogenic data is obtained from the National Land Cover Dataset satellite imagery and the Minnesota Population Center. Climatic data is obtained from the National Climatic Data Center, Oklahoma Mesonet, Drought Atlas, and Forest Service. We will perform statistical analysis, such as regression analysis and PCA, to determine which variable(s) has a stronger influence on grassland change and whether the influence of these variables differs spatially. This presentation will consist of finalized results and discussion.

PRIORITIZATION OF SUBBASINS USING LAND USE METRICS

**McCarty, J.A1., B. Haggard2, M. Matlock1, J.T. Scott3; 1University of Arkansas Office for Sustainability; 2Arkansas Water Resources Center; 3Crop Soil and Environmental Science University of Arkansas.* The purpose of this research was to develop an empirical water quality model using landscape metrics for subwatersheds within the selected watersheds and to develop a baseflow nutrient concentration prioritization system for efficient use of best management practices. Water quality data was collected from each watershed from state and federal sources. A total of 114 sites across the five watersheds were analyzed, which include 12 USGS gages. Relationships between baseflow and stormflow were established to make the case for a prioritization model using baseflow nutrient concentrations. Relationships were established between land use metrics and five constituents; Nitrate-Nitrite, Total Nitrogen, Soluble Reactive Phosphorus, and Total Phosphorus. Pearson, spearman, and principle component correlation analysis were used to identify the land use metrics with the greatest correlation to the constituent of concern. A baseline regression relationship was established between each constituent and a single common land use metric. Stepwise multiple regression analysis was then performed using selected land use metrics for each subcatchment in order to predict annual mean baseflow concentration. Using the developed empirical models, water quality indicators were established for each constituent across all watersheds used in the study. Water quality predictions were then used to rank HUC-12 subwatersheds in order of priority for best management practice prioritization. Empirical watershed models and prioritization schemes such as this one are impactful across the state as an alternative to theoretical watershed modeling and prioritization.

MEASURING THE LAND USE IMPACT OF US PORK PRODUCTION USING LCA

**Ben Putman, Greg Thoma, Marty Matlock; University of Arkansas.* The National Pork Board (NPB) commissioned the Center for Agricultural and Rural Sustainability (CARS) at the University of Arkansas to perform a life cycle assessment (LCA) of United States pork production in order to quantify land use throughout the supply chain. The functional unit is one kg of live swine at the farm gate. The supply chain is divided into two stages: production of swine rations and animal rearing on the swine farm (with three sub-stages for sow, nursery, and finishing barns). The impact assessment methodology is a modified version of the LANCA developed by Saad et al. (2013). Results show that the national average for swine production requires 4.31 m2a of land to produce 1 kg of live swine at the farm gate. On average, 96% of this occupation is attributed to crops grown for swine feed. Land use required for swine production is shown to impact freshwater regulation, erosion regulation, and water purification. The severity of impact is dependent upon the region of production and feed source. Production in regions classified as temperate grasslands, savannas, and shrublands (according to WWF terrestrial ecosystem classification) have the greatest impact on biodiversity and ecosystem services.

Session B 2 (Room 109): 1:30 – 3:00

BIOCHAR FROM HUMAN WASTE – STEPS TOWARDS A NEW SANITATION APPROACH

**Andreas Schoenborn1, Nicola Bulant2, Pascal Schmid1; 1Zurich University of Applied Science, 2Stammerstrasse 20, CH-8260 Stein am Rhein, Switzerland.* Human waste is the source of 80-90% of the nutrients found in domestic wastewater, and can be a

major path of pathogen transmission if the wastewater is not treated adequately. Mixing human waste with other wastewater streams also increases the difficulty to reclaim the nutrients. It is therefore a main goal of ecological sanitation approaches to catch and treat human waste as close to the source as possible, and convert it into a safely reusable form. One possible solution is the direct conversion of human feces into biochar by using a pyrolytical process. An experimental pyrolysis batch reactor was developed and built in fall 2014, to pyrolyse human fecal matter from a composting toilet. Ten test runs were performed, five with wood chips and five with fecal matter from a composting toilet. The resulting biochar was analyzed on elemental composition by using X-Ray Fluorescent Spectroscopy. Water content was a major factor influencing energy demand of this process, and must be < 46% to complete the pyrolysis in a reasonable time. This can be reached either by drying or by mixing the fecal matter with dry organic material (such as sawdust). Biochar from pyrolysis contained potassium, phosphorus and copper in the expected amounts (nitrogen content was not measured). Biochar from feces may be an interesting way to reclaim a maximum of nutrients from human excreta and convert them to a hygienically safe product. We will present ideas how this can be part of an ecological engineering concept.

ADDITION OF BIOCHAR TO IMPROVE BIOGAS PRODUCTION IN CHICKEN MANURE DIGESTION
**Pan Junting1, Qiu Ling1, A.A.M.Hassanein1, Gao Tianlei1, Liang Yong1; 1. College of Mechanical and Electronic Engineering, Northwest A&F University, Yangling, Shaanxi 712100, China.* An orthogonal experiment L9（33）was conducted to determine the effects that adding biochar has on the anaerobic batch digestion of chicken manure under mesosphilic condition (35℃±1℃). Specifically, the effects of three factors, biochar concentration (0，2.5，5，7.5% (based on chicken manure total solids (TS)), inoculum concentration (v/v) (20，25，30% of total mixture volume), and biochar particle size (<0.3 mm, 0.3 - 0.45 mm, 0.45 - 0.9 mm), on biogas production were determined. After 33 days of digestion, the results showed that the addition of biochar increased biogas production by 22.6 - 45.2%, compared to the control that had no biochar. Highest biogas production was observed for the treatment that had 5% biochar concentration, 0.3 - 0.45mm biochar particle size, and 25% inoculum concentration (242 mL biogas /g TS chicken manure).

ANAEROBIC DIGESTION FOR SUSTAINABLE SANITATION LINKED TO AGRICULTURAL PRODUCTION IN HAITI
**Stephanie Lansing1, Alexander Eaton2, Ayella Maile-Moskowitz1, Teddi Galligan1; 1 University of Maryland and 2 IRRI-Mexico.* Haiti has acute sanitation, energy, and food security challenges. Approximately 21% of the population practices open defecation due to lack of sanitary facilities. Wood and charcoal represent 70% of the energy use within the country, requiring 25-50% of daily income ($6-10/week for family). Anaerobic Digestion (AD) is being promoted in Haiti as an affordable way to treat waste, produce energy, and provide fertilizer for agricultural production. Findings from the Haiti Biogas Technology Training Program will be reviewed, with results from the modular AD technology installed in Haiti using three different contexts/design scales: a 200+ AD hospital system, a 20+ residential system, and a combined swine manure and sanitation system. The anaerobic digestion process resulted in 99% reductions in pathogens, with 65% methane in the produced biogas, but variable quantity of biogas (averaging 3.8 ft3/d) due to low organic input from the limited number of toilet users. Sanitation surveys (> 500) revealed that the majority were willing to pay $0.10 - $0.30 for toilet use. Based on the cost analysis of the three installed digestion systems, a three to five year payback period was estimated (other sanitation options do not have payback in real terms), with additional benefits in terms of health, time-savings, and environmental benefits from reduced deforestation, GHG emissions, and improved water quality. The path for moving forward to widespread improved sanitation efforts in Haiti include more training, implementation of pay-for-use models, and combining sanitary and animal waste for more consistent biogas production.

Session C 2 (Auditorium): 1:30 – 3:00

RESTORING A SEVERELY DISTURBED WATERSHED VIA ECOLOGICAL ENGINEERING: THE ROLE OF PASSIVE TREATMENT TECHNOLOGIES. *Robert W. Nairn*, Julie A. LaBar, Leah R. Oxenford, Bryan J. Page, Nicholas L. Shepherd, Juan Arango and Robert C. Knox; Center for Restoration of Ecosystems and Watersheds, School of Civil Engineering and Environmental Science, University of Oklahoma.* Surface and ground waters in the Tar Creek (Oklahoma) watershed of the Tri-State Lead-Zinc Mining District were deemed to be degraded due to "irreversible man-made damages" over 30 years ago. This administrative decision resulted in minimal efforts to address risk from legacy mine waters. The entire Oklahoma portion of the stream from the Kansas

border to its confluence with the Neosho River is listed on the state's list of impaired waters. In addition to metal-contamination impacts from artesian mine water discharges and waste pile leachate and runoff, physical degradation of stream channels impairs natural recovery. The first full-scale passive treatment system, constructed in 2008 to address elevated Fe, Zn, Pb, Cd, and As concentrations, has resulted in documented chemical and ecological recovery of a first-order tributary to Tar Creek. A second passive treatment system is scheduled for implementation in 2015. However, seasonally variable and significant (up to several thousand m3/day) artesian flows remain untreated in the Tar Creek and Beaver Creek watersheds. Hydrologic and chemical data, generated by watershed-scale environmental monitoring efforts, indicate that these discharges are amenable to passive treatment. In addition, tens of millions of tons of mining wastes remain on the surface, contributing contaminated leachate and runoff to local streams. These nonpoint sources of metal-contaminated waters also appear to be amenable to passive treatment. Comprehensive watershed-scale restoration planning indicates that multiple, targeted passive treatment systems would lead to considerable in-stream water quality improvement. Implementation of passive treatment technologies beyond the demonstration level requires revisiting and revising of previous administrative decisions.

LEAKY TREATMENT WETLANDS FOR AQUIFER RECHARGE AND WATER QUALITY RECOVERY: CENTRAL PASCO COUNTY BENEFICIAL WATER REUSE PROJECT. Rafael Vazquez-Burney*1, Jim Bays1, Amanda Berens1, Jeffrey Harris2 1CH2M HILL; 2Pasco County Utilities Engineering. The Pasco County Master Reuse System, located in Florida, is the sole method of wastewater effluent management for Pasco County. Approximately 21 million gallons per day (mgd) of reclaimed water is reused through irrigation, rapid infiltration basins, and industry. In 2010, the feasibility of using constructed wetlands was investigated within central Pasco County for water quality polishing and groundwater recharge in an area of groundwater drawdown. In 2014, hydrogeologic investigations on a suitable parcel were conducted and included boring 12 soil cores, 3 rock cores, drilling 3 pumping wells and 14 monitoring wells, and conducting 5 aquifer performance tests and an infiltration test. Data collected were used to calibrate a modified MODFLOW groundwater model to support planning, design, and permitting. A layout of 176 acres comprised of 16 “leaky” wetland cells has been developed. Model results show that a minimum of 2.5 mgd of recharge is anticipated, with a significant potential for increased flow. Treatment wetlands, particular infiltration treatment wetlands, are effective at reducing nitrate. Water infiltrating to shallow groundwater must pass through the sediment interface of accumulated organic matter where conditions are anaerobic and therefore ideal for denitrification. This system is expected to fully denitrify the reclaimed water and achieve total nitrogen concentrations near background levels. This presentation will describe the evaluations that lead to the planning of this project, the site investigations, and the results that lead to innovative technical approaches to quantifying aquifer recharge, the water quality performance, and ecological recovery of local hydrologically impacted wetlands.

HYBRID CONSERVATION TECHNIQUES FOR SPARTINA DOMINATED WETLANDS IN CONCERT WITH OYSTERS TO ENHANCE SUSTAINABILITY. *Steven G. Hall, LSU AgCenter.* Louisiana has 40% of the nation’s coastal wetlands, but suffers from 90% of the nation’s coastal wetland loss. Some of the factors contributing to this are geological, while biology, human impacts and coastal storms also contribute. Specifically, coastal wetlands are lost to subsidence (sinkage of sediments at a rate faster than new sediment and/or plant material can accumulate). Further losses are related to erosion, some of which is extreme during tropical storm events. Maintaining or restoring such wetlands will require hybrid approaches including plants, animals and likely human intervention. Examples explored in this presentation will focus on three dimensional ecologically engineered structures for oyster growth adjacent to Spartina alterniflora dominated wetlands; natural development of wetland plant biology in growing sedimentary lobes; and vertical growth of Spartina wetlands under various water flow and nutrient regimes. Critical results for optimal design include engineering limits to sediment and nutrient delivery in semi-controlled water bodies; dynamics of hydrological and biological components of natural and restored wetland systems; and vertical accretion and growth balanced by subsidence and erosive impacts. Each of these must be addressed to optimize sustainability of natural and ecologically engineered wetlands, while providing important ecosystem services including carbon sequestration; nitrogen conversion; juvenile fish habitat; coastal protection; edible and extractable components; and recreational and aesthetic value.

Session A3 (Room 108): 3:30 – 5:00

MONITORING LIVING SYSTEMS - WATERSHED CASE STUDY

**Scott Tjaden1, David R. Tilley2; 1Pepco Holdings, Inc., 2University of Maryland.* Data capture and presentation is critical in observing performance of any system. In today's high tech world there is little supporting literature on the integration and set-up of these data monitoring systems. The market is flooded with technologies that can collect the data, but how the data is integrated, collected, and analyzed is up to the installer. WaterShed, the University of Maryland's winning entry in the 2011 U.S. Department of Energy Solar Decathlon competition, integrated solar photovoltaics and energy efficient appliances with many living technologies into the design of the house to improve its environmental sustainability and energy consumption. The house, owned by a regional electric power utility, now serves as a showcase on how residential homes can positively influence their surroundings. This facility is heavily instrumented, while the data is being used as an educational opportunity for schools and local agencies, while also validating system performance. This presentation will be focused on the overall process in instrumenting the house (specifically the living systems), data integration in regards to software, data transfer, and how the data is being presented.

COMBINE LOW IMPACT INFRASTRUCTURE FOR A MORE PURA VIDA IN THE SHUABB

*Rebecca Bender1, Nicole Kruse1, Gina Masell1, *Ronald Aguilar1, David Arias2, Yasmín Granados2, Ana Ruíz2, Ricardo Salazar2, and Dawn Reinhold1; 1Michigan State University, 2Technological Institute of Costa Rica.* Education, water distribution, waste management, electricity, and health services are limited in nearly all the ethnic Bribri communities of the Talamanca region in Costa Rica. In one of these communities, the Shuabb Aborigine Women Association have begun an independent ecotourism project. However, the site they have built cannot be opened until it provides water for human consumption, functional restroom facilities, and a waste management plan. Therefore, the MSU-Biosystems Engineering team joined with the Technological Institute of Costa Rica to overcome that hurdle: to design an integrated water-wastewater-energy system for the ecotourism project led by the Shuabb Aborigine Women Association in Shuabb, as part of the first phase of the People, Prosperity, and Planet program by the EPA. Specifically, we 1) designed and installed a water catchment system to provide for the kitchen and restroom facilities, and point-of-use filters to secure water for drinking; 2) designed a mesophilic anaerobic digester to receive and treat food waste, swine manure, crop residues and black water, while generating renewable energy and alleviating many of the environmental concerns associated with waste disposal; and 3) designed a vertical flow constructed treatment wetland to accommodate the effluent coming from the digestion, kitchen and showers. Unique from other ecotourism projects in the region, the one in Shuabb will promote itself as an ecologically sustainable project which takes care of the waste while creating its own renewable energy. This kind of holistic design will protect the local environment and culture, the country of Costa Rica, and ultimately the planet.

IS HIGH DENSITY DEVELOPMENT AN LID PRACTICE? A MODELING STUDY

**Fouad H. Jaber and Mijin Seo; Texas A&M AgriLife; National Academy of Agricultural Science South Korea.* Low Impact Development (LID) is becoming commonly used as an alternative stormwater management approach in urban areas. The effects of LID on hydrology and water quality have been indicated to be positive through a substantial amount of research showing the decrease of surface runoff volumes and pollutant loadings. However, LID can have varying effectiveness under different conditions. In this research, the effectiveness of LIDs was assessed under various urban planning (compact high-density (UHD), conventional medium-density (UMD), conservational medium-density (UMC)) and under various LIDs conditions (types, locations, and percent allocations) for surface runoff, nitrate, and total phosphorus. Rain gardens, rainwater harvesting systems, and permeable pavements were considered. The Soil and Water Assessment Tool (SWAT) was used and model development was performed to simulate the LIDs considered. A manual optimization was done to identify the LIDs conditions that meet both targeted reduction amounts and minimal cost. The effectiveness of LIDs was evaluated for the three urban land uses and for the optimized LIDs conditions. The largest reduction by LIDs was shown to occur in the order of the following land uses for all variables: UMD > UMC > UHD. Among post-LIDs scenarios, the UHD land use represented low values for surface runoff and nitrate and the UMD land use for TP. In addition, the various combinations of type, location, and percent allocation for each variable changed the effectiveness of LIDs and/or caused the same effectiveness of LIDs. This research can help regulators establish effective LID policies based on the results.

Session B3 (Room 109): 3:30 – 5:00

USING DIGESTION COMBINED WITH MICROBIAL ELECTROLYSIS CELL TO INCREASE ENERGY PRODUCTION

*Amro A M Hassanein1, *Freddy Witarsa2, Qiu Ling1, Stephane Lansing2; 1 Northwest A&F University, College of Mechanical and Electrical Engineering, Yangling, Shaanxi 712100, China, 2University of Maryland, Department of Environmental Science and Technology, College Park.* Anaerobic digestion (AD) is a technology that generates biogas from organic matter. Microbial electrolysis cell (MEC) is a technology that uses electricity to initiate bacterial oxidization of organic matter to produce hydrogen. The objective of this study was to determine the effect that combining AD and MEC (Reactor A) has on energy production when compared with a normal digester without MEC (Reactor B). In reactor A, a single chamber MEC (150 mL) was placed inside a 10 L digester (80% active volume) on Day 10 of digestion. Cattle manure was used as substrate in both reactors, and an inoculum to substrate ratio (volatile solids basis) of 2:1 was used. Cumulative H2 and CH4 production during the batch test (272 h after starting MEC) in Reactor A (2.43 L H2, 23.6 L CH4) was higher than the quantity observed in Reactor B (0.01 L H2, 10.9 L CH4). Hydrogen concentration during the first 24 h of MEC introduction constituted 20% of produced biogas, after which, the H2 decreased, as the CH4 concentration increased from 50% to 64%. After accounting for energy produced in Reactor B, the efficiency of electrical energy recovery (ηE) in MEC was 324% (ηE max.), 73.1% (ηE min.), with an average of 170% over time. COD conversion efficiency was also higher in Reactor A (7.09 kJ/g COD removed) compared to Reactor B (6.19 kJ/g COD removed). This study shows that combining AD with MEC could increase overall energy production from cattle manure digestion.

EFFECTS OF IRON ADDITION ON BIOGAS QUALITY AND METHANOGENIC COMMUNITIES DURING ANAEROBIC DIGESTION OF DAIRY MANURE.

**Annie Yarberry1, Tamara Walsky1, Stephanie Lansing1, Stephanie Yarwood1, Alba Torrents2; 1University of Maryland, College Park Dept of Environmental Science and Technology, 2Dept of Civil & Environmental Engineering.* Anaerobic digestion (AD) is a microbial process that converts waste, in this case dairy manure, to biogas. The biogas contains methane (CH4), carbon dioxide (CO2) and trace gases including hydrogen sulfide (H2S). Hydrogen sulfide is a corrosive gas that decreases the usability of the biogas produced during AD. In order to optimize the biogas for use as an energy source, the hydrogen sulfide content needs to be reduced and the methane content increased. This study investigated how iron (Fe) additions to dairy manure AD could increase biogas quality and alter the methanogen communities. In order to determine changes in biogas quality due to Fe additions, a systematic analysis was performed using zero valent iron, Fe(II) and Fe(III) additions to determine their effects on CH4 and H2S production. Subsequently, the methanogen communities were characterized to determine if type of Fe addition changed the community composition. The results showed that none of the iron additions increased CH4 production beyond the control (no addition). The Fe(III) addition at 20 mM was able to reduce H2S production by 71% and only reduce CH4 production by 6%. In the 20 mM Fe(III) treatment, archaeal community composition differed in the pre and post bottles in all cases, indicating that the incubations selected for a unique archaeal community. These findings show that H2S can be reduced with Fe(III) additions, but the reduction of CH4 production by 6% could be due to the change in the microbial community composition with iron additions.

FORAGE RADISH: A RENEWABLE SOURCE OF ENERGY PRODUCTION FOR DAIRY FARMERS

**Ashley J. Belle1, Stephanie Lansing1, Walter Mulbry2, and Ray R. Weil1; 1University of Maryland-College Park, 2USDA.* Anaerobic digestion was coupled with a new forage radish cover cropping system in order to increase biogas production within a dairy manure digester. This research investigated forage radish as a renewable source of energy in terms of methane (CH4) production, the effect of radish co-digestion on hydrogen sulfide (H2S) production, and the relationship between H2S production and methanogenesis. Substrate co-digestion ratios and inoculum to substrate ratios were determined in the laboratory with biochemical methane potential assays. Pilot-scale complete mix batch digesters (850 L) were constructed and operated to determine energy potential at the pilot-scale. Laboratory results showed that forage radish had 1.5 times more CH4 potential than dairy manure on a volatile solids basis, with increasing the radish content of the co-digestion mixture significantly increasing CH4 production. Initial H2S production also increased as the radish content increased, but the sulfur-containing compounds were rapidly utilized, resulting in all treatments having similar H2S concentrations (0.10-0.14%) and higher CH4 content in the biogas (48-70% CH4) over time. Pilot-scale experiments revealed that radish co-digestion increased CH4 production by 39% and lowered the H2S concentration in the biogas (0.20%) beyond that of manure-only digestion (0.34% – 0.40%). Extrapolated to a farm-scale (200 cows) continuous mixed digester, co-digesting with a 13% radish mixture could generate 3150 m3 CH4/month, providing a farmer additional revenue up to $3125/month in electricity sales. These results

suggest that dairy farmers could utilize forage radish, a substrate that does not compete with food production, to increase CH4 production of manure digesters.

Session C3 (Auditorium): 3:30 – 5:00

LESSONS LEARNED FROM 20 YEARS OF APPLIED ECOLOGICAL DESIGN FOR WASTEWATER TREATMENT

John Todd, Max Rome, Jay Thrasher; John Todd Ecological Design.* With regards to wastewater treatment and the healing of contaminated waters, ecological design supplies a powerful counterpoint to conventional environmental engineering. Over the last 20 years John Todd Ecological Design has worked to create robust and enduring ecological treatment works in which complex whole food chains efficiently convert nutrients and organic waste into living biomass and clean water. These systems not only represent an alternate vision of how wastewater treatment is accomplished but also how it can be integrated into communities and campuses. In this presentation we look specifically at lessons learned from the Corkscrew Swamp Eco-Machine, an ecological treatment system in continuous operation for over 20 years. We review performance and flow data to glean lessons about the energy and operating costs, longevity, success and challenges of this medium sized system. We also discuss the fate of endocrine disruptors and pharmaceutical by-products within the Eco-Machine. This discussion is used to highlight larger lessons learned from 20 years of designing and operating Eco-Machines with an eye toward the future of wastewater treatment.

A HIERARCHICAL APPROACH TO ECOLOGICAL ENGINEERING UNIT PROCESSES

David Austin; CH2M HILL. A common claim in ecological engineering literature is that unit process approaches to design characterize environmental engineering, but ecological engineering uses a distinctly different systems approach. Upon closer examination, these distinctions blur. Treatment wetland design, for example, follows rigorous unit process methodologies coupled with hydraulic/hydrological modeling. These unit processes are an extension of classic wastewater methodologies and readily integrate into larger process diagrams using conventional unit processes. Classic unit process methodologies, however, do not predict the regime changes to ecosystem structure that are common goals of ecological engineering. Yet classic Odum diagrams may also suffer similar limitations. Regime change is a discontinuity in ecosystem behavior, not well described by systems of differential equations. Lake restoration requires regime change. There are hierarchies of constraints, or forcing functions, that must be “peeled-off” to realize improvement to water quality and ecosystem structure. Systematically working through these hierarchies to achieve design goals is essentially a unit process methodology that can address regime change. This presentation will work through a lake restoration example of how a hierarchical unit process method may meet design goals.

CAN UNIT PROCESS NATURAL TREATMENT WETLANDS SOLVE HARMFUL ALGAL BLOOMS (HABS) BY DIRECT FILTRATION?

Alex J. Horne; Ecological Engineering Group, Department of Civil & Environmental Engineering. University of California, Berkeley . Harmful Algal Blooms (HABs) may be the most fashionable aquatic problem of the decade. In summer 2014, Cleveland ran out of drinking water when a potentially toxic blue-green HAB in Lake Erie drifted into their water intake region. Recreation in lakes is often compromised by HABs, usually blue-green scums in beaches or docks and due to neurotoxins and hepatoxins which can kill livestock, occasionally people, and certainly threaten many more. There are methods to reduce HABs with standard methods such as alum treatment or dredging and innovative ones like hypolimnion oxygenation or biomanipulation but sometimes the results are mixed. Similarly, best management practices in the watershed, including simple wetlands, have not lived up to expectations with regard to reducing algae blooms, even though good success has occurred with pathogens or sediments. Could direct filtration of surface HAB scums work to eliminate the symptoms if not the causes? Recently, in San Diego, San Francisco, and Oklahoma the use of Unit Process Natural Treatment Wetlands has been proposed to do just that job. Can we follow and expand the innovative wetlands filtration ideas of the Florida’s St. John’s Water District (Ed Dunne, Michael Coveney et al.)? The pros and cons of direct HAB removals by wetlands will be considered and justified at least sometimes.

Friday, June 5, 2015

Session A4 (Room 108): 8:30 – 10:00

ECOHYDROLOGIC INDICATORS OF LOW-FLOW HABITAT AVAILABILITY IN ELEVEN VIRGINIA RIVERS

**Kinsey Hoffman1, W. Cully Hession1, Robert Burgholzer2, Donald Orth3, and Durelle Scott1; 1Biological Systems Engineering, Virginia Tech; 2Virginia Department of Environmental Quality; 3Fish and Wildlife Conservation, Virginia Tech.* An identified research need for advancing the science of environmental flows is to use existing data to establish flow alteration-ecological response (flow-ecology) hypotheses and relationships to inform statewide water resources policy. As a surrogate for biological metrics, physical parameters were used to establish quantitative flow-ecology relationships. Habitat availability data from eight Instream Flow Incremental Methodology (IFIM) studies completed in Virginia between 1981-2012 were modeled with mean daily streamflow records from U.S. Geological Survey gage locations. Flow metrics of magnitude, frequency, duration, timing, and rate of change were calculated from the Indicators of Hydrologic Alteration (IHA) program implemented in R. Habitat availability metrics (non-exceedance probabilities, seasonal availability, and persistence) were calculated for over 50 individual fish species-lifestage combinations. Spearman correlation coefficients were computed for habitat metrics and flow metrics, and relationships with high correlation coefficients were analyzed for statistical significance. Flow-ecology relationships were also placed into contexts including drainage area, stream classification, physiographic province, and habitat-use guild to assess improved predictive abilities. These flow-ecology relationships are intended for use in the Virginia State Water Plan, a statewide water supply planning process by Virginia Department of Environmental Quality, to balance ecological needs with future water demands.

BENTHIC MACROINVERTEBRATE RESPONSE TO WATER QUALITY AND HABITAT IN CENTRAL APPALACHIA

**Nicholas Cook1, Emily Sarver2, Leigh-Anne Krometis3; 1,3 - Virginia Tech Biological Systems Engineering; 2, Virginia Tech Mining and Minerals Engineering.* Current efforts to mitigate mining impacts on aquatic ecosystem health in the Central Appalachian region vary in approach, from a water quality-driven focus on sediment control to a geomorphological focus on stream/habitat restoration. Due to a variety of studies that report correlations between specific conductivity and benthic macroinvertebrate community diversity, the implications of water quality-based regulatory standards have recently received much attention. We report here on a field sampling campaign along the Kentucky-Virginia border aimed at identifying primary macroinvertebrate stressors in order to inform ecological remediation efforts. Over two years, we collected 178 observations of benthic species diversity at 36 unique sites representing watersheds of varying primary anthropogenic influence (e.g. mining and residential sewerage issues), along with associated data from rapid bioassessment protocols (RBPs). Using landuse metrics (derived from GIS data), water quality data, habitat metrics, and stream condition indices, principal component analysis (PCA) identified surface disturbance, forest cover, and specific conductivity as significant variables comprising the first PC. Habitat appears to be a secondary driver affecting community sensitivity with channel alteration, bank vegetation, riparian vegetation, and epifaunal substrate contributing significantly to the second PC. Change point analysis via 500 bootstrapped replications identified shifts in community composition means at 326, 609, and 1065 mS/cm along the conductivity gradient, and habitat change points at 42.6 and 58.2 along the composite habitat gradient. These findings suggest that regional efforts to restore natural aquatic communities will be most successful if both water quality and structural habitat targets are considered.

RAPID ASSESSMENT OF PERIPHYTON COMMUNITIES IN OKLAHOMA STREAMS USING AN IN SITU BENTHOTORCH FLUORIMETER

**Brad Rogers, Dan Storm, Andy Dzialowski, Bill Henley and Derek West; Oklahoma State University.* Traditional methods of periphyton assessment involve techniques of collection and processing, all of which are time consuming and expensive. Periphyton are microscopic algae that grow attached to substrate in aquatic environments. Because periphyton integrates conditions over time, it is used as an indicator of environmental quality. The BenthoTorch® is a portable fluorimeter probe used to measure in situ benthic chlorophyll-a concentration (ug/cm2) on different substrates without sample preparation. This instrument also estimates the concentrations of green algae, cyanobacteria, and diatoms in less than 20 seconds. If the BenthoTorch® accurately measures benthic algae biomass and composition comparable to traditional methods, the time, cost and resource savings will be significant. In our study we developed a statistically valid experimental design to evaluate the

accuracy of the BenthoTorch® in estimating benthic algal biomass in major stream types and conditions across Oklahoma ecosystems.

Session B4 (Room 109): 8:30 – 10:00

STREAM HABITAT RESTORATION DESIGN BASED ON ECO-GEOMORPHOLOGICAL RELATIONSHIPS
Greg Jennings; Jennings Environmental. Reference stream physical and biological data were used to create eco-geomorphological relationships for the Piedmont and Plateau Ecoregions of Alabama and Tennessee to support stream assessment and restoration design. Hydraulic geometry regional curves for bankfull channel cross-section area, width, mean depth, and estimated discharge were strongly correlated to watershed drainage area. Piedmont regional curves for bankfull dimensions were similar to those measured in other states, while the Plateau streams were found to be typically larger than Piedmont streams. Small high-gradient step-pool streams in the Plateau have a unique regional curve relationship with a steeper slope for watersheds less than 0.1 square mile in drainage area. Instream biota (fishes, crayfishes, and aquatic insects) can be used as "ecological endpoints" in restoration design and assessment efforts. Multiple measures of fish assemblages (both taxonomic and functional) were strongly correlated with watershed drainage area as well as with measures of bankfull geomorphological dimensions. Most fish responses were strongly asymptotic, with rapid initial change as system size increases. Overall, fishes appear to have more promise than crayfishes or aquatic insects as ecological endpoints for restoration design and assessment tools. All three groups have value in determining the 'biological ceiling' of reference conditions. The lack of strong taxonomic relationships with aquatic insects may be a result of a disparity in scales, as macroinvertebrates are small-bodied organisms responding to fine-scale environmental phenomena, and the measures of geomorphology were at the reach scale. However macroinvertebrates did exhibit significant and predictable functional changes associated with drainage area which have use for restoration design and assessment.

APPLICATION OF SWAT TO PREDICT WATERSHED-SCALE STREMABANK EROSION ON COMPOSITE STREAMBANKS
**A.R. Mittelstet, D.E. Storm, G.A. Fox; Department of Biosystems and Agricultural Engineering, Oklahoma State University.* Streambanks can be a significant source of sediment and phosphorus to aquatic ecosystems. Although the streambank erosion routine in SWAT has improved significantly in recent years, the lack of site specific data increases the uncertainty in SWAT predictions. Testing of the latest SWAT streambank erosion routine on the Barren Fork Creek watershed in eastern Oklahoma will be presented. The study uses data from ten sites on the gravel-dominated banks along the Barren Fork Creek, including bank height and width, bank slope, bank gravel d50 and bank composition. The d50 and kd - relationships were used to estimate the critical shear stress ( ) and the erodibility coefficient (kd), respectively. A sensitivity analysis was performed for each parameter at stream depths ranging from 0.1 to 5.0 m. Measured parameters were compared to the SWAT default values, which are estimated from a 10 m digital elevation model and an empirical equation based on bank composition. Results of this study provide recommendations to watershed modelers and managers to focus data collection and parameter estimation efforts on the most critical streambank erosion parameters, thus providing more accurate model predictions.

FLOODPLAIN CONNECTIVITY AT THE CONTINENTAL SALE AND ECOLOGICAL ENGINEERING APPLICATION TO WATERSHED RESTORATION. **C. N. Jones, D. Scott; Virginia Tech, Biological Systems Engineering.* Hydrologic connectivity between rivers and their adjacent floodplains is thought to improve downstream water quality at the catchment scale. However, little work has been done to examine changes in floodplain connectivity in reference to stream order or physiography. Here, we examine floodplain connectivity across the continental US. Using flow data from over 6,800 USGS stream gages, the degree of floodplain connectivity (as measured by floodplain storage volume) was estimated for individual floods across each gage's flow record. This information was then applied to the US stream network, providing a continental scale characterization of floodplain connectivity. The proportion of floodplain storage volume to total flood volume varied between 5% and 50% across all gages, with no observable spatial pattern across the stream network. Estimated floodplain storage increased with stream order, both when examining individual reaches and cumulative storage across the stream network. Our results highlight the role of floodplain connectivity in large river systems, and suggest these areas are potential hotspots for nutrient retention and removal.

Session C4 (Auditorium): 8:30 – 10:00

HYDROLOGICAL RESPONSES ACROSS SPATIAL SCALES: THE IMPACT OF WOODY PLANT ENCROACHMENT IN THE SOUTH-CENTRAL GREAT PLAINS. **Lei Qiao, Chris Zou, Rodney Will, and Elaine Stebler; Department of Natural Resource Ecology and Management, Oklahoma State University.* In the south-central Great Plains, rangeland has been undergoing a steady transition from herbaceous dominated grassland into a tree or shrub dominated woodland for nearly a century and this transition has been accelerating in the recent decades, primarily due to an evergreen juniper species, eastern redcedar (Juniperus virginiana). It is still unknown how this land cover transformation if unconstrained will alter hydrological responses and water budget at watershed and river basin scales across a climate gradient and diverse soil types. This research was to understand this transition and impact using a physically based hydrological transport model, SWAT (Soil and Water Assessment Tool), and in situ observations of experimental watersheds for eastern redcedar and grassland. Our specific objectives were: (1) to refine and compile biophysical parameterization of eastern redcedar in the SWAT model using comprehensive in-situ observations and measurements, (2) validate the calibrated SWAT model in large (landscape-scale) watersheds to demonstrate its capability of simulating eastern redcedar encroachment impacts on streamflow and groundwater recharge at larger scales, (3) discuss the application of improved SWAT model for understanding temporal evapotranspiration dynamics, interactive effect of climate variability and woody plant encroachment on alteration of hydrological cycle at multiple spatial scales in the south-central Great Plains.

PREDICTED INFLUENCE OF EASTERN REDCEDAR REMOVALON WATER QUANTITY AND QUALITY USING WEPP
**Whitney Lisenbee1, Dr. Garey Fox1, Dr. Chris Zou2, Dr. Dan Storm1, Dr. Chad Penn3, Elaine Stebler2, Aaron Mittelstet1; 1-Biosystems and Agricultural Engineering; 2-Natural Resource Ecology and Management; 3- Plant and Soil Science; Oklahoma State University.* Juniper trees, primarily Eastern redcedar (Juniperus virginiana), have encroached approximately 5 million hectares of grasslands in Oklahoma alone as of 2008. Transition from grassland to Eastern redcedar-dominated woodland is associated with loss of several important ecosystem services. Harvesting encroaching juniper species as a biofuel feedstock has been suggested because it could improve both water quantity and quality while providing a sustainable fuel source. However, water quantity and quality impacts during Eastern redcedar harvesting and the biofuel feedstock conversion process must be considered. The Water Erosion Prediction Project (WEPP) was used to determine the predicted changes in water runoff and to evaluate the effects of biofuel feedstocks on a field and catchment scale. The model was initially set up using the default parameters that best represented the experimental watersheds. Site-specific data were collected at field sites for soil properties, runoff, and sediment load then used to calibrate WEPP. Next, the model parameters will be adjusted to predict water quality and quantity under changing land management from an Eastern redcedar back to native prairie or switchgrass. The hydrologic modeling of this process will help to provide trade-offs for water yield, water quality, feedstock choices, and biofuel production in unique settings at either the field or watershed scales.

HYDROLOGY, SEDIMENT AND NUTRIENT YIELDS FROM SWITCHGRASS LAND COVER IN EAST TENNESSEE: IMPLICATIONS FOR BIOENERGY CROP SUSTAINABILITY. **John S Schwartz, Jordan Hayes, and Daniel Yoder; University of Tennessee, Knoxville.* With the potential of switchgrass being a dominant bioenergy feedstock in the Southeast and Midwestern United States, several sustainability studies have assessed its environmental and economic viability. Studies have noted land use conversion from traditional agriculture to switchgrass may provide improvements in surface water quality, i.e., reduced sediment yields and nutrient export to streams, relying on watershed-scale modeling per the Soil and Water Assessment Tool (SWAT) model. In utilizing SWAT, typical values for the hydrology curve number (CN) and the Revised Universal Soil Loss Equation (RUSLE) cover management C-factor defaulted to a hay/pasture land cover assumed value. No field-based studies estimating the CN and land cover C-factor for switchgrass have been published to the author's knowledge. This study completed field-based measurements of rainfall, runoff, sediment, total nitrogen, and total phosphorus in three East Tennessee drainages with switchgrass cover for about one year (April 2013 through February 2014). Use of the statistical asymptotic method, the best CN estimate for switchgrass was 69. The average annual switchgrass C-factor was estimated at 0.0006. Total nitrogen output for the various storms ranged from 7.01E-4 g ha-1 to 1519 g ha-1, with a mean load of 358 g ha-1. Total phosphorus ranged from 0.11 g ha-1 to 400 g ha-1, with an average load of 125 g ha-1. Results of this study support future SWAT modeling efforts by providing a field-measured CN, C factor, and nutrient export ranges that provide critical model input for developing environmental sustainability indicators associated with bioenergy crop production.

Session A5 (Room 108): 10:30 – 12:00

DO FRESHWATER MUSSELS AFFECT MERCURY CONTAMINATION OF AQUATIC FOOD WEBS?
**Brent N. Tweedy, Caryn C. Vaughn; University of Oklahoma, Department of Biology.* Freshwater mussels are an important part of many freshwater ecosystems throughout North America. Mussels drive many significant ecosystem processes in lakes and rivers that link the water column and sediments, such as the conversion of mercury (Hg) found in sediments into highly toxic methylmercury (MeHg) that is released into the water column and subsequently aquatic food webs. Because of mussels' important role in driving ecosystem function, we hypothesized that they regulate the production and/or release of MeHg. We tested this hypothesis with a field survey and a mesocosm study. We sampled fish and habitat parameters at sites with and without mussels and measured Hg contamination. We found no difference in Hg contamination of fish between mussel positive and negative sites. The follow-up mesocosm study used eight replicates of none, low (4), medium (10), and high (16) mussel density treatments. We collected emergent insects and snails for Hg analysis as well as abiotic parameters. We found significantly higher concentrations of mercury in the mussel treatments, with the highest concentrations in the high mussel treatment. These results indicate that mussels likely play an important role in driving Hg dynamics in the ecosystems that they drive and that these already threatened and these already imperiled ecosystems may be more sensitive than previously thought to the now ubiquitous Hg contamination of the environment.

THE RIO BOGATA, COLUMBIA PROJECT: CAN IT BE THE RIVER THAMES REPEATED?
Alex J. Horne; Ecological Engineering Group, Department of Civil & Environmental Engineering, University of California, Berkeley. When I was a boy in the 1950s I occasionally played in the River Thames, in London, England, but not enough to get sick. A survey at that time showed only a single vertebrate, over a 30 km stretch. That eel was reputed to be an escaped pet! Needless to say water quality, including dissolved oxygen was low. By 1992 the Thames had 100 fish species. The Rio Bogotá which lies at the downhill edge of the City of Bogotá, (pop. 9 million) is worse than the Thames ever was. It is black and bubbles with methane emissions. With the help of the World Bank, Bogotá is upgrading or expanding its poor or non-existent sewage treatment to secondary levels (30:30, no nitrification) but this will not be enough to restore the river. Can some innovative in-river methodologies and a new 30 m wide x 68 km long linear wetland within the levees give Bogotá a sparkling, clean and fish-filled river that could be the centerpiece of riverside restoration?

DOES PRUNING IMPROVE STORMWATER BIOFILTER PERFORMANCE?
**BK Winfrey1, AS Mehring2, RF Ambrose1,3, LA Levin2, BE Hatt4, PLM Cook5; 1University of California Los Angeles, 2University of California San Diego, 3Monash University.* Pruning plants is a management technique that is employed with varying frequency in Australian biofilters. The effects of pruning on water quality improvement and infiltration rates of stormwater runoff in biofilters are unknown. We investigated these effects in columns planted with Ficinia nodosa and Carex appressa, two common biofilter plants, at Monash University in Melbourne, VIC, AU from August 2014 to March 2015. Water quality samples were collected before and after pruning plants to 10 cm above the surface of the soil and removing the pruned biomass from the columns. We measured concentrations of total nitrogen and phosphorus, oxidized and reduced nitrogen species, and phosphate in the synthetic stormwater influent and in the effluent of each column. After plants matured in columns in a shade house, five replicates of each treatment (unplanted, two species of non-pruned plants, and two species of pruned plants) were stored under grow lights in a climate-controlled building for the duration of the experimental phase. Growth rates were measured throughout the experiment and plant root characteristics were determined following the last water quality sampling event.

Session B5 (Room 109): 10:30 – 12:00

THE FIRST FLUSH: STUDYING SOIL NUTRIENT DYNAMICS IN A RESTORED FLOODPLAIN
**Dylan Cooper1, Erich Hester2, C. Nathan Jones1, and Durelle Scott1; 1: Biological Systems Engineering, Virginia Tech. 2: Civil and Environmental Engineering, Virginia Tech.* Restoring hydrologic connectivity between stream channels and their adjacent floodplains is a common practice in the stream restoration industry. Floodplain reconnection provides ecosystem services such as flood peak attenuation, geomorphic stability, and nutrient and sediment retention. However, in low order streams where

short residence times restrict biogeochemical processing, floodplains have been shown to be a source of reactive nutrients. Here, we examined soils flushing in the floodplain along a 3rd order stream in the ridge and valley of Virginia. Prior to this study, the site was experimentally flooded during five seasonal experiments. A first flush of reactive solutes (i.e. DOC, NH4+, and SRP) was observed during spring and summer experimental floods. To further examine this phenomena, a monthly soil sampling campaign was conducted to determine how much of the floodplain soil carbon, nitrogen, and phosphorous are "flushable." For each month, ten soil samples were collected from the experimental area within the floodplain. A "gentle" soil extraction using deionized water was performed. The effluent was analyzed for DOC, NO3-, NH4+, and SRP. Initial results have shown that the soil nutrient levels have a similar seasonal pattern to the soil temperature, groundwater levels, and vegetation growth cycle within the floodplain. We are also exploring a possible spatial distribution in extractable nutrients. This is an ongoing investigation in the Stroubles Floodplain Study (NSF) within the StREAM Lab at Virginia Tech.

BENCHMARKING THE WATER USE OF US AGRICULTURE USING LCA: CASE STUDY WITH PORK

**Eric C. Boles1, Marty Matlock2, and Greg Thoma3; 1University of Arkansas Biological Engineering Dept, 2University of Arkansas Executive Director of Sustainability, 3University of Arkansas Chemical Engineering Dept.* Producers of agricultural products and the consuming public have both become aware of the importance of understanding the sustainability of the products they produce and purchase. Life Cycle Assessment (LCA) is a valuable tool used to evaluate entire supply chains. The National Pork Board commissioned a group of University of Arkansas Researchers to compile a scan level LCA of water use in pork supply chain from field-to-fork. The goal was to identify opportunities to reduce water use, consumption of other natural resources and the support of other internal decisions for increasing the efficiency and security of the US pork supply chain. Analysis of the pork supply chain can be used to provide the insight necessary to identify critical leverage points where, in turn, innovation can lead to increased efficiency in the supply chain while simultaneously leading to reductions in the water impact of pork products.

THE SCIENCE OF SUSTAINABILITY: A FRAMEWORK FOR CONTINUOUS IMPROVEMENT

Marty Matlock; University of Arkansas Office for Sustainability. The ASABE ASE-16 Committee on Engineering for Sustainability is developing an ASABE draft standard X629: Framework to Evaluate the Sustainability of Agricultural Production Systems. The initial draft was written by Marty Matlock as a result of his work with numerous stakeholders in Field to Market (FtM), US Soybean Export Council (USSEC), Cotton Incorporated (CI), National Pork Board (NPB), US Poultry and Egg Federation (USPEF), and the National Roundtable for Sustainable Aquaculture (NRSA), among others. Each of these groups faced a common challenge from environmental non-governmental organizations (e-NGOs) to create a transparent continuous improvement framework for their sustainability initiatives. Matlock introduced this framework to USSEC in 2012 in response to criticism of their Soy Sustainability Assurance Protocol (SSAP) from World Wildlife Fund (WWF), an e-NGO. USSEC hosted meetings with a number of producers over an 18-month period to evaluate this process and improve it. Matlock subsequently introduced this framework to NPB as part of their national sustainability initiative. The Sustainability Committee for NPB adopted the framework and implemented it over a two-year period, starting in 2012. Matlock is currently working with the USPEF and NRSA to implement the framework for their production sectors.

Session C5 (Auditorium): 10:30 – 12:00

RELATING STREAM FUNCTION AND LAND COVER IN THE MIDDLE PEE DEE RIVER BASIN, SC

**Anand D. Jayakaran1, Zach T. Smoot2, Dara M. Park1, Daniel R. Hitchcock1; 1 - Clemson University, 2- Woolpert Inc.* It is well documented how anthropogenic changes to the landscape impact riparian systems and in many cases, how these alterations can surpass the system's ability to return to its original state. Modifications to hydrology, geomorphology, nutrient cycling, and sediment dynamics are major threats to the functioning of riparian ecosystem functions and can rarely be linked to a single common stressor. A study was conducted between 2008 and 2010 to quantify the fluvial geomorphic characteristics of streams and rivers in the Middle Pee Dee River Basin (MPDRB) and how indices of stream functioning varied with land cover characteristics analyzed at multiple spatial scales. Even though the physical features of a riparian system are largely intertwined with the biology/ecology of the system, this study focused solely on the abiotic structure of stream and landscape. Study objectives were to: a) develop regional hydraulic geometry curves for streams in the MPDRB, b) relate four indices of stream

function to observed stream geomorphological features, and c) identify which land cover types and at what spatial resolution most influence the four indices of stream function. The end purpose of this study was to determine factors that influence stream system function for their inclusion in the development of planned, state-regulated flow regimes that will maintain the geomorphological and ecological viability of the MPDRB, while ultimately meeting future human and ecological water needs. Preliminary results from this study will be presented at the conference.

INDIRECT FLUXES OF NITROUS OXIDE FROM A LOWLAND ARABLE CATCHMENT
Chris Adams, Oklahoma Water Resources Board & University of East Anglia. The potent Greenhouse Gas (GHG) nitrous oxide (N2O), which has a Global Warming Potential about 300 times more than carbon dioxide, is estimated to account for more than 50% of Agricultural GHG emissions. These are predominantly direct emissions from fertilizer applications and manure applications to land (c. 80%). In addition to direct emissions, indirect N2O emissions in response to nitrogen applications also occur and are now recognized as a quantitatively significant component (c. 20%) of the total N2O emissions budget from agricultural activities. Pathways for indirect N2O emissions are both as a result of nitrification and denitrification of nitrate during leaching and runoff. With a lack of country and climate specific data the IPCC uses default values with high uncertainty to calculate the fraction of all N added that is lost (through leaching and runoff) and to estimate the amount of leached N that is then converted to N2O. Efforts are now being made to improve on this by carrying out regional studies relevant to climates and farming practices. Here we present baseline and storm-event fluxes of nitrous oxide from a UK temperate lowland arable watershed.

IMPACTS OF CLIMATE CHANGE ON THE WATER QUALITY OF BIG CYPRESS CREEK AND LAKE O' THE PINES
Randy Rushin, Water Monitoring Solutions, Inc. The Third National Climate Assessment (2014)1 predicts several impacts on stream and reservoir water quality due to climate change. One long-term effect of climate change in Texas is a significant reduction in annual precipitation and surface runoff. Due to the reduction in flow, climate change impairs the water quality of streams through increased residency times of nutrients and other contaminants. Increased evapotranspiration rates exacerbate the effects on reservoir water quality. Big Cypress Creek flows through East Texas and is a tributary to several reservoirs including Lake Cypress Springs, Lake Bob Sandlin, Lake O' the Pines and Caddo Lake. Trend analyses were performed on over forty years of water quality data collected in Big Cypress Creek, its tributaries, and Lake O' the Pines. Statistically significant trends were identified which support predictions shown in The Third National Climate Assessment. The Assessment and supporting water quality trends from the Big Cypress Creek watershed will be discussed.

Session A6 (Room 108): 1:30 – 3:00

MANAGING GRASSLANDS FOR POLLINATORS: IMPLICATIONS OF MANAGEMENT PRACTICES FOR NATIVE BEES AND MONARCH BUTTERFLIES. **Kristen A. Baum1, Kenneth E. Wallen2, Shannon L. Andreoli1, Elisha K. Mueller1, and Shaun M. McCoshum1; 1Oklahoma State University, 2Texas A&M University.* Natural grasslands have undergone extensive fragmentation and loss, and the contribution of managed grasslands to biodiversity and as refuges for native plants and animals has become increasingly important. Pollinators are an important component of natural and managed grassland ecosystems, providing pollination services to crops, as well as ornamental and native plants. However, documented declines in managed honey bee colonies, native bee populations and communities, and the monarch butterfly population have raised concerns about pollinators and the availability of pollination services. Grassland management practices can influence the distribution and abundance of pollinators, as well as pollinator-parasite interactions. Grassland management practices include prescribed fire, mowing, grazing, and/or herbicide applications. We evaluated the effects of grassland type and management practices on native bees and monarch butterflies in Oklahoma, including consideration of floral resources, host plants, and pollinator-parasite interactions. We sampled native bees in rangelands managed with prescribed fire and/or herbicide applications, as well as canola-wheat-pasture landscapes. We sampled monarch butterflies in rangelands managed with prescribed fire, native hay fields managed with annual mowing, and roadsides managed with herbicide applications and multiple mowings. The composition of the native bee community varied among grassland types and management practices, as well as parasitism rates. Monarch butterfly abundance and parasitism rates also varied among grassland types and management practices. Results are discussed in the broader context of landscape mosaics, including the implications of seasonal and annual variability.

ECOLOGICAL POPULATION MODELS TO GUIDE THE DESIGN OF GREEN INFRASTRUCTURE IN SUPPORT OF SONGBIRD HABITAT CREATION. *David Wituszynski; The Ohio State University.* North American grassland birds are declining at an alarming rate due to habitat loss. One possible solution is to increase the amount of habitat for rare and threatened birds in urban and suburban areas through the use of green infrastructure such as rain gardens and green roofs. However, urban environments present unique pressures, and not all species will be able to thrive in them. There is a need to discern which species might do well if given the proper habitat so that habitat-creation efforts may be properly balanced with other conservation initiatives. I used seasonal transition matrices and published life history traits to create population models for several North American grassland birds of conservation concern, including Henslow's Sparrow (Ammodramus henslowii), Sprague's Pipit (Anthus spragueii), and Northern Bobwhite (Colinus virginianus). Using observed differences in adaptations and life history traits between urban and rural avian populations, I am able to predict how populations of each of these species will fare in an urban environment. For those species that show the promise of increased growth, the model is used to suggest specific habitat interventions, and then refined to explore their effects. In addition to providing insight into the ability of green infrastructure to contribute to urban biodiversity, this project demonstrates the usefulness of ecological population models as a tool to inform engineering design."

Session B6 (Room 109): 1:30 – 3:00

No talks scheduled. Please attend Session A6 or C6.

Session C6 (Auditorium): 1:30 – 3:00

PREDICTING THE IMPACT OF CLIMATE CHANGE ON MAUMEE BASIN HYDROLOGY AND NUTRIENT LOADING
**Andreas Culbertson1, Jay Martin1, Noel Aloysius1; 1The Ohio State University.* Lake Erie provides many ecosystem services, supplying drinking water to approximately 11 million people and supporting one of the world's largest freshwater fisheries. However, these services are threatened by harmful algal blooms (HABs), which cause hypoxia and produce toxins, recently instigating a three day "no-drink" municipal water advisory to 500,000 citizens in Toledo, Ohio. Nutrient runoff from agriculture has been identified as the key driver of HABs in Lake Erie. Though nutrient loading is predicted to increase with climate change, this hypothesis has not been examined with the most recent IPCC projections available, and quantitative predictions for shaping management plans are limited. To fill this knowledge gap and guide future management plans, we analyzed the impact of climate change on Maumee River discharge using the Soil and Water Analysis Tool (SWAT) and an ensemble of 14 Global Climate Models (GCMs) across two IPCC scenarios (RCP2.6 and RCP8.5). The SWAT model used was developed from a published model of the Maumee River watershed, further calibrated for sediments, total phosphorus, dissolved reactive phosphorus, total nitrogen, and nitrate. Calibration was achieved by interfacing the SWAT model with the Model-Independent Parameter Estimation & Uncertainty Analysis software on the Ohio Super Computer. The final results of this project are predictions of future water, sediment, and nutrients from 2011 to 2099 under current land management practices. These results confirm the need to accelerate implementation of management practices to mitigate further degradation of Lake Erie ecosystem services due to climate change.

IMPACTS OF PHOSPHORUS AND ECOLOGICAL ENGINEERING IN THE WESTERN LAKE ERIE BASIN
Jay Martin; Ohio State University. In the summer of 2014, 500,000 residents of the city of Toledo were told not to drink or use their water. While this is the most attention grabbing impact of phosphorus runoff and subsequent harmful algal blooms in western Lake Erie, there have been other important, but less known impacts. These downstream impacts have resulted in several management approaches being applied upstream, several of which involve ecological engineering. These methods to reduce phosphorus runoff include on-field, edge of field, and in-stream approaches. In-field approaches range from changes in fertilizer application methods to soil amendments, such as gypsum, and cover crops. Edge of field approaches include drainage water management where water is held in the field to reduce phosphorus discharge and promote higher crop yields. Two-stage ditches are being applied within streams to limit maintenance costs and improve water quality. The role of ecological

engineering in western Lake Erie demonstrates the utility of these approaches in addressing the more than 750 coastal zones around the globe impacted by eutrophication or hypoxia.

HABS & ECOLOGICAL ENGINEERING—A PANEL DISCUSSION
J. Martin, A. Horne, A. Culbertson, D. Austin, and others

Posters

THE GREEN BULKHEAD: A LIVING SHORELINE DESIGN FOR URBAN HARBORS
Gregory Fuentes, Tessa Hart, Bryant Martinez, Kyle Runion, Kyle Speed, Lela Stanley, Peter May and Patrick Kangas; University of Maryland. In urban harbors there is a reliance on the "gray infrastructure" of armored bulkheads along shorelines. While this form of shoreline technology provides stability and eliminates erosion, it limits aquatic biodiversity and lacks aesthetic value. In this study a living shoreline concept, termed the Green Bulkhead, is described and demonstrated. This is a kind of artificial vertical wetland with plants grown in a porous plastic fabric that is draped over the surface of an existing bulkhead. The system is irrigated with water that is pumped from the harbor. Several alternate designs are tested for planting patterns and water pumping regimes. It is proposed that the green bulkhead system can provide treatment wetland services in an urban setting where cost-effective water quality management options are minimal. The system also has aesthetic benefits by "greening" the harbor environment with wetland plants. This presentation is an annual report of an on-going ecological engineering project with demonstrations around the Baltimore, Maryland Inner Harbor.

HUMAN VALUES AND WATER QUALITY, STROUBLES CREEK, VA
Nicole Carter, Erica M. Davis, Karla Boza, M. Steele, M. Scorice, L.A Krometis, W. Cully Hession; Oklahoma State Univ., Univ. of Tennessee, Manhattanville College, Virginia Tech. The objective of this research project is to identify and map social values associated with the Stroubles Creek watershed. This information is essential for designing effective outreach and awareness programs, as well as management practices that provide the most ecological and social benefits to the surrounding area. A randomly selected representative subsample of the Blacksburg community was surveyed and asked to identify valued surface water features and assign social values to each location. Other survey questions probed the level of contact with each location, stakeholder responsibility, and willingness to pay for water quality. The findings will be compared to recent water quality data to test for correlations between water quality and a feature's aggregate value. Preliminary data indicates there is a discrepancy between the respondents' perception of Blacksburg's water quality and the actual condition of Stroubles Creek. Respondents tend to value certain features, such as the Duck Pond, more frequently than other locations. Additionally, certain values, such as aesthetic, recreation, and environmental value, are identified on a more frequent basis. These findings indicate that water features are not equally valued by residents, but almost all respondents place importance on the issue of water quality. Another common theme is a desire for more information and awareness, as well as ways to get involved in improvement projects and campaigns.

A COMPARISON OF PRODUCTIVITY ON TWO VERSUS THREE DIMENSIONAL SUBSTRATES IN AN ALGAL ECOTECHNOLOGY
Peter May 1,2 and Patrick Kangas 2; 1 Biohabitats, 2 University of Maryland. Several types of algal ecotechnologies are being studied for water quality management. Algae take up pollutants during their growth and water quality is improved when the algae are harvested and removed from the system. One class of these ecotechnologies relies on periphytic algae that grow attached to a substrate on the bottom of a floway. In this study algal growth is measured and compared on two dimensional (a plastic screen) and three dimensional (a commercial fabric) substrates in an algal floway that treats brackish water from the Baltimore Harbor. Small patches of the three dimensional substrates were attached to a larger two dimensional screen and the whole system was studied during the 2014 growing season. Dominant algal taxa on both substrate types were filamentous diatoms (Melosira sp.) and a green macroalga (Ulva intestinalis). Algal productivity on the three dimensional patches was consistently more than 20% greater than productivity on the adjacent two dimensional substrate. The larger surface area of the three dimensional substrates contributed to the greater productivity but other factors also may have been involved. The results are discussed in order to explore optimal alternative designs for periphytic growth in algal floways.

UNDERSTANDING THE RELATIONSHIP BETWEEN URBAN BEST MANAGEMENT PRACTICES AND ECOSYSTEM SERVICES
**Kelsey McDonough, Trisha Moore, Stacy Hutchinson, Aleksey Sheshukov; Kansas State University.* Humans have made rapid changes to the global landscape in order to provide food, fuel, and freshwater to the growing population. These changes provided humans with the necessary resources to sustain a growing population while simultaneously undermining the capacity of ecosystems to provide long-term food production, maintain freshwater and forest resources, and regulate climate and air quality. Continuous unprecedented change to the global landscape by humans will eventually result in an environment so severely degraded that it will no longer have the ability to sustain life. The preservation and restoration of ecosystem services can ameliorate the negative impact of humans on the environment through enhancing the resilience and health of the ecosystems in which we live. Urban ecosystems, characterized by impervious surfaces and high population density, are in dire need of management programs that have the ability to maximize ecosystem services by utilizing limited green space. Prior research has focused primarily on quantifying a single ecosystem service at one time or in valuing ecosystem services economically. There is a need for research that evaluates the multiple and non-linear relationships among ecosystem services. This research quantifies and evaluates ecosystem services in terms of water provision within the urban landscape. Best management practices, in particular, are evaluated in order to understand their role as a tool within a large-scale watershed management program.

FLUE-GAS DESULFURIZATION TREATMENT WETLANDS: AN EXCEPTIONAL SYSTEM FOR GREENHOUSE GAS SEQUESTRATION?
Trisha L.C. Moore, Barett Wellemeyer, Jacob Zortman; Kansas State University. Constructed wetland treatment systems (CWTS) have been identified as a potentially cost-effective technology for removing pollutants from flue gas desulfurization (FGD) effluent, the liquid waste stream resulting from air pollution control systems designed to remove sulfate, heavy metals, and other trace elements from coal-fired power plant stack emissions. An additional co-benefit of these CWTS is greenhouse gas sequestration, which we hypothesize will be enhanced through suppression of methanogenesis by the microbial community due to the elevated sulfate concentrations characteristic of FGD effluent. The objective of this project is to quantify the potential net greenhouse carbon balance (e.g., carbon dioxide sequestration less methane emissions) for a CWTS treating effluent from the flue gas desulfurization process. A wetland column study is being conducted to measure changes in CO2 and CH4 production in vegetated and unvegetated columns dosed with FGD effluent. Predictive models between environmental variables (temperature, redox, and pH) and carbon fluxes will be explored. These data are intended to provide beneficial knowledge regarding the potential for FGD treatment wetlands to serve as a carbon emissions offset as well as practical design guidance for optimizing carbon sequestration in these systems.

DETERMINING THE FEASIBILITY OF UTILIZING RECYCLED HOUSEHOLD WASTEWATER FROM AEROBIC TREATMENT SYSTEMS FOR CATTLE WATERING. *Oden, L., Oklahoma State University.*Alternative sources of water for the purpose of non-human (direct) consumption are needed to mitigate the effects of drought and increasing water resource use and depletion within the United States. Emerging ideas that are already implemented in some regions for the reuse of wastewater include: watering of lawns and the irrigation of some crops. I present an idea that may help to conserve fresh, direct, human potable water through the reuse of wastewater from household aerobic sewage treatment systems. Through the process of these systems' treatment of the wastewater, the effluent (as per U.S. E.P.A. and Oklahoma D.E.Q. Regulations) should be a potential source of water for watering cattle, and could potentially be used for the purpose of irrigating lawns and certain crops.

HAITI SURVEY RESULTS: SANITATION PRACTICES, LIMITATIONS AND WILLINGNESS TO PAY FOR SANITATION FACILITIES
**Ayella Maile-Moskowitz1, Dr. Stephanie Lansing1, Alexander Eaton2 and Teddi Galligan1; 1University of Maryland Department of Environmental Science and Technology, 2IRRI-Mexico.* Access to sanitation facilities is limited in Haiti. Small scale--biodigesters are being proposed to improve sanitation, treat sanitary waste and provide biogas as cooking fuel. A multi-facet project in Haitian communities evaluated the potential of three digestion systems in Haiti, provided training and education programs, and created a Field Digestion Test Kit to monitor the digesters. As part of this project, surveys were distributed in two areas: a rural location: Cange, Haiti, and peri-urban location: Mirebalais, Haiti. Participants were asked about their individual sanitation practices, willingness to pay for access to improved sanitation facilities and factors that affected the use of the facilities. Of completed 550 surveys, results showed that 39% of people in Cange and 18% in Mirebalais had no access to any form of sanitation, including latrines. In regards to using a pay-for-use facility, 38% were very interested and 46% were slightly to moderately interested in Cange, whereas 46% were very interested and 54% were slightly to moderately interested in Mirebalais. The majority of the respondents were willing to pay in the range of $0.10 to $0.30 per use at a sanitation facility,

the higher values for toiled-based facilities - only. The most important factors influencing their desire to use such a facility were related to cleanliness, safety and helping local business, with the greatest limitation being finances. Future work includes building a pay-for-us facility in Haiti where the black water is treated in a digester, providing wastewater treatment, biogas for cooking, and a nutrient-rich fertilizer post-treatment.

A HISTORY OF THE AEES STUDENT DESIGN COMPETITION

David Blersch1, Brandon Winfrey2, Patrick Kangas3; 1Auburn University, 2University of California Los Angeles, 3University of Maryland. The student design competition has been held at annual meetings of the American Ecological Engineering Society since 2006. This event, sponsored and organized by the Society, is intended to engage students in hands-on, creative, and active problem solving while expanding their professional networks. Teams typically comprise graduate and undergraduate students from the same university. In the past, teams have been challenged to create a model of an ecosystem, develop a solution to an environmental problem using ecological design, or create a video explaining an ecological engineering technology. These competitions provide students with a chance to practice ecological engineering with assistance from academics and practitioners in their field in an informal setting. At the end of the competition, teams present their projects to all conference attendees. Teams are judged based on established criteria pertinent to the competition challenge (i.e., scientific method, engineering design, adherence to ecological principles, presentation, etc.). The authors have witnessed most teams participating enthusiastically in these competitions. In this poster presentation, we review the history of the student design competition, its usefulness in promoting professional networking and reinforcing ecological engineering principles, and suggestions for future design competition.

ENHANCING BIOGAS QUALITY IN ANAEROBIC DIGESTION SYSTEMS WITH IRON (III) ADDITIVES. *Angela Perantoni1, Annie Yarberry1, Stephanie Lansing1, Stephanie Yarwood1, Alba Torrents2; 1: University of Maryland, College Park; Dept. of Environmental Science & Technology, 2: Dept. of Civil & Environmental Engineering.* Anaerobic digestion (AD) is a process in which microorganisms degrade organic waste, producing biogas consisting of CH4, CO2 and other trace gases, including hydrogen sulfide (H2S). H2S, even in trace amounts, can corrode biogas utilization systems, while CO2 reduces the combustion value of the biogas. Previous research has focused on both digester additives to reduce CO2 and H2S production and biogas upgrading techniques aimed at removing these gases once produced. The focus of this study is to determine the effect of the addition of Fe (III) compounds to AD reactors on H2S and CH4 production. Iron can oxidize sulfides, decreasing the amount of dissolved H2S present. Fe (III) may also be used as a terminal electron acceptor during anaerobic respiration, resulting in the formation of Fe (II), an important micronutrient for methanogens. This study applied Fe (III) additions to manure-based AD systems, where the addition of Fe (III) compounds has been more limited. A biochemical methane potential (BMP) study was conducted by adding complexed Fe2O3 to dairy manure and inoculum. The organic chelating agents that complex with iron improve the solubility of Fe (III), making it more available for target chemical and microbial processes. The BMP bottles were loaded in triplicate with inoculum only, manure and inoculum, or manure and inoculum with iron (III) additives: Fe2O3 only or one of three different Fe2O3-complexes. Biogas production results from the 18 BMP digestion bottles will be presented for each treatment in terms of CH4 enhancement and H2S reduction.

BYPRODUCT VALUE OF BRICK MAKING FROM ALGAL ECOTECHNOLOGY

Kevin Britt, Hugh Davis, Cody Denton, Kyle Finkbeiner, Michael Gellman and Patrick Kangas; University of Maryland. Several kinds of algal-based ecotechnologies are being studied for removing nutrients and sediments from polluted waters. Algae take up the pollutants through multiple mechanisms and water quality is improved when the algal biomass is harvested. One of the benefits of this approach is that the harvested biomass is a byproduct of the water quality function that can be used in an economic process. In this study data are reported on potential use of harvested algae to make construction materials. The algae harvested from several experimental algal floway studies have high ash content (typically 60 to 80 percent of mass), which may preadapt them for use in brick making. Dried algae are mixed with concrete in ratios to make bricks which are rated for strength, density and durability. Preliminary results of the testing indicate that more than 10% of the mass of bricks can be dried algae without significant loss of the material qualities. The economic viability of algal brick making is discussed. Implementation of this opportunity for byproduct use can help finance algal-based technologies for water quality management.

EXPERIMENTAL ANAEROBIC DIGESTION OF ALGAE FOR BIOGAS PRODUCTION

Tyler Bryant, Joshua Gaimaro, Christopher Shingleton, Meredith Wallach, James Zester, Stephanie Lansing and Patrick Kangas; University of Maryland. Use of algae to make biofuels is an active area of research. Methods include fermentation, lipid extraction, catalytic conversion and others. Algal biofuels are potentially attractive since they would be a source of renewable energy that is at least near carbon-neutral. In this study data are presented on anaerobic digestion of algae grown in an ecotechnology used for water quality management. Laboratory-scale bioreactors were constructed from plastic tubing, using electrical heat tape to elevate temperature into the range of methanogenesis. Biogas production was monitored in month-long experimental trials after addition of algal biomass feedstock. The laboratory data are projected to explore the commercial potential of this approach of biofuel production as a byproduct value of algal-based ecotechnologies.

ANAEROBIC DIGESTION OF POULTRY LITTER AND POST-DIGESTION NUTRIENT RECOVERY

Anna Kulow1, Stephanie Lansing1, Andrew Moss2; 1Department of Environmental Science & Technology, University of Maryland, College Park, 2Planet Found Energy Development, LLC.* Nutrient run-off from excess poultry litter application on Maryland's Eastern Shore has led to eutrophication and anoxia in parts of the Chesapeake Bay. Best Management Practices (BMP) programs, while well-financed, are often inconvenient for farmers needing to dispose of large quantities of waste, due to the high cost of off-site transport. Anaerobic digestion of poultry litter not only provides a means of waste management, but also generates on-site energy and reduces greenhouse gas emissions. However, due to its low moisture content and high ammonia concentration compared to dairy manure, poultry litter is rarely used as the only substrate for digestion. Additionally, the fertilizer produced from poultry litter remains high in nitrogen and phosphorus and, with current TMDLs, cannot be locally applied. The present study aims to: 1) evaluate poultry litter as the sole substrate for anaerobic digestion; and 2) explore methods of post-digestion nutrient removal and recovery to create value-added fertilizer products and reduce nutrient concentrations in the digested litter. We will discuss results from an 800 L up-flow anaerobic digester that showed methane (CH4) production of 0.15 m3 CH4 g-1 VS, with a loading rate of 5% solids and a HRT of 35 days. The digestate was dewatered using reverse osmosis to concentrate nutrients. Phosphorus was removed from the concentrate as struvite by adding MgCl2. The concentrate was then processed in triplicate bench-scale 4L air scrubber reactors using air and CO2 as the flow gas to produce ammonia sulfate and ammonia bicarbonate, respectively. These results will also be presented.

NATURAL GAS DEVELOPMENT ALLEVIATES NUTRIENT LIMITATION OF ALGAL GROWTH IN FAYETTEVILLE SHALE STREAMS

**Bradley Austin1, Natalia Hardgrave2, Brian Haggard1, Sally Entrekin2, and Michelle Evans-White1; 1University of Arkansas, 2University of Central Arkansas.* Construction of natural gas (NG) infrastructure may negatively influence streams by clearing watershed vegetation and increasing sediments and sediment-bound nutrients. Previous research found a positive correlation between NG development metrics and algal biomass. Total nitrogen (TN) can also relate positively to NG metrics, but no direct correlations between N and algal biomass were found. We used nutrient diffusing substrates (NDS) with +N, +phosphorus (P) and +NP treatments to explore potential NG effects on N- and P- limitation of algal production within 8 streams in the Fayetteville shale region of Arkansas. Algal production in streams with well densities <0.12 wells/km2 was primarily N-limited and was co-limited in one stream. Streams with high NG activity (>0.12 wells/km2) were not nutrient limited. Additionally, algal production from the +N treatments was negatively related to both well density (R^2= 0.57; p= 0.03) and background TN (R^2= 0.52; p= 0.04). These data provide additional evidence supporting the hypothesis that the mechanism by which NG activity stimulates Fayetteville shale stream algal production is via alleviation of N-limitation.

COMPARATIVE LIFE CYCLE ASSESSMENT (LCA) OF UNHEATED CHINESE FIXED-DOME DIGESTER WITH HEATED AND INSULATED PLUG-FLOW DIGESTER IN THE US.

**Freddy Witarsa1, Stephanie Lansing1, Amro Hassanein2, Ge Yihong3, Qiu Ling2; 1Environmental Science & Technology Dept., University of Maryland, College Park, MD 2Mechanical & Electrical Eng. College, Northwest Ag. & Forestry University, Shaanxi, China 3Agronomy College, Northwest Ag. & Forestry University, Shaanxi, China.* Anaerobic digestion is a microbial process that converts manure into renewable energy in the form of methane-enriched biogas. In addition to producing renewable energy, the process also reduces odor, total solids, volatile solids, and chemical oxygen demand of manure, reducing the harmful effects that manure can have on the environment. Despite these benefits, implementation of small-scale digesters in the US are hampered by high costs, partially due to the need for heating and insulation to maintain digester temperatures at 25-35 °C. In China, the majority of digesters are designed as unheated fixed-dome digesters, while the majority of digesters in the US are heated plug-flow and complete mixed digesters. The objective of this research is to use life cycle assessment (LCA) to compare net energy production of an unheated Chinese fixed-dome

digester and heated and insulated small-scale plug-flow digesters constructed at the USDA Beltsville Agricultural Research Center facility. In addition to calculating net energy produced, LCA was also used to assess the CO2 emissions of these digesters in order to better access overall sustainability. The ultimate goal of the project is to provide recommendations for improving digester designs for smaller-scale settings throughout the world.

MEASURING THE EFFECTS OF MYCELIUM IN STORMWATER MANAGEMENT SYSTEMS

Rebecca Bender, Jacob Cochrane, Alexandra Fischer, Katerina Tsou; Department of Biosystems and Agricultural Engineering.

Mycelium is known to have a profound impact on soil infiltration, plant growth, and ecological resilience. Fungi are diverse, adaptive, and opportunistic in many ecosystems, and may prove a resource in ecological engineering. The goals of this study are to quantify and qualify the impact of mycelium on the success of stormwater management systems. Laboratory-scale models were assembled to mimic green roofs and rain gardens, with mycelium and plants grown independently and combined. Systems have been evaluated based on erosion resistance and stormwater pollutant removal.

ACCUMULATION AND METABOLISM OF TRICLOCARBAN BY HYDROPONICALLY GROWN PEPPER (CAPSICUM ANNUUM)

Khang Huynh, Emily Banach, Dawn Reinhold; Department of Biosystems and Agricultural Engineering, Michigan State University. The accumulation of reclaimed wastewater and biosolids-associated antimicrobials and their metabolites by several vegetable species has been a growing concern due to potential health hazards. In this study, we investigated the accumulation and biotransformation of triclocarban (TCC) in hydroponically grown pepper plants (Capsicum annuum), using both radioactive labeled 14C-TCC and non-labeled TCC. Our results showed that TCC was detected in all plant tissues followed the order of roots > stems > leaves > fruits. The TCC concentrations were 26.0, 2.9, 0.1 and 0.04 µg/g dw, respectively, after 12 weeks. Analysis of plant tissues extracted with solvent indicated that 14C was predominantly present in non-extractable forms (e.g. up to 90.1% for stem and 100% for fruit samples after 12 weeks). Our hypotheses were that TCC molecules undergo several biotransformation processes following root uptake, and ultimately sequestered into cellulose compartments, which was non-extractable by conventional solvent extraction methods. As a result, this might lead to an underestimation of the extent of uptake and potential hazards in studies related to human exposure to xenobiotic pollutants via food chains.

HOW CAN SWMM MODELING IMPACT URBAN PLANNING POLICY

**Grant Brady, Stacy Hutchinson, Trisha Moore, Brent Chamberlain; Kansas State University.* Urbanization poses great impacts to water quality and quantity. These problems are no stranger to the sprawling suburbs of Johnson County, KS in the Greater Kansas City area. In 2014, the Kansas Department of Health and Environment (KDHE) listed 62 303(d) listed “impaired” or “potentially impaired” waterbodies in Johnson County, primarily affecting aquatic life. Previous research shows watersheds that are crisscrossed by multiple politically boundaries see increases in water quantity and decreases in water quality. Using Johnson County’s Shawnee Mission School District (SMSD), a 43% impervious 72 square mile area incorporating 45 schools and 14 cities, this research investigates how a large nested political boundary can help undo the negative effects of watershed fragmentation as well as how watershed modeling can change urban planning policy. Specifically, two progressive management styles of Johnson County’s urbanization will compare water quality and quantity improvements using the EPA’s Storm Water Management Model (SWMM). First, policy driven management models reduced impervious surfaces in FEMA floodplains and commercial parking in the SMSD area with respect to the EPA’s Smart Growth guidelines. Secondly, grassroots driven management models educational green infrastructure at the SMSD properties and adopted rain barrels throughout the district to simulating a more watershed educated population. Both management styles will provide area governing offices quantitative results on how their decisions can help improve Johnson County’s watershed health.

GRADE SCHOOL STUDENT CHANGES IN STEM SELF-EFFICACY FOLLOWING PARTICIPATION IN UNDERGRADUATE-DESIGNED LABORATORY ACTIVITIES.

L.A. Krometis, T.M. Thompson, T. Blair, E. Kaufman, W.C. Hession; Virginia Tech and Concord College. Although effective communication of scientific results to the general public is an essential professional skill, aspiring scientists and engineers have limited formal opportunities during their undergraduate careers to gain experience presenting to non-peer groups. This study assessed gains in awareness, content knowledge, interest in science, self-efficacy, and career knowledge by middle school students participating in hands-on laboratory exercises led by undergraduate students. The undergraduate teachers developed the exercises in groups as part of the Virginia Tech StREAM Research Experience for Undergraduates (REU) program, and the activities were intended to parallel their own summer undergraduate research on water sustainability and urban streams. The 60-minute exercises were offered to groups of 20-25 students. The middle school students completed these

exercises as part of a larger campus-sponsored summer camp program design to encourage interest in future STEM careers. Six separate camp activities were offered over three summers (three/summer) to over 120 middle school participants. To assess participant gains in knowledge and self-efficacy due to the activity, students completed a retrospective post-then-pre survey, administered following the workshops. Results indicate participants' positive attitudes increased related to awareness, content knowledge, interest in science, self-efficacy, and career knowledge. The greatest change occurred in the awareness construct. Implementation of the survey was simple and straightforward, requiring only 5-10 minutes. Further use of this, or similar survey instruments, is encouraged to understand and quantify the benefits of similar outreach experiences amongst grade school students, and to demonstrate to young scientists the opportunities associated with presentations to general audiences.

USING MICROBIAL SOURCE TRACKING TO IDENTIFY SOURCES OF HUMAN FECAL CONTAMINATION IN A SMALL URBAN WATERSHED. *Christine Hart, Sarah Medley, Andrea Stewart, B. Badgley, L.A. Krometis, R. Stewart, W.C. Hession; Smith College, UVA-Wise, UNC, Virginia Tech.* Surface waters contaminated with fecal pollution represents a public health risk from the potential transmission of human pathogens. However, fecal indicator bacteria (FIB), which have been traditionally used to assess microbial water quality, cannot distinguish between animal and more threatening human inputs. Previous research at one site on Stroubles Creek observed consistently high levels of a new genetic marker for human Bacteroides (BacHF183) during storm events, which is highly indicative of the presence of sewage contamination. This project aims to survey the watershed in an attempt to locate potential sources of contamination, including both surface waters and stormwater infrastructure, to identify areas that may require infrastructure inspection and repairs. Duplicate water samples were collected from 42 sites across the watershed. Concentrations of two commonly used FIB, E. coli and enterococci, were determined using most probable number, and quantitative polymerase chain reaction was used to measure the concentration of the BacHF183 marker for each sample. Geospatial analysis was utilized to identify hotspots of suspected human fecal contamination, and these locations were resampled at a finer scale. Expected benefits include a better understanding of the performance of BacHF183 concentrations for tracking contamination sources spatially and recommendations to improve water quality in Stroubles Creek and Blacksburg's Total Maximum Daily Load implementation plan.

SELF-OPTIMIZATION OF MIXED ALGAL COMMUNITIES VIA AUTOMATED FEEDBACK CONTROL OF LIGHT INPUT
Jesse Blanton, David Blersch; Auburn University Biosystems Engineering Department. Ecosystems display characteristics of being moderated by internal feedback control, but there has been little study into the influence of external feedback pathways on the internal organization of those systems. The objective of this research is to investigate the metabolic self-optimization of an aquatic phototrophic microcosm that is subject to automated feedback control of light input. In this research, self-contained miniature phototrophic ecosystems have been prepared in 1 gallon glass jars. Each microcosm is maintained within a narrow temperature range (~5°C), with an LED light source sufficient for algal photosynthesis, as well as mixing and additional carbon supplied by bubbling air via an air stone. In the experiment, replicate microcosms are isolated from external light input, and connected to a continuous pH monitoring system that toggles the activation of the light source based on high and low pH setpoints. Frequency and length of light and dark periods are recorded, as well as temperature fluctuations, optical density, chlorophyll-a content, cell count, and dissolved oxygen concentrations over time. These community expressions of metabolic characteristics will be used to determine net auto- or heterotrophy, growth rates, and net primary productivity of the organisms present. It is expected that light and dark periods will stabilize in a sinusoidal oscillation about an optimal cycle length that maximizes the efficiency of growth and productivity with minimal light input. The data gathered from this experiment will be used to develop mathematical models for use in designing feedback control systems for mixed-community photobioreactors.

THE DISTRIBUTION OF NUTRIENTS IN URBAN AND AGRICULTURAL PONDS USED IN DETERMINING THE COST EFFECTIVENESS OF A BIOCHAR FILTER BMP. *JaymeLee Ewing1, Cort Hammond2, Caleb Higginbotham3; Virginia Tech, Washington and Lee, Virginia Tech.* Excess phosphorus (P) from urban and agricultural locations contributes significantly to cultural eutrophication of the nation's water bodies, negatively impacting biological systems, economic systems, and health. Current Best Management Practices (BMPs) such as retention ponds have reduced nutrients entering water bodies but have disadvantages, including the potential to reach nutrient saturation. Traditional BMPs also do not recycle nutrients and offer no economic incentives for implementation. The objectives of this project are 1.) to find trends in P concentrations in local retention ponds to justify implementation of a filtration system, and 2.) to model the costs and benefits of using a biochar filter to remove P from these ponds. Water and soil samples were collected at different depths and locations (inlet, outlet, middle) from five retention ponds

(agricultural, urban, golf course) in Montgomery County, VA. Results indicate that total phosphorus (TP) was as much as 20 times greater than dissolved phosphorus (DP) in some ponds and exceed recommended limits for lakes and reservoirs, indicating the amount of stored P available and its potential for release. TP was correlated with low conductivity and high dissolved organic carbon (DOC), and there was no correlation with the sampling location (inlet, outlet, middle of pond). The potential for the biochar media from the filtration system to be reused as a fertilizer was also investigated. A model of a filtration column demonstrated that, while the reuse of the biochar media will not be profitable, this system may be more economically attractive than traditional BMPs.

EFFECTS OF INTERSECTING LIMITING FACTORS ON THE COLONIZATION AND GROWTH OF ALGAL BIOFILMS IN CULTIVATION SYSTEMS. *Olivia Elliott, Dr.David Blersch; Biosystems Engineering Department, Auburn University.* There is growing interest in the large-scale cultivation of algal biofilms in engineered raceways for nutrient pollution recovery and biomass generation. Little is known, however, about the process of substratum colonization and regrowth in response to controlling factors such as nutrient concentrations and flow velocity. The objective of this research is to determine growth and colonization parameters of a unialgal community under the combination of intersecting limiting factors of nutrient ratio and current velocity. Spirogyra communis was cultured at the bench scale on unglazed ceramic penny round tiles over a range of nitrogen: phosphorous ratios and different flow velocities. A regulated active culture was inoculated into experimental replicate culture dishes with tiles, provided nutrient media enriched over a range of N:P ratio, and agitated with an orbital shaker table. Repeated trials were performed at velocities with a frequency over a range from 0 to 80 s-1. Each velocity was tested for eighteen days and maintained constant light exposure using a chemo-stat process. Tiles were removed serially and analyzed for change in dry weight, and used to construct growth curves of the various conditions. This information will help create a database for growth parameters and controlling factors of algal types typical in the design of large scale algal biofilm reactors.

COMPARISON OF TWO METHODS TO QUANTIFY HYDROCARBON REDUCTION BY BIORETENTION
**Abigail Tamkin, Jay Martin, James Bauer, Yu-Ping Chin; Ohio State University.* As a class of chemicals, hydrocarbons contain many carcinogenic and mutagenic compounds. Hydrocarbons are a prevalent pollutant in stormwater, coming from sources such as automotive fluids, combustion products, and asphalt. Quantifying hydrocarbons effectively is a priority for monitoring urban and suburban water quality. Bioretention cells have been shown to address many water quality and water quantity issues, including reducing and/or removing metals, nutrients and hydrocarbons from stormwater. There are many methods for quantifying hydrocarbons, of varying complexity and cost. We have chosen two bulk methods for comparison: US EPA Method 1664 B: N-Hexane Extractable Material (hexane extraction, gravimetric analysis) and Massachusetts Department of Environmental Protection Method: Extractable Petroleum Hydrocarbons (methylene chloride extraction and GC-FID analysis). The gravimetric method requires much less time, expertise, and equipment, but the GC-FID method gives detailed information about the composition of the hydrocarbons contained in the sample. These two methods are being applied to water and soil samples from bioretention cells in a suburb of Columbus, Ohio. Results from a series of controlled, simulated rain events using synthetic stormwater input to bioretention cells will be presented. The two methods quantify the ability of the bioretention cells to reduce the known amount of hydrocarbons in the synthetic stormwater.

ASSESSMENT OF LIVESTOCK EXCLUSION BEST MANAGEMENT PRACTICE ON A SMALL TRIBUTARY IN SOUTHWEST VIRGINIA
Teneil Sivells, W. Cully Hession, and Durelle Scott; Biological Systems Engineering, Virginia Tech. The 2006 Stroubles Creek Total Maximum Daily Load (TMDL) Implementation Plan (SCIP) addressed the need to remove a 4.1 mi reach of Stroubles Creek from Virginia's 303(d) List of Impaired Waters by reducing sediment loads to the stream. Best management practices (BMPs) have been installed in Stoubles Creek watershed in response to the TMDL; however, excess sediment loading is still a major concern. This project will monitor the effects of livestock exclusion, an agricultural BMP included in the SCIP, on a 0.41 mi tributary to Stroubles Creek using a before-after-control-impact (BACI) design. The treatment reference reach will be sampled monthly for total nitrogen (TN), total phosphorus (TP), nitrate (NO3-), ammonia (NH4+), dissolved phosphorus (P), suspended sediment concentration (SSC), temperature, dissolved oxygen (DO), and conductivity for one year prior to BMP implementation and one year after BMP implementation. The collected data will be utilized to compare the sediment and nutrient loads prior to and following livestock fencing. An analysis of E. coli and fecal coliform counts will also be performed due to a new bacteria TMDL for Stroubles Creek. The evaluation of the livestock exclusion BMP will provide valuable information regarding the bacteria and sediment TMDLs in order to determine if the BMP is effective for the watershed.

NANO ZERO VALENT IRON PARTICLES (NZVI) AS A SOIL REMEDIATION TECHNIQUE TO REMOVE AS, CD, CU AND PB
Chelsea Westra, Dulasiri Amarasiriwardena, Christina Cianfrani. Zero-valent iron nanoparticles (nZVI) are increasingly being used for adsorption and degradation of inorganic and organic contaminants, respectively (Li et al. 2006, Mueller et al. 2012). These engineered nano particles exhibit special properties due to their high surface area and core-shell structure that can remove trace metals through reduction and chemisorption (Yan et al. 2010). This study aimed to assess removal efficiencies of trace metals As, Cd, Cu and Pb from solution and soil. nZVI particles for this study were synthesized via bottom-up methods and characterized with transmission electron microscopy (TEM). nZVI particles were added to five replicates of 10 ppm As, Cd, Cu and Pb solutions at a ratio of 0.1 mg nZVI to 10 mL solution and equilibrated at 170 RPM for 24 hours. Kinetic studies involved removing 5 mL samples over a 24-hour period to determine adsorption rates. Competitive trace metal adsorption kinetic studies with humic acid (HA) coated nZVI also performed, as humic acids are ubiquitous in soils and will interact with nZVI in situ. Results showed highest percent removal efficiency (n=5) by pristine nZVI for Pb (99.2% ± 0.2%) followed by As (98.6%; n=1), Cu (98.5% ± 0.8%) and Cd (96.6% ± 0.6%). This suggests that nZVI is successfully removing As, Cd, Cu, and Pb and can be a practical approach for remediation of toxic trace metals contaminated soils.

GREENHOUSE GAS EMISSIONS FROM SOIL CORES FROM A RIPARIAN-UPLAND TRANSECT: HOW DO PRECIPITATION REGIME AND LANDSCAPE POSITION AFFECT SOIL CO2, CH4, AND N2O FLUXES? *Tyler Weiglein*, Durelle Scott, and Brian Strahm. Virginia Tech.* Global climate models predict climate change caused by anthropogenic greenhouse gas (GHG) emissions will result in altered precipitation regimes by the end of the 21st century. Although there is still uncertainty regarding how mean annual rainfall will change in the mid-Atlantic region, it is predicted that there will be more intense rainfall events followed by extended dry periods. Given the important role played by soils in global GHG fluxes, a key question that remains unanswered is how changes in precipitation will affect soil GHG emissions across the landscape. This project investigates the impact of rainfall magnitude and frequency as well as landscape position on soil CO2, CH4, and N2O emissions. Soil cores were taken from a riparian-upland transect within a restored stream reach in Virginia Tech's StREAM Lab and divided into treatment groups based on landscape position and simulated precipitation regime. Each group received the same total amount of water over 13 days, but the timing and magnitude of water additions were manipulated to simulate storm events of various sizes. Chamber headspace concentrations of CO2, CH4, and N2O were measured with a cavity ring-down spectrometer and used to calculate fluxes from the cores. No statistically significant differences in cumulative changes in emissions were found among the treatment groups, which is believed to be largely due to soil heterogeneity. However, all treatment groups experienced a decrease in CO2 emissions due to the simulated precipitation events, and the data suggest that variability in CH4 emissions decreases with increased rainfall magnitude.