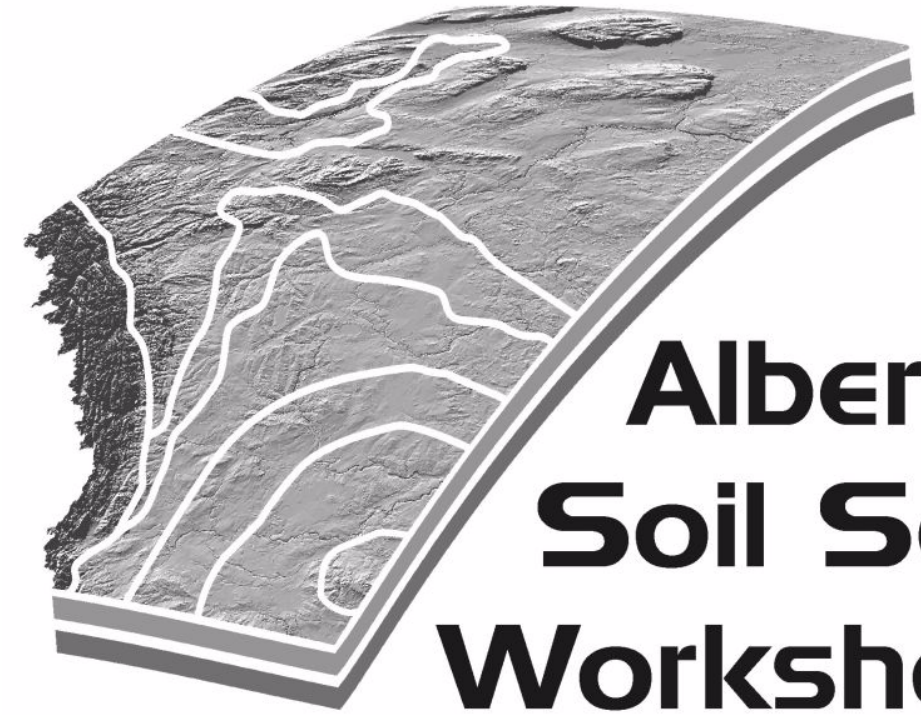
Program for the 52nd Annual



Alberta Soil Science Workshop

Workshop Theme:

The International Year of Soils

February 17 to 19, 2015

Four Points Sheraton on Argyll
7230 Argyll Road
Edmonton, AB

www.soilsworkshop.ab.ca

About the Alberta Soil Science Workshop

Background

The Alberta Soil Science Workshop is held to facilitate regional interaction among professionals in soil science. Typically 100 to 150 participants gather for a 1½ to 2 day program that comprises 40 to 60 oral and poster presentations. These include: keynote papers focussed on the workshop theme, technical papers within four distinct fields, and volunteer papers. Currently the four technical groups are: Land Use, Soil Fertility, Land Reclamation, and Forest, Riparian and Wetland Soils.

Workshop participants include a diversity of professionals from private industry (e.g. consultants in agronomy, pedology, reclamation, remediation, and environmental services; chemists from commercial analytical laboratories), government (federal, provincial, municipal) and academia (universities and colleges). The Workshop is graduate student-friendly, providing an excellent opportunity to enhance presentation skills in a supportive setting (travel bursaries are available for out-of-town students; awards are made for the best student presentations).

Organizing Committee for the 2015 Alberta Soil Science Workshop

Past Chair:	Jay Woosaree Alberta Innovates – Technology Futures, Vegreville, AB
Chair:	Derek MacKenzie Dept. Renewable Resources, Univ. of Alberta, Edmonton, AB
Treasurer:	Amanda Schoonmaker NAIT Boreal Research Institute, Peace River, AB
Secretary:	Preston Sorenson Solstice Canada, Edmonton AB

Chairpersons for Technical Groups:

Soil Fertility:	Len Kryzanowski Alberta Agriculture & Rural Development, Edmonton, AB
Land Use:	Karen Raven Alberta Agriculture and Rural Development, Edmonton, AB
Land Reclamation:	Deo Heeraman and Jay Woosaree AMEC-Foster Wheeler, Calgary, AB Alberta Innovates – Technology Futures, Vegreville, AB
Forest, Riparian & Wetland Soils:	Bin Xu NAIT Boreal Research Institute, Peace River, AB
Pedogenesis & Soil Inventory:	Konstantin Dlusskiy Paragon Soil and Environmental Consulting, Edmonton, AB

Program - 2015 Alberta Soil Science Workshop

Overview

Tuesday, February 17, 2015

3:00 – 5:00 PM	**QGIS Short Course**
7:00 – 10:00 PM	**Evening Reception and Registration**

Wednesday, February 18, 2015

7:00 AM – 5:30 PM	**Registration**
7:00 – 8:00 AM	**Breakfast**
8:05 – 11:55 AM	**Plenary Session** **The International Year of Soils**
9:45 – 10:15 AM	**Coffee and Refreshments**
11:55 – 1:00 PM	**Lunch**
1:00 – 4:10 PM	**Concurrent Sessions (Oral Presentations):** **Volunteer Session 1** **Volunteer Session 2**
2:30 – 3:00 PM	**Coffee and Refreshments**
4:15 – 6:00 PM	**Poster Session**
4:30 – 9:00 PM	**Cash Bar**
6:00 – 10:00 PM	**Banquet and Entertainment**

Thursday, February 19, 2015

7:00 – 8:00 AM	**Breakfast / Day Registration**
8:00 – 9:30 AM	**Technical Sessions:** **Reclamation Technical Session** **Land Use Technical Session**
9:30 – 10:00 AM	**Coffee and Refreshments**
10:00 – 11:45 AM	**Technical Sessions:** **Soil Fertility Technical Session** **Wetland and Riparian Soils Technical Session**
11:45 – 1:30 PM	**Lunch and ASSW Business Meeting**

Detailed Program

Wednesday, February 18, 2015
Plenary Session

8:00 – 8:05 AM **Welcome and Introduction**
Chair: **Derek MacKenzie**, University of Alberta

8:05 – 8:55 AM **Soil and Society**
Rattan Lal, Professor, Carbon Management and Sequestration Center, The Ohio State University, Columbus, OH

8:55 – 9:45 AM **Soil Carbon in Temperate and Boreal Ecosystems: First, Do No Harm**
Thomas H. DeLuca, Professor and Director, School of Environmental and Forest Sciences, University of Washington, Seattle, WA

9:45 – 10:15 AM **Coffee and refreshments**

10:15 – 11:05 AM **Underground tree talk: the roots of forest resilience**
Suzanne Simmard, Professor, Department of Forest and Conservation Sciences, The University of British Columbia, Vancouver

11:05 – 11:55 AM **Soil Moisture and Hydrology in Western Canada**
John Pomeroy, Canada Research Chair in Water Resources and Climate Change, Centre for Hydrology, University of Saskatchewan, Saskatoon, SK

Wednesday, February 18, 2015 – Afternoon
Concurrent Sessions

***Graduate Student Presentations**

PM	**Volunteer Session 1 – Oral Presentations**	**Volunteer Session 2 – Oral Presentations**
1:00 – 1:05	Introduction	Introduction
1:05 – 1:25	Evaluation of Nutrient and Irrigation Management BMPs in Southern Alberta **Janna Casson, Jollin Charest, Lynda Miedema, Barry Olson** Alberta Agriculture and Rural Development, Lethbridge, AB	Long-term Research on Irrigated Cropping Systems **Benjamin Ellert, Henry Janzen and Elwin Smith** Agriculture and Agri-Food Canada, Lethbridge, AB
1:25 – 1:45	The Private Cost of Adopting BMPs **Marius Cutlac, Marian Weber, Peter Boxall, Wanhong Yang, and Yongbo Liu** Alberta Innovates – Technology Futures, Calgary, AB	Long Term Influence of Manure Type and Bedding Material on Soil Mesofauna **Jeff Battigelli** Stantec Consulting, Edmonton, AB **Jim Miller and Bruce Beasley** Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB
1:45 – 2:05	Soil Characteristics in Life Cycle Assessment of Agri-Food Production **Aung Moe, Kerrianne Koehler-Munro, Roger Bryan, Tom Goddard and Len Kryzanowski** Alberta Agriculture and Rural Development, Edmonton, AB	Wood ash improves soil properties and crop yield up to 7 years after applications and saves fertilizer **Kabal S. Gill & JP Pettyjohn** Smoky Applied Research & Demonstration (SARDA), Falher, AB.
2:05 – 2:30	A Method for Determining Community Level Physiological Profiles of Organic Soil Horizons **Mathew J.B. Swallow** Department of Environmental Science, Mount Royal University **Sylvie A. Quideau** Department of Renewable Resources, University of Alberta	Can agroforestry enhance carbon sequestration and mitigate GHG emissions in Canada's agricultural landscape? **Mark Baah-Acheamfour and Scott X. Chang** Department of Renewable Resources, University of Alberta, Edmonton, AB **Edward W. Bork and Cameron N. Carlyle** Department of Agricultural, Food and Nutritional Science, University of Alberta, Agriculture/Forestry Centre, Edmonton, AB

2:30 – 3:00
Coffee break

3:00 – 3:20	Predictive Mapping of Soils in Ireland - a Model for Updating Soil Maps in Alberta? **Gero Jahns** Integrated Environments (2006) Ltd., Calgary, Alberta, Canada **Rachel Creamer and Iolanda Simo** Teagasc - Environment, Soils and Land-use Centre, Johnstown Castle, Wexford, Ireland. **Chris Evans** Integrated Environments (2006) Ltd., Calgary, Alberta, Canada	
3:40 – 5:30	**Poster Session**	

Poster Session
Wednesday, February 18, 2015, 4:05 – 6:00 PM

***Graduate Student Posters**

1	**Modelling Interacting Effects of Invasive Earthworms and Wildfire on Forest Floor Carbon Storage in the Boreal Forest** **Cindy Shaw, Stephen Kull** Natural Resources Canada, Canadian Forest Service, Edmonton, AB **Erin Cameron, Erin Bayne** Department of Biological Sciences, University of Alberta, Edmonton, AB **Werner Kurz** Natural Resources Canada, Canadian Forest Service, Victoria, BC
2	**Calibration of Forest Soil Carbon Modeling Parameters Using Probabilistic Inversion** **Cindy Shaw, Arlene Hilger** Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, AB **Sasha Hararuk, Werner Kurz** Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC
3	**Impact of Industrial Development on the Forest Carbon Budget in the Athabasca Oil Sands Region: A Pilot Study** **C. Shaw, S. Rodrigue, M. Voicu** Natural Resources Canada, Canadian Forest Service, Edmonton, AB **W.A. Kurz** Natural Resources Canada, Canadian Forest Service, Victoria, BC **Bin Xu and Amanda Schoonmaker** NAIT Boreal Research Institute, Peace River, AB **Shari Hayne** Environment Canada, Gatineau, QC
4	**Carbon dynamics on agricultural woody land transitions** **Mihai. Voicu, Cindy Shaw** Natural Resources Canada, Canadian Forest Service, Edmonton, AB **Werner Kurz, Max Fellows, Scott Morken, Gary Zhang** Natural Resources Canada, Canadian Forest Service, Victoria, BC **Ted Huffman, Jiangui Liu** Agriculture and Agri-Food Canada, Eastern Cereal and Oilseed Research Centre, Ottawa, ON **Darrel Cerkowniak** Agriculture and Agri-Food Canada, Saskatoon Research Centre Saskatoon, SK
5	**Preliminary Assessment of Nitrous Oxide Emissions, Soil Temperature and Soil Oxygen Concentrations following Fall Manure Injections** **Sisi Lin, Guillermo Hernandez Ramirez, Huping Hou** Department of Renewable Resources, University of Alberta, Edmonton, AB **Len Kryzanowski, Trevor Wallace, Craig Sprout, Germar Lohstraeter, Leigh-Anne Powers** Alberta Agriculture and Rural Development, Edmonton and Lethbridge, AB

6	**Responses of herbage P, Ca, K and Mg content and Ca/P and K/(Ca+Mg) ratios to long-term continuous and discontinued cattle grazing management on a rough fescue grassland** **Xinlei Gao, Xiying Hao, Douglas H. Marchbank*, Ryan Beck, and Walter D. Willms** Agriculture and Agri-Food Canada, Lethbridge, AB **Mengli Zhao** Inner Mongolia Agricultural University, Hohhot, Inner Mongolia, PR China
7	**Coarse-Textured Soil Reclamation in the Athabasca Oil Sands Region: A Soil Quality Approach.** **William Barnes and Sylvie Quideau** Department of Renewable Resources, University of Alberta, Edmonton, AB **Mathew Swallow** Department of Environmental Science, Mount Royal University, Calgary, AB
8	**Conservation Cropping System Adoption in Alberta's Brown soil Zone** **Rob Dunn (retired), Wally Sawchuk** Alberta Agriculture and Rural Development, Lethbridge, AB
9	**Spatial variability in nutrient availability and CO_2 efflux in oil sands reclaimed and benchmark upland boreal forest ecosystems** **Sebastian T. Dietrich, Sanatan Das Gupta and M. Derek MacKenzie** Department of Renewable Resources, University of Alberta, Edmonton, AB
10	**The effectiveness of subsoiling on improving soil physical and hydraulic properties of a reclaimed coal mined soil** **Christina Hebb, Guillermo Hernandez-Ramirez and Miles Dyck** Department of Renewable Resources, University of Alberta, Edmonton, AB
11	**Laboratory-Measured Soil Organic Carbon Mineralization in Soil Samples from Six Long Term Crop Rotations in Alberta as a Function of Sample Disturbance** **Kyle Kipps, Miles Dyck and Sylvie Quideau** Department of Renewable Resources, University of Alberta, Edmonton, AB **Henry Janzen** Agriculture and Agri-Food Canada, Lethbridge, AB

Banquet and Entertainment, 6:00 – 10:00 PM

Thursday, February 19, 2015 – Morning
Concurrent Technical Sessions

***Graduate Student Presentations**

AM	**Forest, Riparian and Wetland Soils Technical Session**	**Land Use and Conservation Technical Session**
8:00 – 8:05	Introduction **Chair: Amanda Schoonmaker** NAIT Boreal Research Institute	Introduction **Chair: Karen Raven** Alberta Agriculture and Rural Development, Edmonton, AB
8:05 – 8:25	Responses of Nutrient Dynamics to Warming and Water Table Lowering Simulations of Climate Change in a Northern Treed Bog **Tariq M. Munir** Geology, St. Mary's University **Bin Xu** Boreal Research Institute, Northern Alberta Institute of Technology, Peace River, AB **Maria Strack** Department of Geography and Environmental Management, University of Waterloo	The Land-use Framework: An updated look six years later **Jason Cathcart** Alberta Agriculture and Rural Development, Edmonton, AB
8:25 – 8:45	Seasonal Groundwater Variation in a Mineral Soil Wetland **Ivan Whitson** Edmonton, AB	From mammals to mites: Biodiversity Management Frameworks for Alberta's Land Use Planning Regions **Shannon R. White, Jim Herbers, Jasmine Janes and Sarah Depoe** Land-Use Framework Regional Planning Branch, Environment and Sustainable Resource Development, Government of Alberta
8:45 – 9:05	The fractal characteristics of soil particle size distribution in tidal flats in the Yellow River Delta **Xiaofei Lyu** Key Laboratory of Coastal Environmental Processes and Ecological Remediation, Yantai Institute of Coastal Zone Research (YIC), Chinese Academy of Sciences (CAS), Yantai 264003, China University of Chinese Academy of Sciences, Beijing 100049, China **Scott Chang** Department of Renewable Resources, University of Alberta	Conservation Offset: A Tool for Land Management **Anish Neupane** Alberta Environment and Sustainable Resource Development

	Land Reclamation Technical Session Chair: Deo A. Heeraman	
9:05 – 9:25	Case studies of evaluating soil microbiota on reclaimed sites in the Oil Sands Region **Mel Zwierink, Marcie Plishka and Collen Middleton** Golder Associates Ltd., Calgary, Alberta **Leila Oosterbroek, Bryon Shore and Lyriam Marques** HydroQual Laboratories, Calgary, Alberta	Promoting Efficient Use of Land in Alberta's municipalities **Anthony Hamilton** Land Use Secretariat (Government of Alberta), Edmonton, AB
9:25 – 9:45	Efficacy of Biochar On Remediation Of Metal Contamination In Oil Sands Process-Affected Water **Kangyi Lou** Department of Renewable Resources, University of Alberta **Anushka Upamali Rajapaksha** Korea Biochar Research Center, Kangwon National University, Korea **Yong Sik Ok** Korea Biochar Research Center, Kangwon National University, Korea **Scott Chang** Department of Renewable Resources, University of Alberta	Land Fragmentation and Conversion in Alberta **David Spiess, David Hildebrand, Reuben Joosse, and Jason Cathcart** Alberta Agriculture and Rural Development, Edmonton, AB

9:45 – 10:15 AM Coffee and Refreshments – Emerald Ballroom

	Land Reclamation Technical Session	**Soil Fertility Technical Session**
10:15 – 10:20	Introduction **Chair: Deo A. Heeraman** AMEC-Foster Wheeler, Calgary AB	Introduction **Chair: Len Kryzanowski** Alberta Agriculture and Rural Development, Edmonton, AB
10:20 – 10:40	A Comparison of Site Preparation Methods on Sub-Surface Soil Resistance and Moisture on Reclaimed Industrial Sites in NW Alberta. **Marc Mayhew, Alan Pollock** Northern Alberta Institute of Technology, Edmonton, AB **Amanda Schoonmaker** NAIT Boreal Research Institute, Peace River, AB	Nutrient changes in Luvisol and crop production with four annually repeated six soil test based fertilizer rates **K. S. Gill & JP Pettyjohn** Smoky Applied research & demonstration Association (SARDA), Falher, AB
10:40 – 11:00	Coarse Woody Debris Increased	Factors Influencing the Relationship of Ion

	Microbial Activity but Did Not Affect Soil Enzyme Activity in Cover Soils for Oil Sands Reclamation **Jin-Hyeob Kwak, Scott X. Chang and M. Anne Naeth** Department of Renewable Resources, University of Alberta **Wolfgang Schaaf** Soil Protection and Recultivation, Brandenburg University of Technology Cottbus-Senftenberg, Germany	Exchange Membrane (PRS Probe) Measurements to Extractable Nutrient Concentrations **Eric Bremer and Kishari Sooriya Arachchilage** Western Ag Innovations, Lethbridge, AB and Saskatoon, SK
11:00 – 11:20	Soil amendments for Boreal forest reclamation on fine-textured soils **Amanda Schoonmaker** NAIT Boreal Research Institute, Peace River, AB **Dani Degenhardt and Bonnie Drozdowski** Alberta Innovates Technology Futures, Edmonton, AB	Early growing season soil nutrient supply and mid-season NDVI predicts grain yield **Dick Puurveen and Miles Dyck** Department of Renewable Resources, University of Alberta **Eric Bremer** Western Ag Innovations, Lethbridge, Alberta
11:20 – 11:40	Nursery Nutrient Loading Promotes Growth of Jack Pine Seedlings Planted in Oil Sands Reclamation **Prem Pokharel, Stephanie Ibsen, Jin-Hyeob Kwak, Gulam Murtaza Jamro, Kangyi Lou & Scott X. Chang** Department of Renewable Resources, University of Alberta	Balanced fertilization for increased productivity and reduced soil GHG emissions in sulfur-deficient soils **Miles Dyck, Mekonnen Giweta, S. S. Malhi and D. Puurveen** Department of Renewable Resources, University of Alberta
11:40 – 12:00	Inclusion of soil biodiversity metrics in environmental impact and ecosystem function assessments - perspectives from the consulting industry **Marshall McKenzie** Alberta Innovates – Technology Futures, Vegreville, AB **Mel Zwierink and Collen Middleton** Golder Associates Ltd., Calgary, Alberta **Lyriam Marques** HydroQual Laboratories, Calgary, Alberta	Influence of Feedlot Manure Type and Bedding Application on Feed Barley Agronomy and the Environment **Jim Miller and Bruce Beasley** Agriculture and Agri-Food Canada

12:00 – 1:30 PM Lunch and ASSW Business Meeting
Emerald Ballroom

Plenary Session

Wednesday, February 17, 2015 – Morning

Soil and Society

Rattan Lal
Carbon Management and Sequestration Center, The Ohio State University,Columbus, OH

Correspondence: lal.1@osu.edu

Abstract
The 68th UN General Assembly declared 2015 the International Year of Soil (IYS 2015). Among others, the principle objectives of IYS are to create full awareness of civil society and decision makers about the fundamental roles of soils for human's life, and to promote effective policies and actions for the sustainable management and protection of soil resources. Indeed, sustainable management and restoration of soils are essential to food and nutritional security, climate change adaptation and mitigation, renewable freshwater supply and quality, biodiversity, energy security, poverty alleviation, and sustainable development. Despite major improvements in agronomic production since 1960s, 805 million (~11% of the world population) are food insecure, and several billion are prone to hidden hunger. Almost, one-third of world's soils are degraded by accelerated erosion; excessive depletion of C, N, and major plant nutrients; salinization; acidification and other processes. Since the dawn of settled agriculture about 10 millennia ago, soils of agroecosystems have been source of greenhouse gases. However, restoration of degraded soils and adoption of agroecosystems, which create a positive C budget, can make soils a sink of atmospheric CO_2. In addition to offsetting a part of the anthropogenic emissions, soil C sequestration is important to providing numerous ecosystem services essential to human wellbeing and nature conservancy. Soil must be integral to any agenda to mitigate climate change, improve the environment and advance food security. Soil restoration and sustainable management are indispensible to achieving global peace and political stability. Thus , soil stewardship and care must be embedded in every fruit and vegetable eaten ,in each grain ground into the bread consumed, in every cup of water used, and in every breath of air inhaled.

Soil Carbon in Temperate and Boreal Ecosystems: First, Do No Harm

Thomas H. DeLuca
Professor and Director, School of Environmental and Forest Sciences, University of Washington, Seattle, WA

Correspondence: deluca@uw.edu

Abstract
Human induced CO_2 loading of the atmosphere has increased interest in mechanisms for mitigation schemes based on storage of C in terrestrial plants and soils. While this may make sense from a perspective of soils being the largest terrestrial body of C on Earth, it ignores the importance of soil C in promoting soil physical, chemical and biological properties and it ignores the likelihood that soils may represent a net source of CO_2 (eq) in a warming planet. Soil C is a dynamic and ever changing soil attribute that defines the biotic potential of a landscape, yet it is also subject to the whim of human and natural disturbance. In recognition of the International Year of Soils, this talk will focus on global, regional and local examples of how disturbance or climatic change may alter soil C in forest and prairie ecosystems and how that change will influences the sustainability of these systems. Specific attention will be paid to: (1) The boreal biome (with its ~1,700 Pg of soil C) and its potential to serve as a C source or sink; (2) The Great Plains prairie ecosystems and the rapid conversion of 120 million ha of native sod to row crop monocultures at the turn of last Century; (3) Temperate coniferous forests and the potential for altered C storage with shifting fire regimes. Future land management choices will dictate the capacity to build, maintain or lose soil C in a warming world, the outcome of which will have a direct impact on the resilience of our forest and agricultural ecosystems. Our oath to soils should be: First, do no harm!

Underground tree talk: the roots of forest resilience

Suzanne Simard
Department of Forest and Conservation Sciences, The University of British Columbia, Vancouver

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Abstract
Nature emerges from the myriad of interactions among plants, animals, fungi and microbes – many hidden in soils. We are discovering that these belowground interactions are highly sophisticated, involving interplant biochemical signaling and resource transfer through mycorrhizal networks. Mycorrhizal networks are webs of beneficial fungal species linking plant symbionts underground. They serve as a dynamic pathway for continuous back-and-forth movement of carbon, nutrients and other chemicals between plants, and support complex communities of soil animals and microbes responsible for nutrient cycling. We have come to the startling realization that these network-mediated interactions are a form of social communication, and this communication is crucial to the organization of forest ecosystems. For example, carbon, nitrogen and water that is transferred from old trees to nearby regenerating seedlings via mycorrhizal networks improves the survivorship and growth of the seedlings, especially if they are kin seedlings. Additionally, lethal injury to the old trees from insects or disease results in massive carbon transfer to the neighbouring seedling, akin to legacy transfer. It also triggers defense signaling so the seedlings can increase their defense resistance against the invading pests. This communication through mycorrhizal networks thus affects both the birth and death dynamics of trees, and hence the resilience of our forests.

Soil Moisture and Hydrology in Western Canada

John Pomeroy
Canada Research Chair in Water Resources and Climate Change, Centre for Hydrology, University of Saskatchewan, Saskatoon, SK

Correspondence: john.pomeroy@usask.ca

Abstract
Soil moisture is an incredibly important mediator of hydrology in western Canada as it plays a major role in apportioning rainfall and snowmelt into runoff, storage and evapotranspiration. The presence of seasonally frozen soils in the Canadian Prairies is associated with the largest runoff and streamflow generation events and permafrost soils in the North control streamflow generation throughout the summer. Important characteristics of soil moisture for hydrology are its spatial distribution, the influence of soil texture and structure, and the potential to manage soil hydraulic characteristics through tillage and landcover management. The physical principles that govern infiltration and runoff generation as influenced by soil hydraulic properties including frozen soils will be reviewed along with their management potential. The varying interaction of soil moisture and hydrological processes during recent droughts and floods in the Prairie Provinces will be discussed. Uncertainties in the hydrological and water quality response to minimum tillage systems are presently a key debate in western Canadian hydrology that will be explored.

Volunteer Session 1
Wednesday, February 18, 2015 – Afternoon

Evaluation of Nutrient and Irrigation Management BMPs in Southern Alberta

Janna Casson, Jollin Charest, Lynda Miedema, Barry Olson
Alberta Agriculture and Rural Development, Lethbridge, AB

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Abstract
The ability of the agricultural industry in Alberta to adopt beneficial management practices (BMPs) is critical to meet current and future environmental, social, and economic expectations. The Nutrient BMP Evaluation Project was a 6-yr study conducted to evaluate the effectiveness of selected BMPs in Alberta. As part of this study, two irrigated field sites (65 and 130 ha) with a history of heavy cattle manure applications were selected. The concern at these sites was the elevated soil test phosphorus (STP) concentration and high concentration nutrients, sediments, and bacteria in edge-of-field runoff. The BMPs were selected to address the source and the transportation of nutrients from land to water. Practice change included cessation of manure application, nutrient management plan, grassed channel, modification of irrigation system, and irrigation scheduling. The Battersea Drain Field (BDF) and Lower Little Bow (LLB) sites were monitored for 2-yr prior to BMP implementation and 3- to 4-yr post-BMP. Surface water quality samples were collected during snowmelt, rainfall, and irrigation runoff and were analyzed for nitrogen, phosphorus, sediment, and bacteria concentrations. Surface soil samples (0- to 15-cm) were collected each spring and fall and were monitored for nitrogen (NO_3-N and NH_4-N) and STP concentrations.

After nutrient management and irrigation BMPs were implemented at the BDF and LLB sites, overall post-BMP nutrient, sediment, and bacteria concentrations were significantly lower than in the pre-BMP period. Soil NH_4-N was significantly reduced in the post-BMP period at the BDF and LLB sites; however, the STP was not reduced and several more years without manure application would be required to reduce STP through crop removal to a more desirable level.

The Private Cost of Adopting BMPs

Marius Cutlac, Marian Weber, Peter Boxall, Wanhong Yang, and Yongbo Liu
Alberta Innovates – Technology Futures, Calgary, AB

Corresponding author: marius.cutlac@albertainnovates.ca

Abstract
A defining feature of environmental farm planning programs is that they rely on voluntary participation. Also, in many cases, funding is available under cost-sharing schemes, where producers are required to contribute their own funds to implement the program. Although total funding depends on the perceived public benefits, or budget constraints, the funding of a specific project and its uptake depends exclusively on farmer's assessment of how such funds compensate the costs of adoption. These costs are truly known only to the farmers, and vary significantly due to spatial and temporal heterogeneity in land characteristics and production profiles. This paper develops supply functions for nutrient abatement by estimating the farmer's private costs of adoption of BMPs and linking it to changing nutrient loads through imWEBS, a spatially explicit model that links farm level BMPs to farm level nutrient loads which are then fed into a SWAT model. An extensive dataset is used, covering 16 years of agricultural practices (crop choice, yield, and management inputs) in the South Tobacco Creek watershed in Southern Manitoba. A farm behavior model is build, and used to evaluate field, farm, and watershed level adoption costs for five BMPs: zero tillage, riparian buffers, holding ponds, forage conversion, and wetland restoration. This research is intended to provide public institution that runs conservation programs with much needed information about the adoption costs of BMPs.

Soil Characteristics in Life Cycle Assessment of Agri-Food Production

Aung Moe, Kerrianne Koehler-Munro, Roger Bryan, Tom Goddard and Len Kryzanowski
Alberta Agriculture and Rural Development, Edmonton, AB

Corresponding author: aung.moe@gov.ab.ca

Abstract
Life cycle assessment (LCA) is being increasingly used to evaluate potential environmental impacts of agri-food production systems. Despite the increased applications to agriculture, there is a lack of consideration of soil characteristics due to spatial and temporal variability of soil properties and complexity of interactions with climate and agricultural management practices. Characterization factors to quantify soil-related impacts need to be developed for agricultural LCA because soil function and quality play a significant role in agricultural productivity and ecosystem sustainability. In LCA methodology, soil function and quality are generally considered within the land use impact category which covers the actual use of land (land occupation) and changes in land use (land transformation).

The recently developed global land use impact assessment framework provided general principles and guidelines for methodology development of land use impact assessment in LCA considering spatial variation in soil properties and changes in agricultural management practices. Major problems of developing characterization factors for soil-related impacts include a lack of life cycle inventory data on soil characteristics and difficulty in developing regionalized impact assessment method which accounts for spatial variation and complex interactions with climate and the management practices. This presentation will explore the issues of developing regionalized characterization factors for assessing soil-related impacts and potential midpoint impact categories for soil function and quality.

A Method for Determining Community Level Physiological Profiles of Organic Soil Horizons

Mathew J.B. Swallow
Department of Environmental Science, Mount Royal University

Sylvie A. Quideau
Department of Renewable Resources, University of Alberta

Corresponding author: mswallow@mtroyal.ca

Abstract

Community level physiological profiles (CLPPs) have been widely used to assess microbial community diversity in soils. Refinement of techniques to determine soil CLPP eventually led to the development of the MicroResp technique. This technique avoids many of the pitfalls of earlier methods by using a whole-soil approach coupled with the convenience of microplates. However, issues related to soil pretreatment (primarily sieving) can arise when using the standard MicroResp method to determine the CLPPs of forest floors. Here, we developed a modified multi-SIR (multiple substrate induced respiration) method that lessens the effects of pretreatment by using a larger soil volume in custom 24-well deep-well plates. Microbial community indices including catabolic evenness (*E*) and CLPP were determined on a range of forest soils using both the standard MicroResp and our modified multi-SIR method. The modified method reduced the variation among the triplicate substrate wells and displayed a wider range of *E* among the soils measured. Additionally, using multivariate nonmetric multidimensional scaling (NMDS) as well as cluster analysis, we found that the modified method was able to better detect differences in soil CLPPs. The standard MicroResp method remains a valuable technique for many soils; however, our modified multi-SIR method is more suitable for organic soils, such as forest floors, that have low bulk density.

Predictive Mapping of Soils in Ireland - a Model for Updating Soil Maps in Alberta?

Gero Jahns
Integrated Environments (2006) Ltd., Calgary, Alberta, Canada

Rachel Creamer
Teagasc - Environment, Soils and Land-use Centre, Johnstown Castle, Wexford, Ireland.

Iolanda Simo
Teagasc - Environment, Soils and Land-use Centre, Johnstown Castle, Wexford, Ireland.

Chris Evans
Integrated Environments (2006) Ltd., Calgary, Alberta, Canada

Corresponding author: gero.jahns@int-env.ca

Historical soil surveys in Ireland were completed from the 1960s to the 1980s with only 44% of the entire country has been previously mapped in detail at a scale of 1:126,720. The Irish Soil Information System project was established in 2008 in order to develop a national soil survey map at a 1:250,000 scale. The project adopted a combined methodology of utilizing novel geo-statistical predicted mapping techniques in tandem with traditional soil survey applications. Soil predictive mapping utilized in the project incorporated vegetation, climatic, topographic, geologic and historic soil data parameters (total of 30 environmental co-variables). The results of the Irish Soil Information System project has contributed detailed, accurate, updated soil data and maps across Ireland, which is presented on the Irish Soil Information System internet mapping viewer at: http://gis.teagasc.ie/soils/index.php.

Current soil interpretation and mapping techniques used in the Irish Soil Information System project can be applied as a model to update and complete soil surveys in regions with insufficient soil information such as northern and western forested regions of Alberta. Updated soil surveys using recent soil modelling techniques should be considered to contribute towards environmental and reclamation planning of future industrial developments in regions with incomplete, existing soil databases.

Volunteer Session 2

Wednesday, February 18, 2015 – Afternoon

Long-term Research on Irrigated Cropping Systems

Benjamin Ellert, Henry Janzen and Elwin Smith
Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB

Corresponding author: benjamin.ellert@agr.gc.ca

Abstract
Long-term cropping systems studies smooth over the influence of environmental fluctuations, and can provide valuable insight to important processes that change slowly. Such studies demand a deft balance between simplicity to contain expenses and adequate sophistication to enable long-term monitoring of critical ecosystem processes, such as C and N cycling. Long-term studies offer one of the few approaches to assess the capacity of our agricultural systems to sustain long-term productivity without compromising future productivity or having adverse effects on adjacent environments. The objective of this presentation is to share our experience with one of the longest-running irrigated cropping system studies on this continent.

An irrigated sequence of ten crops, labelled “rotation U”, was established at Lethbridge in 1910. Originally the rotation was used to showcase a sequence appropriate for a mixed farm, as it included six years of alfalfa forage, three years of cereals and one high-value root crop (potato or sugar beet). Long-term yield dynamics and changes in soil C and N will be presented, and major technological and agronomic changes will be discussed. In particular, major changes implemented from 1990 to 2005 will be reviewed. We will discuss the need for changes in the original cropping sequence, how excessive complexity threatened the study, and how the experiment was modified to include contrasting treatments. Finally, we will present a case study of greenhouse gas emissions from soils under contrasting treatments as an example of how shorter, detailed experiments may coexist with long-term agro-ecological research.

Laboratory-Measured Soil Organic Carbon Mineralization in Soil Samples from Six Long Term Crop Rotations in Alberta as a Function of Sample Disturbance

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Abstract
Soil organic carbon (SOC) plays a dual role in soil; as a key compound determining the function and performance of agricultural soils and as the main terrestrial pool of carbon. However, the carbon content of cultivated soils has been found dependent on management practices. Crop rotation and tillage regimes are two management components commonly viewed as factors in determining soil carbon balance. This laboratory experiment serves to quantify the effect of a given crop rotation and type of physical disturbance on the amount of mineralizable SOC.

Soil samples collected from two different long-term research sites in Alberta were selected due to their contrasting soil classification, Orthic Dark Brown Chernozem and Orthic Gray Luvisol, yet similar crop rotations and management history. Three different rotations, varying in relative annual OM additions, were sampled from each location and air-dried. Following drying, sub samples from each rotation were subjected to three different levels of physical disturbance; hand broken aggregates, single pass through a 2 mm roller mill and processing in a dish-ring-puck mill to create 18 unique treatment combinations. Four replicates of each treatment combination were rewetted and then equilibrated to 60 kPa using a pressure extractor to achieve a consistent moisture content throughout each soil sample. Each soil sample was then placed its own incubation chamber. Soil moisture content was maintained by a 20 ml reservoir of deionized water in each incubation chamber. Atmospheric samples from the incubation chambers were taken at decreasing intervals over the course of 167 days and analyzed using gas chromatography. At each sampling event, the atmosphere in the incubation chamber was allowed to equilibrate with the ambient atmosphere. Preliminary results show distinct differences among treatments.

Long Term Influence of Manure Type and Bedding Material on Soil Mesofauna

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Jim Miller and Bruce Beasley

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Abstract
The addition of manure to agricultural plots influences physical, chemical and biological properties of soils. Soil biological activity is vital for terrestrial ecosystems. Soil fauna are responsible for physical and chemical transformation of litter which maintains soil fertility and sustains terrestrial productivity. Changes in soil fauna community structure can alter long term soil productivity. This study presents preliminary data on the influence of two types of manure (composted and stockpiled) and two different bedding materials (woodchip and straw) annually applied for 16 years at a rate of 13Mg/ha on the density and diversity of soil mesofauna.

Four soil cores were collected from each of four treatment plots as well as from a control plot in the fall of 2014. Preliminary results suggest that manure type had no effect on soil mesofauna density. However, densities of soil mesofauna differed significantly ($P \leq 0.05$) between bedding materials. For example, densities of oribatid mites and entomobryid springtails were greater in soil under wood-chips than under straw. Densities of total Collembola, oribatid mites, and onychiurid springtails were also greater with manure application than without. Sampling of these same treatments will be repeated in 2015 to provide a second year of data and possibly confirm these preliminary findings.

Wood ash improves soil properties and crop yield up to 7 years after applications and saves fertilizer

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Abstract

Traditionally, lime has been used to mitigate the soil acidity in Western Canada. Wood ash may be a better substitute to lime, due to an oxide rather than carbonate form of lime, presence of other essential plant nutrients and potential to reduce fertilizer requirements. The study compared the effects of wood ash and recommended fertilizers applied in 2006 and 2007; on soil properties, crop yields and contribution margin from 2006 to 2014. The Check (no fertilizer or wood ash), Fert (soil test based fertilizers), Ash (wood ash rate to supply amounts of phosphorus equivalent to the fertilizer treatments 3.48 t/ha in 2006 and 4.38 t/ha in 2007); and Ash+N (same as wood ash + N fertilizer) treatments were applied in 2006 and 2007. Residual effects of treatments were studied up to 2014. A RCBD with four replications was used; and repeated on 3 adjacent sites (termed as the North, Centre and South) on a Luvisol in southeast Peace, AB, Canada. Canola (north), peas (centre), and barley (south) were grown in 2006. Oats were grown on all plots in 2007. In 2008, 2010, 2012, 2013, and 2014, same crops were grown using similar fertilizer rates on all plots.

Wood ash had a bulk density of 624 g L^{-1} and held 900 mL water L^{-1} at saturation. It showed the presence of all the essential plant nutrients, except nitrogen. Also, the amounts of other elements were low and did not appear to pose a problem.

The soil samples, collected in 2007, 2008 and 2013, had or tended to have higher pH, potassium, calcium, phosphorus, sulphur, zinc, manganese, iron, copper, chloride, and sodium levels for the Ash and Ash+N treatments than the Check and Fert treatments. This indicated soil quality improvement due to wood ash applications.

In the 2006 and 2007 years of treatments applications, the crop yields were usually highest from the Ash+N treatment, followed by Fert, Ash and Check in a decreasing order.

In 2008, 2010, 2012, 2013 and 2014, the seed yields were usually greater from the Ash and Ash+N treatments compared to both the Check and Fert treatments. There were no consistent differences in yield between the Fert and Check treatments and between the Ash and Ash+N treatments, clearly showing residual effects for the wood ash applications in 2006 and 2007.

Extra seed yield in kg ha^{-1}, from the Ash+N treatment compared to the Fert treatment, was 597 barley (2006), 553 oats (2007), 593 wheat (2008), 168 wheat (2010), 287 oats (2012), 702 canola (2013), and 275 canola (2014). Extra income from sale of crops added to $630/ha and the saving from P fertilizer in 2006 and 2007 was $89/ha. Thus extra contribution margin from the Ash+N over the Fert treatment was $719/ha, i.e. $92 from each ton of applied wood ash.

Overall, wood ash reduced fertilizer cost and improved seed yield, contribution margin and soil quality.

Can agroforestry enhance carbon sequestration and mitigate GHG emissions in Canada's agricultural landscape?

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Abstract
Agroforestry systems are common land-uses across Canada's agricultural landscape and could play a substantial role sequestering carbon (C) as part of Canada's efforts to reduce GHG emissions. Further, these systems contribute other ecosystem services such as providing wildlife habitat, maintaining biodiversity, and improving air quality, reducing erosion, and enhancing both surface and ground water quality. However, C sequestration is the only service for which mechanisms currently exist to promote these systems on the landscape by rewarding landowners for enhanced C sequestration. Moreover, this option is limited to Alberta where regulators tax large C emitters and actively seek offset opportunities through agricultural policies, but these do not currently apply to agroforestry systems. In this paper, we provide an overview of C sequestration and GHG offset potential for agroforestry systems in Canada, and identify knowledge gaps. We compiled data from relevant, published studies (n = 22) were data was collected in different agroforestry systems (alley cropping, shelterbelt, riparian buffer, natural hedgerow, silvopasture system) across Canada. We then estimated C sequestration (Mg C ha^{-1} $year^{-1}$) of these systems by dividing C stocks within the above and belowground pools by the age of the system. Mean vegetative (above- and belowground) C sequestration in alley cropping systems alone is estimated to be 0.8 Mg C ha^{-1} $year^{-1}$. Similarly, the rate of soil organic C accumulation under these systems was calculated to be 2.9 Mg C ha^{-1} $year^{-1}$. We estimate that 19 Tg C could be sequestered annually in Canada's 51 million ha of agricultural land areas suitable for long-term cultivation if 10% of this land was allocated to alley cropping systems. The data available for the other agroforestry systems was insufficient to estimate their C sequestration potential. The potential for C sequestration through agroforestry is large, but more datasets would enhance our ability to refine estimates of agroforestry as a practice that reduces C and other GHG emissions from Canadian agriculture.

Poster Session
Wednesday, February 18, 2015 – Afternoon

Modelling Interacting Effects of Invasive Earthworms and Wildfire on Forest Floor Carbon Storage in the Boreal Forest

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Abstract
In forest ecosystems, earthworms and wildfire are two ecological agents that cause carbon (C) stored in the forest floor to be transferred to the atmosphere as greenhouse gases, either through heterotrophic respiration (earthworms) or through periodical combustion (wildfire). For centuries, wildfire has been an important ecological driver in the boreal forests of Canada where most fire emissions to the atmosphere originate from the forest floor. In contrast, earthworms are recent invaders, having been introduced to the Canadian boreal during the 20th century. We examined stand-level effects of earthworms and wildfire on forest floor C by adapting an earthworm-C simulation model for the boreal and using it in combination with a forest C accounting model. We combined results from the stand-level simulation with a spatial model of earthworm spread to calculate the total predicted change in C storage at the landscape-level following earthworm invasions in northeastern Alberta. Within 35-40 years after initiation of the invasion forest floor C stocks were reduced by 49.7 to 94.3% depending on earthworm species. Because earthworm activities reduced the amount of forest floor C available for burning, emissions from wildfire were lower in the presence of earthworms. Spatial modelling of earthworm effects within a 6 million hectare area projected that forest floor C stocks decreased 50,875 Mg C by 2006, and 2,706,355 Mg C by 2056, compared with the same area if earthworms were not present. Loss of forest floor C averaged over the 50 year simulation was 10 g m^2 yr^{-1}; similar in magnitude to estimates for C loss in the Canadian boreal due to wildfire or harvesting. These results indicate effects of non-native earthworms on the forest floor should be included in predictions of forest ecosystem C budgets to ensure accurate attribution of emissions to heterotrophic respiration or combustion.

Calibration of Forest Soil Carbon Modeling Parameters Using Probabilistic Inversion

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Abstract
Recent evaluations of the performance of global-scale models used to quantify ecosystem carbon dynamics have shown that the models, in general, are poor at predicting soil carbon stocks. Improved parameterization and conceptualization of soil carbon models used at national or global scales is required and this is especially challenging for Canada's forested area for which there is a dearth of data compiled that are useful for model development. Availability of such data is essential for accurate prediction of carbon stocks and their dynamics under various climate conditions and disturbance scenarios. Data-model fusion techniques facilitate model improvement through parameter calibration against the observed data on carbon stocks and the associated errors, as well as assigning the uncertainties to the model predictions. We have just completed a new upland forest soil carbon database containing approximately 3300 records for soil carbon stocks in the organic horizons and mineral soil horizons to 100 cm depth. The database includes ancillary data for climatic variables, leading tree species and soil taxonomy that will be used to test different approaches to modeling forest soil C using probabilistic inversion. Examples of applications of the approach will be shown.

Impact of Industrial Development on the Forest Carbon Budget in the Athabasca Oil Sands Region: A Pilot Study

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Abstract
Regulators and policy makers seek to understand the cumulative effects of industrial activities at the landscape scale in the Oil Sands region of Alberta. This pilot project aims at assessing the impact of industrial development on the forest carbon budget in a part of the Athabasca Oil Sands region. The project is in the early stages of development. We are using Landsat-derived land cover and disturbance times-series to generate inputs to the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) to create a spatially-explicit (30 m resolution) representation of annual carbon flux indicators over the period from 1984 to 2012.

We will show preliminary results of spatial time-series of annual carbon flux indicators from Phase 1 of the project to demonstrate the project's potential. Approaches taken to improve land cover and disturbance times-series products for Phases 2 and 3 will be illustrated with examples. The range of disturbances and land types, and the approach to simulating disturbance impacts in forest ecosystems will also be described.

Carbon dynamics on agricultural woody land transitions

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Abstract
There is growing interest in improving estimates of the greenhouse gas balance in response to land-use changes (LUCs) involving agriculture-forestry interactions for national scale reporting, and for carbon offsets. Accordingly, Agriculture and Agri-Food Canada (AAFC) and the Canadian Forest Service (CFS) collaborated on a pilot project in the Ontario Mixedwood Plain ecozone to analyze change in carbon emissions and removals on lands in transition between cropland and forest land (i.e. forest regeneration on abandoned cropland). A system recently developed by the Carbon Accounting Team at the CFS made it possible to execute C dynamic simulations with the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) at the fine spatial scales required for these types of LUCs.

Thirty-six photo plots (2km X 2km) consisting of paired aerial photographs corresponding to circa 1990 and circa 2000 at a scale of 1:10K or larger (for a total area of 835 ha within the Ontario Mixedwood Plains ecozone) were selected by randomly choosing intersection points from the 20km X 20km National Forest Inventory (NFI) grid and searching for suitable imagery. For each photo plot, LUCs were identified and summarized. Soil and forestry maps, reports and expert knowledge were used to develop assumptions for soil and disturbance types, lead tree species and their associated yield curves. Polygons identifying areas of LUC within each photo plot were processed to provide input data for the modeling system.

Results for annual C stocks (e.g., Total Ecosystem C) and fluxes (e.g., Net Primary Production) from the analyses will be shown along with average C indicators (over a 15 year period), and the associated estimate for C accumulation, for the pilot study area. Additional collaborations are underway contributing to our effort to estimate carbon stocks and fluxes from woody land transitions on a national scale.

Preliminary Assessment of Nitrous Oxide Emissions, Soil Temperature and Soil Oxygen Concentrations following Fall Manure Injections

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Abstract
It is well acknowledged that nitrous oxide (N_2O) is a major greenhouse gas (GHG) which mostly derived from agriculture. About 58% of GHG emissions from agriculture are N_2O, and two-third of these N_2O emissions come from cropping systems which soils repeatedly receive manures or synthetic nitrogen fertilizers. The main objective of this research is to investigate GHG mitigation strategies and provide efficient management practices to enhance ecosystem services. This research compares N_2O emissions from two contrasting manure injection times (fall vs. spring), examines the effectiveness of two nitrification inhibitors {nitrapyrin and 3, 4-dimethylpyrazole phosphate (DMPP)} and identifies the key ecological controls on N_2O flux in Alberta cropping systems. Field experiments were initiated in two locations (Edmonton South Campus and Lacombe) in the early fall 2014 and will continue until winter 2016. The two locations receive different manure types; dairy manure is injected at South Campus, while swine manure is injected in Lacombe. All manure injections resulted in a significant increase in N_2O emissions compared to the controls without manure (264 vs. 18 g N_2O-N ha-1 for South Campus, and 348 vs. 2 g N_2O-N ha-1 for Lacombe; Ps < 0.005). At the South Campus site, addition of nitrification inhibitors numerically reduced N_2O emissions in average by 17% compared to the manure injected without any nitrification inhibitors. For the Lacombe site, nitrification inhibitors reduced in average 35% of the N_2O emissions (P < 0.047). Summarizing these preliminary findings from the fall 2014 measurements, the overall average reduction due to the use of nitrification inhibitors was about 26%. These experiments will continue during the next two growing seasons to reveal the annual effects of inhibitors and times of manure injections.

Responses of herbage P, Ca, K and Mg content and Ca/P and K/(Ca+Mg) ratios to long-term continuous and discontinued cattle grazing management on a rough fescue grassland

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Abstract
Herbage minerals are important for the growth and development of grazing cattle. This study investigated the levels of four minerals (P, K, Ca and Mg) and herbage Ca/P and K/(Ca+Mg) ratios in herbage using a long-term grazing site on a rough fescue grassland. We investigated the herbage mineral content responses to stocking rate, continuous vs. discontinued grazing, position on the slope of a hill, and sampling year by utilizing an existing grazing study. Cattle have been stocked at 2.4 and 4.8 animal unit months (AUM)/ha since 1949. Permanent exclosures were installed in April 1998 at the top, middle and bottom of the west aspect of a hill for both stocking rates to emulate discontinued grazing conditions. Triplicate herbage samples collected inside and outside the exclosures in 2001, 2003, 2008 and 2012 were analyzed for mineral content. There were no differences in herbage mineral contents between the two stocking rates. Herbage Ca (bottom of the slope only), Mg and K contents under the discontinued grazing treatment were lower ($P < 0.05$) than with continuous grazing while P content was similar ($P > 0.05$) between the two grazing practices. Higher herbage P and K and lower Ca and Mg contents were observed ($P < 0.05$) in years with greater precipitation and lower temperatures. Herbage mineral content, with the exception of P, exceeded minimum recommended levels for cattle. Given the low P (0.74 g/kg to 1.19 g/kg) and high Ca/P ratios during the dry and hot year (2001), a dietary P supplement should be considered in such years. The low K/(Ca+Mg) ratios (< 2.2) during most of the grazing season suggest there is little risk of grass tetany in cattle grazing on this rough fescue grassland.

Coarse-Textured Soil Reclamation in the Athabasca Oil Sands Region: A Soil Quality Approach.

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Abstract
Creation of functional boreal landscapes is the ultimate goal following surface mining in the Athabasca Oil Sands Region (AOSR). Successful reclamation is reliant on the soil resource as it is needed to support equivalent forest productivities compared to natural counterparts. Based on these issues, prior knowledge of the natural soils in the region is necessary to guide the reclamation process and assess whether or not reclamation has been successful in the long term. A significant portion of the pre-mining landscape in the AOSR is comprised of soils developed from sand deposits of glaciofluvial and eolian origin. These soils provide unique challenges to reclamation due to their relatively unproductive nature largely resulting from low soil moisture and nutrient availability. We selected twenty sites throughout the AOSR derived from sandy parent material in an attempt to capture the natural range of variability in forest productivity. Soils were described and sampled by morphologic horizon in the field and a suite of forest productivity characteristics were measured in an attempt to link physical and chemical properties of natural sandy soils to forest productivity in the AOSR, thus providing a frame of reference for their reclaimed counterparts.

Conservation Cropping System Adoption in Alberta's Brown soil Zone

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Abstract:
Adoption of dryland conservation cropping systems over the past 20 years on cultivated lands in Alberta's Brown Soil Zone has helped to increase total grain production, crop diversity and water use efficiency at the landscape level. Land use, precipitation and crop yields were acquired for the time periods of 1990 to 1992 and 2010 to 2012. To determine the cropping pattern and tillage practices, two representative Soil Landscape of Canada (SLC) units were selected in southeast Alberta (near Foremost). SLC's are landscape units with similar soil characteristics for planning purposes. Statistics Canada Agriculture Census information was interpolated to these 2 SLC's to determine the crop and land use information for 1991 and 2011. To compare the moisture available for crop production, the crop year (September 1st to August 31st) precipitation patterns and totals were acquired from the Foremost long term weather station. Both timing and total accumulated precipitation were very similar for the two periods (398 versus 387 mm). The long term average for the area is about 375 mm. Yields were derived from Alberta Financial Services Corporation (AFSC) crop insurance records for Foremost area dryland production, averaged for those two time periods and applied against the SLC Ag Census crop areas for 1991 and 2011. In comparing 1990 – 1992 with 2010 – 2012, aggregate grain yield and cropping system water use efficiency increased by 87% in the representative SLC area. That resulted from the combination of increased unit area yield and total cropped area (reduced summerfallow). From 1991 to 2011, summerfallow area decreased by 76% and no-till increased from 5% to 75% of the cropped area. Crop diversity transitioned from predominately cereal – fallow to a rotation that included cereals, oilseeds and pulse crops. Pulse crops (pea, chickpea and lentil) and oilseeds (mainly canola and mustard) increased from 8% to 27% of the cropped area.

Spatial variability in nutrient availability and CO_2 efflux in oil sands reclaimed and benchmark upland boreal forest ecosystems

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Abstract

Background: Oil sands mining have created a huge industrial scale disturbance in the boreal regions of northern Alberta that legally requires industries to reclaim the disturbed landscapes to prior disturbance conditions, but still lacks comparable benchmark databases and understanding to the mechanisms that generates ecological variability. In this study, we measured nutrient availability and CO_2 efflux in oil sands mine disturbed sites reclaimed with different top soils, and benchmark natural sites disturbed by fire and harvesting in order to compare the ecosystem recovery patterns among the three disturbance types. The reclamation treatments were peat mineral mix (PMM) and forest floor mineral mix (FFM) as top soils over reconstructed subsoil profiles, and the natural benchmarks included sites recovering from fire and harvesting disturbances. Nutrient availability was measured using Plant Root Simulator™ probes and CO_2 efflux was measured monthly during the growing season using Li-Cor 8100A system. Geo-statistics were used to characterize and model the spatial relationships between soil and environmental factors.

Findings: Significant spatial patterns were detected both in nutrient availability and CO_2 flux data. FFM reclamation treatment showed finer scale (4 – 9 m) variability in N-P-S availability than the PMM treatment (no pattern to 12 m). On the other hand, natural benchmark sites had spatial range less than 8 m, except in harvested site for S availability (> 23 m). CO_2 efflux measured in FFM site during June – Aug had spatial range ≤ 20 m; however, PMM site and natural benchmark sites mostly showed large scale spatial autocorrelation (> 23 m), except in June which had fine scale patterns (≤ 6.5 m), which perhaps was related to moisture patterns. In general, growing season CO_2 efflux in the FFM site was significantly ($p \leq 0.05$) higher than the PMM and harvested sites, which could have resulted from the dense understory vegetation growth on this site.

Implications: The comparable fine scale spatial patterns in nutrient availability and CO_2 efflux in the FFM and natural benchmark sites primarily indicate that using selectively salvaged forest floor materials as top soils in oil sands reclamation might have a potential to create variability usually found in upland boreal ecosystems after natural disturbance, such as fire. Although CO_2 efflux data showed some detectable spatial patterns in all the studied sites, more mechanistic understanding of the relationships with regulatory environmental factors needs to be developed to reach to an ecologically meaningful conclusion about the processes happening in these novel reconstructed ecosystems.

The effectiveness of subsoiling on improving soil physical and hydraulic properties of a reclaimed coal mined soil.

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Abstract

Soil compaction, caused by repeated movement of heavy machinery during soil reconstruction of surface mined lands, hinders the re-establishment of native vegetation. Sub-soiling has been shown to be an effective management tool to improve soil physical and hydraulic properties. The main objective of this research is to quantify the benefits of sub-soiling on soil physical and hydraulic properties of reconstructed following open cast coal mining. In 2010, an experimental research site was established at the Genesee Prairie Mine, 70 km west of Edmonton to investigate the potential for compaction amelioration using a heavy-duty rip plough. An area of 575 m X 25 m was delineated and stratified into six blocks each containing 2 – 36 m X 25 m plots separated by 20 m buffers. In the fall of 2010, a McNabb Winged Subsoiler attached to a D7R XR Caterpillar completed subsoiling to a 60 cm depth on 1 plot per block resulting in 6 replicates of control and subsoiled treatments. Soil hydraulic conductivity was measured in-situ using a Guelph Permeameter and Tension Infiltrometer at 0, 15, 30, 45 and 60 cm depths. Undisturbed core samples were collected at 5-10, 15-20 and 30-35 cm depths for conductivity testing by the falling head method and HYPROP. The mass fractal dimension of the soil was determined through 3D laser scanning from clod samples at the 15 cm depth. Depending on measurement methods, preliminary results indicate median saturated hydraulic conductivity was higher in subsoiled plots, but the differences were not statistically significant. Results indicate mass fractal dimensions were not significantly different between ripped and unripped plots, with the exception of plots 3 and 5.

Land Use and Conservation
Technical Session
Thursday, February 19, 2015 - Morning

The Land-use Framework: An updated look six years later.

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Abstract
Recognizing competing demands for land use, Albertan's identified, following several years of public engagement, that current land management systems in Alberta were at risk of being overwhelmed by the scope and pace of intense economic activity and population growth driven dominantly by a strong, albeit cyclical, energy sector. They identified that a new approach was needed to manage both public and private lands and Alberta's natural resources to achieve the provinces desired economic, environmental and social goals. As a response, the Government of Alberta introduced the Alberta Land-use Framework (LUF) in December of 2008.

December, 2014, marked six years since the LUF was released, and significant activity aimed at achieving the LUF goals is currently underway. The focus of this presentation is to report on the progress to date on the development of regional plans, their governance and compliance requirements. Other key strategies and policy gaps that form the basis of subsequent presentations in this technical section will also be introduced. To date, two regional plans have been implemented and a third plan is underway. The first plan under the LUF, the Lower Athabasca Regional Plan, was a plan for a region experiencing rapid growth in response to the development of the oil sands. The second plan, the South Saskatchewan, addresses the needs of close to 45 percent of Alberta's population, but whose future growth is constrained by water supply. Currently under development, the North Saskatchewan Regional Plan is home to Alberta's capital city as well as extensive industrial development both in support of and resulting from the energy sector throughout Alberta. Much has been and will continue to be learned as all seven regional plans are developed, and this continues to shape this important provincial initiative.

From mammals to mites: Biodiversity Management Frameworks for Alberta's Land Use Planning Regions

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Abstract
Starting with the first international Convention of Biological Diversity in 1993, there has been a growing number of initiatives to develop biodiversity targets at federal, provincial and regional levels. Through the regional planning process, the Government of Alberta has committed to the establishment of environmental frameworks for the management for cumulative effects of development on air and water, along with biodiversity. The Biodiversity Management Framework (BMF) for the Lower Athabasca Region (LAR) is the first of these biodiversity-focused management frameworks under development. The BMF is designed to meet outcomes established in the Lower Athabasca Regional Plan, especially, "Landscapes are managed to maintain ecosystem function and biodiversity". Through a process involving stakeholder engagement, twelve potential indicators for regional biodiversity have been identified. The indicators span species and habitats, and aquatic and terrestrial systems. Regional triggers and associated management intent are developed for each indicator. Expected release of the final LAR BMF is 2015.

Conservation Offset: A Tool for Land Management

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Abstract
Alberta's landscapes face multiple and often competing demands. Offsets are one of the potential tools Alberta is exploring to address these demands. Offsets are actions taken, after all reasonable efforts to avoid and minimize impacts, to counteract remaining significant residual impacts from an activity. Offset application is not new to Alberta, the early example being the wetland replacement requirement. However, offset was first formally introduced in land use context in Alberta in 2008 through the Land Use Framework.

Alberta Environment and Sustainable Resource Development and the Land Use Secretariat are currently developing system design elements for conservation offset. These elements articulates Alberta's intent on how offset fits within Alberta's various regulatory processes and identifies a set of requirements that will be common to each regulatory offset program. An example of these design elements will be provided using wetland policy replacement requirement.

Promoting Efficient Use of Land in Alberta's municipalities

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Abstract
As stated in Alberta's Land-use Framework, "Land is a limited, non-renewable resource, and so it should not be wasted. Land-use decision should strive to reduce the human footprint on Alberta's landscape. When it comes to land use, other things being equal, less is more – more choices for future generations. This principle should guide all areas of land-use decision-making."

The objective of the Government of Alberta's Efficient Use of Land (EUL) Strategy is to minimize the amount of land that is required for development of the built environment over time. To support this objective, the government has recently endorsed six EUL principles and released compendium of tools and best practices. The presentation will speak to the EUL principles, highlight some EUL tools and the government's approach for promoting efficient use of land.

Land Fragmentation and Conversion in Alberta

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Abstract
Alberta has approximately 21,100 hectares of land (2011 census of Agriculture) whose soils are capable of supporting agricultural production activities over a wide geographic area. Many other land use activities are in direct competition with agricultural production and require careful monitoring and planning to ensure that the best possible use of Alberta's Soil resource is occurring. The Land Use Framework (LUF) initiative is an ongoing process that, among other objectives, plans for the orderly and efficient use land throughout Alberta. LUF is a multi-department initiative and Alberta Agriculture and Rural Development's (AARD's) role is to monitor the fragmentation and conversion of private agriculturally productive land in Alberta.

The Purpose of this presentation is to give a status update on the progress AARD has made in monitoring the conversion and fragmentation of agricultural land in Alberta. Describe some of the key challenges and assumptions we have had to make along the way. Give a sense of what it is we can monitor to date, what is left to monitor, and what cannot be monitored.

Forest, Riparian and Wetland Soils
Technical Session
Friday, February 14, 2014 - morning

Responses of Nutrient Dynamics to Warming and Water Table Lowering Simulations of Climate Change in a Northern Treed Bog

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Abstract
Mid-latitude treed peatlands have accumulated significant carbon stocks and are predicted to be highly sensitive to global climate change. In a dry continental treed bog of hummock-hollow microtopography, we compared three sites 1) control, 2) recently drained (2-3 years; experimental), and 3) older drained (12-13 years; drained) with water levels at 38, 74 and 120 cm below the surface, respectively. At each site/microform we quantified total inorganic nitrogen [TIN = nitrate nitrogen (NO_3^--N) + ammonium nitrogen (NH_4^+-N)] and phosphate phosphorus [PO_4^{3-}-P] dynamics in response to open-top chamber warming of ~1 °C and the above-mentioned water level gradient. We also compared how the response varied between hummocks and hollows. We used ion exchange membranes to capture available nutrients followed by potassium chloride extraction to quantify the extractable nutrients from peat, and vegetation sampling to determine C:N ratio of above-ground dominant plant functional groups.

The drainage (36 and 82 cm deeper water table) significantly increased available and extractable nutrients in the bog. Deeper drainage for a longer-term resulted in higher TIN availability with an increase of 28% relatively to the control. TIN availability increased by 18% in response to the shallower drainage over short-term. In contrast to TIN, the increases in available and extractable pools of PO_4 were more in response to the recent drainage (51% and 56%, respectively) compared to no increase at the older drained site. Both the available and extractable pools of TIN, NO_3^- and NH_4^+ increased the most at the older drained hummocks likely due to the significant increase in productivity at these locations. The OTC warming alone increased the extractable TIN, NO_3^-, NH_4^+ and PO_4^{3-} compared to unwarmed controls by 13%, 7%, 32% and 11%, at the drained site, 10%, 4%, 24% and 31% at the experimental site, and 11%, 9%, 12% and 37% at the control site. The warming response also varied between the microforms. The

strongest response to warming was from drained hummocks for TIN and experimental hummocks for PO_4^{3-}. The C:N ratios of shrub and tree functional groups decreased along the gradient of decreasing water level indicating increasing N uptake by these plants post-drainage. Available nutrient pools were strong predictors of extractable nutrient pools which in turn were strongly related to the vegetation C:N ratios.

We conclude that the predicted climatic changes will likely enhance nutrient pools in the soils of forested non-permafrost ombrotrophic boreal bogs. These changes in bog nutrient dynamics are likely to shift plant community composition favouring woody plant growth and NPP, and thereby affecting whole ecosystem functioning.

Seasonal Groundwater Variation in a Mineral Soil Wetland

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Abstract
Boreal wetlands are important for biodiversity and water resources but are facing increasing development pressure. Mineral soil wetlands may function differently than more common peatland systems but have received less research attention. To this end a small forested study catchment in the Boreal-Parkland transition was selected for observations of groundwater behavior in the catchment and surface runoff (Q) from the wetland. Well-piezometer pairs were installed along the lower end of a two ha catchment and beginning in 2012 monitored through a combination of manual and automated measurements. Hydraulic head was calculated as the sum of elevation above a benchmark and pressure readings from piezometers. Discharge was estimated at the wetland outlet by means of a calibrated relationship between piezometric head and manual measures of Q. Piezometric head was shallower and more stable in the wetland soils than just upslope in the concave toe slope. Vertical hydraulic gradients were usually upward (discharge) in the wetland soils and downward (recharge) upslope at the toe position. Hydraulic head decreased towards the wetland confirming a connection with the concave portion of the hillslope. Catchment discharge during the snowmelt was estimated at 17 and 2 mm for 2013 and 2014 with runoff coefficients of 0.14 and 0.06 respectively.

The fractal characteristics of soil particle size distribution in tidal flats in the Yellow River Delta

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Abstract
Tidal flat is a critical component of coastal wetland systems. The erosion risk in tidal flats in coastal wetlands has seldom been studied. Giving that high fractal dimension values indicate high risks of soil erosion, characterizing fractal dimensions of soil particle size distribution (PSD) is an approach that can be used to quantify risks for soil erosion. The objective of this work was to analyze the fractal dimensions of soil PSD in a successional series of tidal flats in a coastal wetland in the Yellow River Delta (YRD) in eastern China. Based on the fractal scale theory and network analysis, we determined the singular fractal dimension (D) and multifractal dimensions (including capacity dimension (D_0) and entropy dimension (D_1)) of soil PSD along a series of tidal flats in a coastal wetland in the YRD. The results show that the fractal dimension values increased from the supratidal to the subtidal flat. This reveals that the risk of erosion increases from the supratidal to the subtidal flat. We also found that the percent of particles with size ranging between 0.4 and 126 μm was related with fractal dimensions. In conclusion, tidal flats in coastal wetlands in the YRD, especially subtidal flats, are facing the risk of soil erosion.

Land Reclamation
Technical Session
Friday, February 14, 2014 - morning

Case studies of evaluating soil microbiota on reclaimed sites in the Oil Sands Region

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Abstract
Environmental practitioners and stakeholders are increasingly recognizing the critical roles soil organisms perform in fulfilling key ecological functions and providing ecosystem services, leading to higher demand for incorporation of soil biodiversity and ecology in assessing environmental degradation and improving restoration outcomes. This is limited, however, by the lack of standard methods and knowledge of linkages for incorporation into existing models and frameworks. While our understanding is growing rapidly, it is not yet possible to routinely predict effects of altered soil biota on ecosystem structure and function across ecosystems and soil types.

In the Oil Sands region, novel initiatives involving soil organisms were applied to evaluate and improve reclamation outcomes. Case studies utilizing soil organisms and/or biodiversity to resolve environmental problems include a morphometric assessment of ectomycorrhizal diversity and abundance on tree roots on reclaimed tailings slopes with varying degrees of revegetation success; and the detection of sulphur oxidizing bacteria in stockpiles and reclaimed soils to evaluate the potential to convert elemental sulphur into sulphate. Despite the success of these studies, the current generation of molecular tools (e.g., metagenomics, DNA barcoding) presents a greater opportunity to incorporate measures of soil biodiversity and function in environmental monitoring and restoration programs, provided that standard procedures can be developed. To this end, assessing heterogeneity of soil biodiversity and function within and between soils and ecosystems likely to be affected, as well as effects of typical disturbances on soil biodiversity and corresponding changes in the provision of ecosystem services, is required. Potential studies of value include before-after-control-impact (BACI) studies incorporating reference, disturbed, and reclaimed soils.

Efficacy of Biochar On Remediation Of Metal Contamination In Oil Sands Process-Affected Water

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Abstract
Aqueous bitumen extraction generates large quantities of tailings by the oil sands industry. In reclamation of tailings, end pit lakes (EPLs) are designed to cap fluid tailings to build a wet landscape where oil sands process-affected water (OSPW) is being taken as a water source. Metal contamination in oil sands process-affected water (OSPW) has been recognized and requires to be treated to reach acceptable levels that can be tolerated in aquatic systems. Production of biochar from waste materials has reported to be economical and hence biochar can potentially be used to treat OSPW. Biochar produced from pine sawdust at 300 and 550 °C with or without steam activation were characterized and evaluated for metal adsorption in OSPW. The sorption of metals was interpreted as a function of biochar production condition, metal species under study, pH and physicochemical characteristics of biochar. Steam activated biochar produced at either temperature had a higher surface area but did not increase the adsorption capacity for metals. Biochar produced at 550 °C were more effective in adsorbing some metals compared to that produced at 300 °C. The results showed that temperature was the dominant factor to affect the metal adsorption capacity of biochars.

A Comparison of Site Preparation Methods on Sub-Surface Soil Resistance and Moisture on Reclaimed Industrial Sites in NW Alberta.

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Abstract
Soil compaction has been identified as a potential barrier to successful reclamation of industrial sites in upland (forested) areas of northern Alberta. Three site preparation methods, as well as an untreated control, were evaluated on three different industrial sites. This research considered the effect of mounding, Rip-Plow, and mixing treatments on soil resistance and soil moisture on a dry, a moderate-wet, and a wet industrial site.

Field research conducted in the summer of 2013 showed that volumetric water content (VWC) at 20cm depth was strongly correlated with the moisture conditions of the industrial site. In contrast, VWC showed very little variation between site preparation methods although marginal tendencies were identified across sites. Mixing treatments trended towards lower VWC while mounding and control plots trended towards higher VWC. Rip-plow treatments had similar VWC to mounding and control treatments on the wet site, slightly lower VWC than mixing on the moderate-wet site, and intermediate VWC on the dry site. Higher VWC was generally associated with lower soil resistance measurements. Trendlines for soil resistance indicated that mixing was consistently correlated with relatively high soil resistance while Rip-Plow treatments were associated with lower soil resistance at all depths. Mounding treatments showed intermediate soil resistance on all three sites. The main recommendation based on these results suggest that, at least for these soil types, surface soil mixing is likely to have the least benefit for improving soil physical structure while other treatments such as mounding or use of rip-plow appear to improve the soil.

Coarse Woody Debris Increased Microbial Activity but Did Not Affect Soil Enzyme Activity in Cover Soils for Oil Sands Reclamation

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Abstract
Forest floor mineral soil mix (FMM) and peat mineral soil mix (PMM) are common cover soils used for land reclamation post open-pit oil sands mining in northern Alberta. Coarse woody debris (CWD) can be used as an organic matter source in land reclamation to regulate soil temperature and water content and increase organic matter content and microsites for microorganisms and vegetation establishment. We studied the effects of CWD on soil microbial community level physiological profile and soil enzyme activities in two cover soils, FMM and PMM.
This experiment was conducted with a 2 (FMM vs PMM) × 2 (near vs away from CWD) factorial design with 6 replications. The study site was established between November 2007 and February 2008. Fresh aspen CWD was placed on each FMM or PMM plot at the time of plot establishment. Top 10 cm soil samples were collected within 5 cm from CWD and more than 1 m away from CWD on July 8, August 8, and September 4, 2014. Soil microbial community level physiological profile was measured using a Biolog Ecoplate and average well color development was calculated. Fluorometric and colorimetric methods were used to determine extracellular enzyme activities.
The average well color development in PMM was greater than that in FMM, likely associated with the higher organic matter content in PMM. Application of CWD increased average well color development in FMM and PMM in August and September samplings ($p<0.05$). Soil enzyme activities such as β-glucosidase, acid phosphatase, cellobiohydrolysis, and peroxidase were significantly greater in FMM than in PMM ($p<0.01$); however, CWD application did not affect enzyme activities. Microbial and enzyme activities were mainly affected by cover soil type but microbial activities were also affected by CWD application. We conclude that CWD application in land reclamation can enhance microbial activities that would increase nutrient cycling and improve ecosystem function.

Soil amendments for Boreal forest reclamation on fine-textured soils

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Abstract

In the boreal region of Alberta, many soils are clay-rich and tend towards higher bulk densities. The physical structure of these soils is particularly fragile and present difficulties for soil water movement and plant rooting. Regionally available organic amendments including pulp sludge (or bio-solids) and biochar may facilitate soil development and initial establishment of forest vegetation following soil reclamation. The objectives of this project were to evaluate the ameliorating effect of Biochar, manure pellets and mechanical pulp (MP) sludge in terms of: (1) the physical, biological and nutrient condition of the soil and (2) the ability of these amendments to enhance vegetation productivity of desirable boreal plant species.

Organic amendments were applied in 10 x 10 meter plots on a recently reclaimed sump site in the Peace River region of Alberta in May 2013. Three tree species (*Populus balsamifera, Picea glauca* and *Populus tremuloides*) and four shrub species (*Alnus viridis, Shepherdia Canadensis, Cornus sericea* and *Vaccinium myrtilloides*) were established within research plots in the previous year. Plant Root Simulator (PRS) probes were installed during the growth months of 2013 and 2014 to provide an index of nutrient availability in the studied treatments. Initial baseline soil samples were collected prior to amendment application and samples were also collected in fall 2014 for chemical characterization and nutrient analysis.

Preliminary results after two growing seasons indicate that amendments had little impact on overall vegetation cover. Individual woody species either responded positively to amendment application or similarly to control treatment. Detailed soil analysis and the PRS probe data showed a positive effect on the amount of available nutrients from amendment application, with MP sludge and manure pellets treatments having the greatest effect on nitrogen and phosphorus, respectively. The overall effect of amendment on vegetation growth and soil nutrient status will be discussed in detail, as well as future monitoring plans.

Nursery Nutrient Loading Promotes Growth of Jack Pine Seedlings Planted in Oil Sands Reclamation

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Abstract
Low nitrogen (N) availability is one of the major limiting factors of tree growth in land reclamation in the oil sands region. We examined the effect of nutrient loading in jack pine (*Pinus banksiana* Lamb.) to improve growth performance of seedlings used in oil sands reclamation. We hypothesized that nutrient reserves built up in the nutrient loaded seedlings would help to improve their early growth in the field using greater nutrient retranslocation to support new growth when their roots have poor contact with soils. Nutrient loaded and non-loaded seedlings were produced in a nursery in 2013 and were transplanted in an oil sands reclamation site in 2014. Nursery nutrient loading increased N concentration by 82% and content by 39% relative to non-loaded seedlings with no significant difference in total plant dry mass. After outplanting, both seedlings had high survival rates (93% in nutrient loaded and 98% in non-loaded seedlings) in the first year. Nutrient loaded seedlings had 33% ($p = 0.01$), 135% ($p < 0.001$) and 51% ($p = 0.001$) greater root, new needle and total dry mass production, respectively, than those of non-loaded seedlings. Height, root collar diameter and projected leaf area of nutrient loaded seedlings were greater ($p = 0.003$, $p < 0.001$ and $p < 0.001$, respectively) compared to non-loaded seedlings at the end of the active growing season. Nursery nutrient loading promoted the early growth of jack pine seedlings that could improve the future success of land reclamation in the oil sands.

Inclusion of soil biodiversity metrics in environmental impact and ecosystem function assessments - perspectives from the consulting industry

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Abstract

Global impact assessment guidelines and governments require resource-development companies to assess impacts on biodiversity, along with ecosystem services. Currently there is no requirement to include biological aspects of soil in environmental impact assessments (EIAs). There are increasing requirements by regulators and expectations by stakeholders to mitigate project impacts and restore ecosystem function. As an example, Oil Sands operators are mandated to return the disturbed land to an equivalent capability with minimal loss of ecosystem functions, which requires healthy starting soils. Knowledge of soil biodiversity baseline conditions and how it is affected by industrial disturbance in Oil Sands is scarce, due to limited information on success of current reclamation projects (which take decades to achieve in cold, northern climates) and a lack of defined ecologically relevant soil health indicators. Local communities in Canada have expressed concerns with such limitations and are starting to request mining and oil companies to include additional data in EIAs, including soil biological assessments. Application of knowledge and procedures that can enhance and/or accelerate reclamation in this region is of great interest for all stakeholders.

To this end, there is a need for consulting professionals who understand and can translate technical and regulatory information to resource-development companies, as well as facilitate transfer of such information to key stakeholders. Environmental consultants have a key role to play in informing companies of the value of the inclusion of soil biodiversity data in EIAs, as well as contributing to the body of knowledge on soil biota pre *vs*. post disturbance.

We present considerations and approaches for conducting soil diversity assessments as part of EIAs to guide the implementation of scientifically sound, practical and cost effective solutions to ecosystem disturbances.

Soil Fertility
Technical Session
Friday, February 14, 2014 - morning

Nutrient changes in Luvisol and crop production with four annually repeated six soil test based fertilizer rates

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A**bstract**

Agronomists consider soil test based fertilizer application as a sustainable technique to optimize crop production while minimizing negative effects. Most of the soil test based work has been done using a different site each year. The objectives were to study the effects of 0, 60, 80, 100,120 and 140% of the recommended soil test based fertilizer (N, P, K and S) rates on nutrient changes in Luvisol and on crop production; when the designated rates were repeated on the same plots for 4 years. A wheat – canola – barley – field pea rotation was followed to grow all crops from 2009 to 2012; starting with a different phase of rotation on 4 adjacent sites in southeast Peace, AB, Canada.

The amounts of N, P, K and S after the 2009 (1st year) and 2011 (adequate soil moisture available) crops showed no effect of the fertilizer rate, with similar fertilizer amounts recommended for all treatments of a given crop in subsequent years. But in a dry year of 2010, the amount of nitrate-N after the barley, canola and wheat crops tended to greater when higher N rates had been applied, apparently due to crop's inability to use nutrients in a dry year; which resulted in lower N recommendations for the following crops in 2011. The amount of nitrate-N after the 2010 peas and of P, K and S after all the 2010 crops were not influenced by the fertilizer rates, with almost the same fertilizer amounts recommended for all fertilizer rates to a specific crop in 2011. After the 2012 crops, there was a tendency for increased P, K and S after most crops, probably due to cumulative effects of higher fertilizer amounts applied from 2009 onward, even when adequate soil moisture was available.

The yield of crops in the dry years of 2009 and 2010 increased or tended to increase up to the 60% treatment with only small increase at higher fertilizer rates. In 2011 and 2012, with adequate soil moisture, crop yields increased or tended to increase with higher fertilizer rates.

Overall, soil tests were able to detect the changes in residual nutrients due to changes in soil moisture availability in a year and allow changes in nutrient recommendations to subsequent crops. Residual nutrient amounts depended on soil moisture adequacy and on the cumulative amounts of nutrients applied on the given plots. The increase in seed yield from fertilization was greater with the first than subsequent increments, and when adequate soil moisture was available.

Factors Influencing the Relationship of Ion Exchange Membrane (PRS Probe) Measurements to Extractable Nutrient Concentrations

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Abstract
Plant Root Simulator (PRS) probes are widely used for *in situ* monitoring of soil nutrients in a wide range of ecosystems. Although PRS-probe measurements are often strongly correlated to extractable soil nutrient measurements, the relationship is not constant or linear due to the different factors that influence these two types of measurement. A meta-analysis of previous studies was conducted to elucidate controlling factors and facilitate appropriate comparisons between measurements.

The main factor contributing to differences between PRS probe and extraction measurements is soil ion mobility. Short-term PRS-probe measurements of mobile soil ions such as nitrate and sulfate are often strongly correlated to extraction measurements, but the quantitative relationship varies with soil moisture and duration of PRS probe exposure. In contrast, PRS-probe measurements of immobile nutrients such as NH_4-N, P and K are often relatively insensitive to duration of burial, but are not as strongly correlated with extraction measurements (which also vary widely and are not consistently related). Ion interactions may influence PRS measurements to a greater extent than extraction measurements. The two methods of monitoring soil nutrients often complement each other, and can often be compared with appropriate consideration of method and context.

Early growing season soil nutrient supply and mid-season NDVI predicts grain yield

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ABSTRACT

The Breton Classical Plots were initiated in 1929 near Breton, Alberta on the Breton Gray Luvisolic loam series. These plots consist of 8 fertility treatments superimposed on a 2-year wheat-fallow (WF) rotation and a 5-year wheat-oats-barley-hay-hay (WOBHH) rotation. As such, these Plots are an ideal setting for assessing a crops response to nutrients. This presentation compares observed Plant Root Simulator (PRS) measured soil nutrient supply rates, GreenSeeker-measured canopy NDVI and yield in selected fertility treatments (NPKS, PKS, NPK and Check) in the wheat phase of both WF and WOBHH rotations over 4 growing seasons. Consistent relationships between NDVI, crop yield and nutrient supply were observed.

Balanced fertilization for increased productivity and reduced soil GHG emissions in sulfur-deficient soils

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Abstract
The Right product component of 4R nutrient stewardship includes addressing nutrient deficiencies with fertilizer nutrients formulated to be readily available to crops while minimizing environmental losses. One of the most significant greenhouse gasses produced in agricultural soils is nitrous oxide and N fertilizer additions are known to stimulate emissions. However, there is a lack of knowledge about how or if other fertilizers (P, K, S) interact with N fertilizers to influence nitrous oxide emissions. This research focusses on the interaction of N and S fertilizers in a dark grey, sulfur-deficient soil from the Breton Plots. Results show that long-term S fertilization has increased crop yields, the rate of soil carbon sequestration and that the type S fertilizer applied may significantly affect soil nitrous oxide emissions. These results have important management implications for S-deficient soils which occupy an area of about 4 million ha in the cultivated areas of the Canadian Prairie Provinces.

Influence of Feedlot Manure Type and Bedding Application on Feed Barley Agronomy and the Environment

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Abstract
The long-term field experiment was initiated in the fall 1998 on a clay loam Orthic Dark Brown Chernozemic soil at Lethbridge, AB. The 12 amendment treatments with four replicates included a complete factorial arrangement of two manure types (stockpiled and composted beef cattle manure), two bedding materials (unchopped barley straw and wood-chips), and three application rates (13, 39, and 77 Mg ha^{-1} yr^{-1}, dry weight basis). An unamended control and inorganic fertilizer treatment were also included in the study, resulting in a total of 14 treatments. The influence of treatments on crop yield, feed quality, infiltration, leaching, runoff, soil denitrification, soil N mineralization and nitrification, P sorption in soil, wind erosion, soil mesofauna, soil organic C chemistry, and various other soil physical and chemical properties were measured over the last 16 yr. Overall, bedding and application rate had more treatment effects than manure type. Producers shifting from land application of stockpiled to composted manure application will likely not experience any reduction in feed barley yields; but shifting from straw to wood-chip bedding may cause soil N immobilization and reduced yields.