Impacts of multiple disturbances on species composition in the southern boreal forest
Elias Anoszko, Natural Resources Science and Management

Current climate research projects a doubling of fire frequency throughout most of the North American boreal forest by the year 2090. While windstorms are historically rare events in the boreal forest, increasing temperatures and precipitation variability are likely to cause similar increases in severe windstorm frequency by centuries end. The net result is likely to be a dramatic increase in disturbance frequency and the possibility of multiple compounding perturbations, or multiple disturbances within a short period of time with uncertain impacts on succession and biodiversity. I will present preliminary results from a multiple disturbance case study in the Boundary Waters Canoe Area Wilderness of Northern MN where a series of recent disturbance events including a severe windstorm (193,000 ha) and two large wildfires (40,000 ha) have created a unique matrix of disturbance combinations and severities. I will present my preliminary analyses that compare single and multiple disturbance events and their impacts on tree community composition and succession.

Inventory, Water Characterization, and KAP Survey of Source Water Areas in Rural El Salvador
Adam J Birr, Master of Science candidate in Natural Resources Science and Management (Economics, Policy, Management, and Society track)

The rural populations of Chinameca, El Salvador are commonly afflicted with waterborne diseases caused by consuming contaminated water. Source water protection has been widely recognized as the first stage of managing water quality, particularly when action is taken to mitigate fecal contamination at the source. The Rural Source Water Protection Project was initiated to gather information related to water quality and management of source waters areas (SWAs) serving the rural population of Chinameca. A total of forty SWAs were identified and characterized, of which twenty principal SWAs were studied in further detail. All but two of the studied SWAs were found to have water unfit for human consumption. Although only three of the principal SWAs were actively maintained by a water user or organization, water users felt their water was safe and well managed as found through a Knowledge, Attitudes, and Practices (KAP) survey. The results of this survey show an alarming disconnect between reality and community perceptions of water quality and management in Chinameca. Despite these concerns, the findings of this project articulate the presence of interested and untapped community members and an organizational gap for them to fill, with respect to source water protection and management. With the right community leadership and action, the future of improved source water quality and management in Chinameca is hopeful.
A farmer considering a transition to organic crop management faces a difficult decision. Even leaving aside personal perceptions of environmental or health benefits, the farm manager must weigh the expected profitability and risk of each system against the cost of transition. Furthermore, the option remains to do nothing and wait for more information about the comparative profitability of the alternative systems to be revealed. Most previous studies that compare the profitability of organic and conventional cropping systems have found that returns to organic crop management are equal to or exceed those to conventional management. However, relatively few crop farms have undertaken the organic transition required to obtain certification.

This study investigates the decision to convert from conventional to organic crop production by modeling the decision as a dynamic programming problem in which the costly transition period and significant uncertainty may discourage transition, despite higher average returns to the organic cropping system. The model calculates the optimal transition strategy given different farm sizes, government assistance scenarios, and starting levels of conventional crop returns. Results suggest that smaller farms are more likely to transition than larger farms, and that when returns to conventional management are high, not only is the likelihood of organic transition greatly reduced but organic farms may abandon organic management.

Long-term green tea extract consumption may reduce body mass index in healthy postmenopausal women with the low-activity COMT genotype

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Objectives: This interim analysis assessed effects of decaffeinated green tea extract (GTE) on body weight and BMI in postmenopausal women at high risk for breast cancer. Potential effect modification by catechol-O-methyltransferase (COMT) genotype was also analyzed. Methods: A biostatistician conducted a preliminary analysis on 205 women who have completed the randomized, double-blind, placebo-controlled study. Women consumed either a study supplement containing 800 mg epigallocatechin gallate (EGCG) or placebo capsules daily for 12 months. Body weight and BMI were assessed at baseline and 12 months. Outcomes: Average age of participants was 58.4±5.4 years old; average BMI was 25.4±5.5 kg/m². When stratified by treatment group alone, there was no significant difference in BMI change between GTE (n=100) and placebo (n=105). When the groups were stratified by COMT genotype, women in the low-activity (A/A) group who consumed GTE (n=27) showed a trend toward decreased BMI when compared with the placebo group (n=28)(-0.36±0.82 vs. 0.05±0.80 kg/m²; p=0.06). No differences were observed between GTE and placebo groups for the intermediate-activity (A/G) genotype. Changes were reversed for the high-activity (G/G) genotype: BMI increased in women
consuming GTE (n=20) compared to those on placebo (n=17) (0.28±1.62 vs. -0.49±0.93 kg/m²; p=0.09). Body weight significantly increased in women with the G/G genotype consuming GTE as compared to placebo (0.22±1.70 kg vs. -1.70±3.00 kg; p=0.02). **Conclusion:** These results suggest that long-term daily exposure to GTE containing 800 mg EGCG may decrease BMI in postmenopausal women with the low-activity COMT genotype. This effect may be reversed in women with the high-activity genotype.

**The Effect Of Hay Net Design On Rate and Amount of Forage Consumed By Adult Horses**

Emily Glunk, PhD student, Animal Science
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Modern horse management systems have altered horses’ natural behavior by decreasing the amount of time horses have access to forage. The objective was to investigate the effects of hay net design on the rate and time to consumption when feeding horses. Eight adult horses were fed in individual boxstalls in a replicated Latin Square design, with two horses per treatment. Horses were fed hay off the box stall floor (control), or from one of three hay nets: large net (LN, 15.2 cm openings), medium net (MN, 4.4 cm openings) and small net (SN, 3.2 cm openings). Horses had access to hay in treatment for two 4 hour periods each day. Stopwatches were used to calculate intake rate and time to consumption. Total forage consumed was calculated by subtracting amount of refuse from hay offered. Data were analyzed by using the Proc Mixed procedure of SAS with statistical significance set at P ≤ 0.05. Mean consumption rates were 1.49, 1.33, 1.11 and 0.88 kg/h (±0.025) for the control, LN, MN and SM, respectively, with all treatments being different from one another (P < .0001). Mean percentage of offered hay consumed was 95, 95, 89 and 72% (± 1.63) for the control, LN, MN and SN, respectively. These results demonstrate that the MN and SN were effective in decreasing both rate and amount of forage consumed by adult horses.

**Evaluating an interspecific Helianthus annuus x Helianthus tuberosus population for use in a perennial sunflower breeding program**

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Perennial crops show promise for sustainable agricultural production tool while providing ecosystem services (maintaining healthy soil, controlling erosion, improving water quality, and enhancing wildlife habitat). Perennial crops could also provide economically viable cropping option to farmers. Sunflower (*Helianthus annuus* L.) is an ideal crop for perennialization because of existing genetic resources and a wide variety of end-uses. The objective of this research was to evaluate interspecific hybrids between perennial *Helianthus tuberosus* L. (2n=6x=102) and annual *Helianthus annuus* L. (2n=2x=34) for perenniality and agronomic traits; assessing their utility in developing a perennial seed crop. Field trials indicated that seed yield traits were
positively correlated with flower traits. Tuber traits, which are required for perenniality, and seed yield traits were not correlated, indicating that simultaneous selection may be able to target high yielding lines that also tuberize. The F1 individuals were intermated for one generation and the intermated F1 (IM1F1) showed increases in flower head size (up to 20%) compared to the best F1 individual. The lack of correlation between tuber and seed traits coupled with phenotypic improvement after one generation of intermating suggest that the best improvement strategy for perennial sunflower is a recurrent selection program focusing on yield.

Movement and genetic studies indicate lakes prone to winter hypoxia function as nurseries for the invasive common carp
Justine Koch, Conservation Biology Graduate Program
Co-authors: Loren Miller (MN DNR) and Peter Sorensen (UMN)

Recent research suggests the common carp (Cyprinus carpio) is often invasive in the North American Midwest due to its propensity to exploit shallow basins prone to winter hypoxia as nurseries. To test this hypothesis we surveyed the fish communities of six interconnected lakes in central Minnesota from 2009 to 2012. Each year, the only sites with large numbers of young-of-the-year carp were the two basins that experienced winter hypoxia. To determine whether these highly productive basins function as a source of recruits to the entire watershed, we investigated carp emigration by marking and releasing 1,360 carp of all ages with individually numbered t-bar anchor tags (n=636) and passive integrated transponder (PIT) tags (n=724). Additionally, we collected tissue samples for genetic analysis from a subset of carp in the proposed nurseries (n=191) and from the main lakes in the chain (n=281). We found direct evidence of movement of individually tagged carp out of the proposed nurseries to connected waters (n=11) as well as genetic evidence that suggests these basins have been functioning as nurseries since the mid-1970s. Microsatellite analysis revealed two genetically distinct populations of carp within the watershed, one population found throughout the nurseries and the main lakes and a second population found exclusively in the main lakes. Continued research on carp movement patterns and population genetics will enhance our understanding of carp ecology and aid in the development of both population models and targeted management strategies to combat this highly invasive and destructive species.

Energizing the Landscape: An economic analysis of conventional and alternative crops in the Mississippi River Watershed
Tom Nickerson
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In 2007, the United States Congress passed the Energy Independence and Security Act (EISA 2007). Within EISA 2007 a Renewable Fuel Standard provision (RFS2) exists, which mandates that thirty-six billion gallons of renewable fuels must become part of the transportation fuel budget by 2022. In addition, only fifteen billion gallons of may come from conventional corn ethanol. This corn ethanol limit means that twenty-one billion gallons of renewable fuels must come from cellulosic and advanced sources.
To meet the requirements of RFS2, many producers will need to make decisions and begin new ventures. This study assesses the economic profiles of cash and energy crops in the Mississippi River Watershed to provide a more transparent view of the economic scenarios for current and future agricultural production. This will be done through the creation of enterprise budgets for four cash crops in this region (corn, soy, winter wheat, and sorghum grain) as well as a leading biomass crop (switchgrass). These databases will then be spatially analyzed to determine potential crop economics.

Examining the economic pathways while working toward greater volumes of biofuels can unearth a variety of potential advantages and pitfalls that have been previously overlooked. At a minimum, delving further into this space will create conversation and discourse around the process of achieving the goal, rather than solely the goal itself.

What role do fungi have in the biofiltration of livestock emissions? Novel approaches to measure their presence and test their performance.

Jason P. Oliver, Ph.D. Student, Dept. of Bioproducts & Biosystems Engineering

The impact of livestock production and manure management on air quality is an increasingly recognized and significant problem. The United Nations claims animal agriculture is a primary cause of environmental pollution, greenhouse gas production and human health problems globally. Wood chip biofilters (WCBs) have the potential to treat these complex emissions, but removal efficiencies are variable. Expanding the capabilities of WCBs and developing effective management practices requires a better understanding of how microbial communities residing in biofilter media affect emissions reductions. Most research investigating the link between microbial ecology and function in WCBs has focused on prokaryotes and neglects the potential importance of fungi in these systems. We hypothesize that fungi are crucial to WCB performance and can facilitate improvements in capture due to their aerial, filamentous growth and tolerance to desiccation. By both monitoring the role of fungi in full-scale biofilters, and testing their performances in bench-scale biofilters we aim to shed light on the role of fungi in WCBs and improve the ability of these technologies to mitigate emissions from livestock operations. Here we demonstrate successful adaptation of ergosterol and chloroform fumigation extraction techniques to measure fungal: total microbial biomass on biofilter media and present preliminary data from bench-scale fungal biofilter trials.

Effects of browsing by white-tailed deer on understory community composition and tree regeneration in old-growth restoration treatments in northern hardwood forests

Laura Reuling
Natural Resources Science and Management

As researchers realize the value of old-growth forests and their unique attributes and dynamics, managers have begun developing management regimes aimed at restoring old-growth characteristics in forests managed for wood products. This includes encouraging gap-phase natural regeneration. However, modern challenges including presence of invasive plant species and overbrowsing by high populations of white-tailed deer can have major effects on regeneration and understory community composition in general. The objective of this research
was to determine the effects of browsing by white-tailed deer in several old-growth restoration treatments and on tree regeneration and understory community composition in northern hardwood forests in northern Wisconsin. Community composition and tree regeneration were measured in stands with six different silvicultural treatments replicated across three large study areas (> 50 ha). Treatments were developed to emulate natural disturbance regimes and included multiple small (25 m²) deer exclosures. Assessment of cover by herbaceous plants and seedlings indicated that browsing by deer had some effect on community composition. Species richness was significantly lower inside exclosures than outside, although several browse sensitive species including *Trillium* spp. were largely restricted to exclosures. Overall the density of established tree seedlings was higher inside exclosures, but there were significant regeneration differences between silvicultural treatments. These results underscore the importance of accounting for herbivory impacts when implementing natural disturbance-based silvicultural treatments.

**Factors affecting detection of recorded bird songs in mid-continent grasslands**

Elizabeth A. Rigby, Department of Fisheries, Wildlife and Conservation Biology

Additional author: Douglas H. Johnson

Bird surveys are an easy and common way to quantify biodiversity, but many factors affect the number of birds counted on a given survey. These effects are poorly understood, particularly in grasslands. We broadcast taped songs of ten grassland bird species and recorded detections at mixed-grass prairie sites in Minnesota. Detections were recorded at 35 sites by 1 observer in 2011 and at 12 sites by 4 simultaneous observers in 2012. Detection or non-detection of each broadcast song was used as the binary response variable in logistic regression analyses with site as a random effect. We analyzed species separately and examined five potential covariates of detection: distance from sound source, indices of wind speed and direction and habitat structure, observer-identified presence of masking noise, and observer identity (for sites with multiple observers). Detection varied most due to distance from sound source and wind speed and direction. For the single observer in 2011, probability of detection averaged \( p = 0.65 \) over all species and ranged from \( p = 0.26 \) for Le Conte’s sparrow (*Ammodramus leconteii*) songs to \( p = 0.85 \) for eastern meadowlark (*Sturnella magna*). Probability of detection decreased linearly with distance for all species. Mean probability of detection 30 m from the sound source ranged from \( p = 0.74 \) (Le Conte’s sparrow) to \( p = 1 \) (6 species), compared to \( p = 0.04 \) (Le Conte’s sparrow) to \( p = 0.55 \) (vesper sparrow, *Pooecetes gramineus*) at 150 m. Probability of detection differed among observers and was highest for experienced observers.

**Monitoring the fate of Applied Nitrogen on Irrigated Sandy Soils in Minnesota**

John Rubin, Masters student, Land and Atmospheric Science

A significant amount of Minnesota cropland is located on glacial outwash sands and is therefore irrigated due to low water holding capacity. These acres are some of the most productive and environmentally sensitive areas in Minnesota, so obtaining information on nitrogen use efficiency is critical for corn (*Zea mays* L.) grown on these soils. Corn was grown at two locations on sandy soils in Minnesota. Nitrogen was broadcast as split applications of urea at rates of 0, 40, 80, 120, 160, 200, 240, and 280 lbs. /acre. The first application was done at
planting and the second at the V3 growth stage. A randomized complete block with four replications was used at both field sites. In-season measurements of NDVI and leaf chlorophyll were taken at the V8 and V12 growth stages. Plant masses and tissue analysis for nitrogen was also done at the V8 and V12 growth stages. Ceramic cup lysimeters were installed at a four foot depth at one site to measure nitrate levels in water leached below the root zone. Results showed increases in plant mass, NDVI, and leaf chlorophyll with increased nitrogen rates. Yield benefits of applying additional nitrogen diminished between the 200 and 240 lb. /acre nitrogen rates. Leachate collected in lysimeters from plots with higher applied nitrogen rates often had higher nitrate-N concentrations. Regardless of nitrogen treatment, leachate tended to be higher in nitrate-N later in the growing season.

**Understanding survival, cause-specific mortality, and habitat relationships for moose (Alces alces) calves in northeastern Minnesota**

Bill Severud, Natural Resources Science and Management-Wildlife Ecology and Management

Adult survival is an important driver of large herbivore population dynamics; however, low and variable recruitment also can have a strong influence on population trajectory. The northeastern (NE) Minnesota moose population has been exhibiting a downward trend since 2005. Neonate and seasonal survival rates and specific causes of mortality (e.g., predation, undernutrition, disease) of calves are largely unknown. The greatest hazard relative to survival occurs within the first 3-4 months of life for ungulates. The goal of my research is to improve our understanding of calf production, seasonal and annual survival rates, and specific causes of mortality in NE Minnesota. I will estimate seasonal and annual calf survival rates, and investigate and determine proximate and ultimate causes of mortality and factors contributing to calf vulnerability. I will also estimate seasonal home ranges of survivors and non-survivors and compare respective habitat compositions, and examine movement patterns of surviving and non-surviving calves and their dams to detect potential temporal and spatial differences in proximity and use of habitat. Fifty neonates will be fitted with GPS collars during spring 2013 and tracked intensely throughout their first year. We will retrieve collars from calf mortalities to deploy on at least 25 neonates in spring 2014. Identifying specific causes of calf mortality and understanding their relations to various landscape and other extrinsic factors should yield insight into mechanisms contributing to the declining moose population in northeastern Minnesota and serve as a basis for an ecologically-sound management response.

**Warfare on wood: How global warming is shaping wood-degrading fungi and their functions**

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Other authors: Jonathan Schilling, Dept of Bioproducts and Biosystems Engineering

Wood decomposition is primarily fulfilled by brown rot and white rot fungi in temperate and boreal forests. The balance between these fungi determines the patterns of wood decomposition and carbon cycle in forests. But this balance may shift in a warmer environment, especially in high latitude. In this study, paper birch and two common fungi are used as a model system to study the effect of warming on fungal competition and their consequences.
A microcosm system was used to simulate competition between *Piptoporus betulinus* (brown rot fungi) and *Fomes fomentarius* (white rot fungi) on small birch stem in the presence/absence of its endophytes. Microcosms were incubated in 25°C and 30°C for five months. Samples were tested for mass loss, water content, dilute alkaline solubility and pH. Quantitative PCR were used to obtain relative abundance of *P. betulinus* and *F. fomentarius*.

The activity of *P. betulinus*, the brown rot, was reduced in higher temperature, but the white rot fungi *F. fomentarius* was unaffected. Character of residue showed that when both fungi were present, wood tend to have white rot in higher temperature. Higher temperature also tends to shift the community of endophyte toward more white rot fungi. Our study indicated that brown rot fungi are more susceptible to higher temperature than white rot fungi, which is in accordance with the theory that brown rot evolved to adapt to colder environment. Further studies on temperature and endophyte will deepen our understanding on forest carbon cycle under the influence of global change.

*Spatial modeling of post-settlement alluvium with local and upslope terrain characteristics*

An-Min Wu, PhD candidate in Land and Atmospheric Science Program, Department of Soil, Water, and Climate

Human disturbance has dramatically affected soil properties and processes. Native prairie and forests in Minnesota’s Des Moines Lobe region, a young glaciated region with closed depressions, were nearly all converted to cropland following European settlement. It has generally been assumed that tillage intensifies soil erosion and accelerates oxidation of soil organic carbon (SOC) and the subsequent release of carbon dioxide to the atmosphere. However, recent studies suggest that eroded sediments, or post-settlement alluvium (PSA), redistribute to low-lying areas, and burial of SOC by PSA may serve as a carbon sink. The distribution of PSA critical for SOC dynamics is not yet known. My goal is to understand PSA distribution and quantity in relation to topographic controls in this region. Although commonly applied in spatial modeling, terrain attributes (TAs) are mostly limited to those created in local 3x3 neighborhoods. TAs in upslope contributing areas (UCA) relevant to flow-related processes (ex. erosion) were hardly used. My objectives are 1. to develop variables representing UCA TAs for soil-landscape modeling, and 2. to predict distribution and amount of PSA in this depressional landscape. I observed PSA occurrence and thickness in soil profiles on transects at the Lake Rebecca Park Reserve. Local TAs, including elevation, slope, catchment area, curvature, wetness index and stream power index, were developed from LiDAR digital elevation models. Spatial UCA TAs for each sampling site were carefully queried and investigated. Correlations between PSA thickness and UCA in thresholds of slope and profile curvature were identified and used for spatial PSA modeling.

*Sub-lethal effects of neonicotinyl insecticides on honey bee (Apis mellifera L.) queens and colony development*

Judy Wu, Department of Entomology
Bees provide crucial pollination services for natural and managed agriculture systems. In recent years, both wild and managed bee populations have declined. Neonicotinoid insecticides are highly toxic to insects and are systemically translocated to all parts of a treated plant including nectar and pollen. These insecticides are readily used on crops, trees, and ornamental plants visited by bees. Bees become exposed to neonicotinoids while foraging and may return to their hive with contaminated resources. The main objective of this project is to determine if and how neonicotinyl insecticide exposure might contribute to honey bee colony decline. We analyzed sub-lethal effects of neonicotinyl exposure to honey bee colonies on individual bees (queens and workers) and on the colony. We examined queen fecundity and locomotive activity, brood development, and foraging rates in observation hives treated at varying levels of imidacloprid (one active ingredient within this class of insecticides). Preliminary data suggest adverse effects of imidacloprid exposure on queen egg-laying ability, queen locomotive activity, worker foraging activity, and on brood production. This study will improve our understanding of how neonicotinoids may impact core functions, reproduction, growth and development, of honey bee colonies.

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