Rangeland Research Institute (RRI)

2014-2015 Annual Report

UNIVERSITY OF ALBERTA
FACULTY OF AGRICULTURAL, LIFE & ENVIRONMENTAL SCIENCES
Rangeland Research Institute

Table of Contents

1. Introduction

The University of Alberta's Rangeland Research Institute (RRI) supports the sustainability of rangeland ecosystems by carrying out innovative research, teaching and outreach on western Canadian ranches, and beyond. Since being established by the Faculty of Agricultural, Life & Environmental Sciences (ALES) in 2011, the institute has undertaken study of today's most pressing land management issues, while working to increase its capacity to generate and share knowledge with key stakeholders. Throughout 2014-15, the RRI and the Faculty of ALES worked closely to ensure the institute's critical work of advancing our understanding of rangeland ecology and management will be sustained over the long term. Most notably, a significant contribution was made to the Rangeland Ecology and Management Endowment Fund this year, following the placement of a $3.8-M conservation easement on the university's Mattheis Research Ranch near Duchess, Alberta. The establishment and growth of this endowment is pivotal to the RRI fulfilling its mandate, as the fund will assure continual support for western Canadian rangeland research. Ultimately, the fund will also ensure that the Mattheis family's inspirational vision be realized of their former ranch supporting a prominent and innovative institute focused on rangeland ecosystems.

Edwin and Ruth Mattheis at the University of Alberta-Western Sky Land Trust conservation easement announcement in Calgary, March 10, 2015.

This report summarizes activities undertaken by the RRI from April 1, 2014 through March 31, 2015. Rangeland research conducted at the University of Alberta ranches is highlighted, outreach by the institute and activities of the RRI Strategic Advisory Council are reviewed, and a financial summary for the past year is presented. Finally, important developments that have increased the institute's capacity to fulfill its mandate are reported.

2. Research

Rangelands are vitally important components of terrestrial landscapes across the globe, covering approximately 40 percent of the earth's surface, including large portions of western Canada. These complex ecosystems sustain people, livestock and wildlife by supplying a wide variety of ecological goods and services. While historically valued primarily as a source of forage and livestock production, other important services from rangelands are being increasingly recognized, and include carbon sequestration, biodiversity conservation, pollution abatement, and flood control. The latter however, have rarely been accounted for in the policy or practice of rangeland management. By focusing research attention on rangelands, the RRI aims to build a more complete understanding of the complex function and socio-economic value of these ecosystems in a rapidly changing world.

During 2014-15, researchers working at the University of Alberta's Mattheis and Kinsella Research Ranches used a variety of approaches to study topics such as invasive species, grazing management, climate change, soil nutrient cycling, and human history on rangelands. More than 70 individuals accessed the ranch facilities to conduct research, spending ≥200 person-days at Kinsella, and ≥375 person-days at the Mattheis ranch. The most active researchers were from the Faculty of ALES, with six projects being carried out by investigators from each of the Departments of Agricultural, Food & Nutritional Science and Renewable Resources. Regular users of the university research ranches also included faculty members from the Faculty of Science (Depts. of Biological Sciences and Earth & Atmospheric Sciences), as well as researchers from the University of Calgary, Oregon State University, Agriculture and Agri-Food Canada, and the Agricultural Financial Services Corporation. Strong collaborative relationships are being built with researchers who have shown continued interest in working at the two ranches, and with other stakeholders. Of particular note is a significant collaborative agreement entered into by one of the commercial cattle operators on the Mattheis Ranch, which had led to a novel study testing residual feed intake in range cattle by linking genetic information with animal performance and animal grazing behavior.

Because they serve as living laboratories of appropriate scale to test pressing questions about rangeland ecology and land use, the Mattheis and Kinsella ranches are increasingly attracting external research attention. Despite this, several of the 20+ studies carried out at these facilities in 2014-15 were funded by the RRI Competitive Grants Program (Table 1). This program began funding research at the Mattheis Ranch in 2012, and final reports for the first round of funded projects were received in summer

2014. Summaries of completed project findings are presented in Appendix I. In 2015, six applications for funding were received, and four new projects that will train one post-doctoral fellow and three graduate students at a total cost of approximately $450,000 received $159,700 of direct support from the RRI (Table 2).

Table 1. Research activity at the Mattheis and Kinsella Ranches in 2014-2015 funded by the RRI Competitive Grants program

Project Title	Principle Investigator (Dept.)	Total Award	Duration
Mechanisms for smooth brome invasion and the possibility of an invasional meltdown	Dr. James Cahill	$16,708	2013-2015
Long term monitoring of rangeland ecosystem functions on the Mattheis and Kinsella Research Ranches	Dr. Cameron Carlyle	$18,700	2013-2015
Effects of grazing on methane production and oxidation in soils of the Mattheis Ranch	Dr. Scott Chang	$20,000	2013-2015
Oasis on the prairie: quantifying and characterizing water resources on the Mattheis Ranch - preliminary groundwater assessment	Dr. Miles Dyck	$20,000	2013-2015
Tools to guide management of invasive species in rangeland ecosystems	Dr. Ellen Macdonald	$20,000	2013-2015
A proposal to conduct baseline archaeological research on the Kinsella and Mattheis Ranches	Dr. Jack Ives	$20,000	2013-2016
Grazing effects on the plant-pollinator relationship: a contrast of native legumes with an invasive (*Astragalus cicer* L.)	Dr. Cameron Carlyle	$19,600	2014-2016

Table 2. New projects funded by the RRI Competitive Grants program in 2015

Project Title	Principle Investigator	Total Award	Duration
Differentiating and understanding the roles of soil nutrient and soil community heterogeneity on plant growth, carbon storage, and biodiversity	Dr. James Cahill	$36,100	2015-2017
Defoliation and altered precipitation effects on soil microbial communities in the Mattheis Ranch	Dr. Scott Chang	$43,600	2015-2017
Quantifying the carbon balance of Mattheis Ranch	Dr. John Gamon	$40,000	2015-2017
Biophysical quantification and mapping of soil quality at the Mattheis Ranch	Dr. Guillermo Hernandez Ramirez	$40,000	2015-2017

3. Communications

In addition to generating knowledge about rangelands, the RRI aims to share that knowledge with ranchers and rangeland users, and to build a diverse network of engaged stakeholders. One of the major tools the institute has used to bring together its audience to date has been hosting field day events. In 2014-15, the RRI organized a field day at the Mattheis Research Ranch that was attended by approximately 100 neighbouring farmers and ranchers, nature enthusiasts, and professionals, researchers and students with an interest in rangelands. The work of the RRI was also featured heavily at the Roy Berg Kinsella Ranch Field Day, and in the University of Alberta Beef and Range Report released at the event (Table 3). Print and online copies of the Beef and Range Report, which was jointly prepared by the RRI and Livestock Gentec, includes 28 articles summarizing research recently completed or currently underway at the University of Alberta Mattheis and/ or Kinsella Research Ranches, and has since been widely circulated. Faculty, post-doctoral fellows, and graduate students working on RRI-funded projects also presented their work at key local events (Table 4), and at the international Society for Range Management meeting in Sacramento, CA (Table 5).

Communicating about the importance of rangeland research, and the significant opportunities to carry out groundbreaking work within the RRI, is another important part of achieving the institute's mandate. Throughout the past year, RRI representatives promoted key messages at a variety of meetings and events: from the afore-mentioned field days, to the large Western Canadian Grazing Conference held in Edmonton in 2014 (Table 6). Additionally, the institute organized two private tours of the Mattheis Ranch for a total of 25 oil and gas industry stakeholders, and introduced a class of undergraduates from the Department of Art & Design to the RRI, complete with a visit to the Kinsella Ranch. These students carried out a class project to design a logo for the RRI, and to create a wayfinding system (e.g., maps and signage) for the ranch. This project has already proved valuable, as one student, since hired by the university to create promotional materials, has specifically highlighted rangelands and the work of the RRI when designing a new brochure on university centres and institutes.

In 2014-15, the RRI also promoted its research, teaching and outreach activities on its website (rri.ualberta.ca) and social media pages. Now with almost 300 followers, the institute's Twitter feed (@UAlbertaRRI) is getting visited and mentioned at an ever-growing rate, and re-tweeted posts have reached thousands of users.

Table 3. Articles about RRI-supported research in the University of Alberta Beef and Range Report, August 2015

Title	Author(s)
Quantifying carbon stores in perennial grasslands across Alberta and its relation to grazing	Bork, Carlyle, Hewins, Lyseng, Schoderbeck, Chang, Adams, Thompson, Willms
Encroachment of thorny buffaloberry (*Shepherdia argentea*) into the Mixedgrass Prairie and implications for cattle production	Bork, Dahl
Seasonal availability of cool and warm-season herbage in Northern Mixedgrass Prairie	Bork, Irving
Testing residual feed intake in extensive cow-calf systems and evaluating behavioral aspects of efficiency	Bork, Plastow, Coros, Doerksen, Lynch-Staunton, Basarab
Pasture forage and compositional dynamics in response to defoliation regime and moisture	Broadbent, Bork, Willms
Impact of an invasive legume (*Astragalus cicer*) on ecosystem goods and services in the dry mixed prairie	Carlyle, Le
A new look at rangeland health and productivity	Gamon
Understanding the ecological impacts of smooth brome (*Bromus inermis*) invasion into Alberta's native grasslands	Stotz, Cahill
Native pollinators in Alberta's agricultural landscape	Sturm, Kohler, Phung, Manson, Carlyle
Introducing the University of Alberta's Mattheis Research Ranch	Tastad, Bork, Irving

Table 4. Presentations of RRI-supported research during 2014.

Title (Format)	Presenter/Author(s)	Venue/*Publication*	Date
Benchmarking soil carbon across Alberta's grasslands: informing the valuation of ecosystem goods and services (Poster)	Schoderbek, Bork, Chang, Carlyle, Hewins, Lyseng, Willms, Adams, Demaere, Moisey, Richman, Kupsch	Alberta Livestock and Meat Agency's Future Fare Edmonton, AB	Jun 16-17, 2014
An invasive legume (*Astragalus cicer* L.) alters multiple ecosystem services in Mixed Prairie grassland (Poster)	Le, Carlyle	Roy Berg Kinsella Ranch Field Day Kinsella, AB	Aug 13, 2014
Native pollinators in Alberta's agricultural landscape (Poster)	Phung, Kohler, Sturm, Manson, Carlyle		
Do specific plant community changes under grazing mediate carbon storage in Alberta grasslands? (Poster)	Hewins, Chuan, Schoderbek, Lyseng, Adams, Chang, Carlyle, Bork		Aug 13, 2014
		Alberta Innovates Bio-Solutions Workshop Edmonton, AB	Oct 4-5, 2014
Native pollinators in Alberta's agricultural landscape (Presentation)	Sturm, Kohler, Carlyle, Manson	62nd Annual Meeting of the Entomological Society of Alberta Lethbridge, AB	Oct 16-18, 2014

Table 5. Presentations of RRI-supported research at the 68th Society for Range Management Annual International Meeting, Sacramento, CA, Feb 2-5, 2015

Title (Format)	Presenter/Author(s)
Pollinator diversity and abundance in Alberta's agricultural landscape (Poster)	Carlyle, Phung, Sturm, Kohler, Manson
Litter decomposition rates of different grass species across a broad environmental gradient in Alberta's rangelands (Presentation)	Chuan, Hewins, Bork, Carlyle, Chang, Adams
Ecological and cattle production impacts of an invading native shrub (*Shepherdia argentea*) in a mixed prairie landscape (Presentation)	Dahl, Bork
The effect of plant community change on soil organic carbon cycling in a northern grassland (Presentation)	Hewins, Broadbent, Bork
Understanding grazing induced changes in carbon stores through microbial pathways and processes (Poster)	Hewins, Chuan, Schoderbek, Lyseng, Adams, Chang, Carlyle, Bork
Sweet clover effects on soil crust and plant community composition in mixed grass prairie in southern Alberta (Poster)	Kisko, Pyle, Bork
Does annual precipitation regulate the proportion of species diversity that comprises invasive species? (Poster)	Lyseng, Bork, Carlyle, Hewins, Schoderbek, Adams, Alexander, Richman, Moisey, Willoughby, DeMaere
Linking seed bank composition to oil and gas pipeline disturbance in southern Alberta's mixedgrass prairie (Poster)	Pyle, Bork, Hall
Seedling recruitment of contrasting legume species in Alberta's parkland and mixedgrass prairie in response to litter and defoliation (Presentation)	
Agricultural land-use differences in soil carbon content and stability in Alberta (Presentation)	Schoderbek, Hewins, Carlyle, Chang, Adams, Bork
Estimation of soil quality under contrasting land uses in Alberta (Poster)	Schoderbek, Hernandez Ramirez, Bork

Table 6. Outreach and promotional activities undertaken in support of the RRI during 2014-15.

Event/*presentation title*	Presenter(s)	Venue	Audience(s)	Date
Tour; *Overview of research activity on the Mattheis Research Ranch*	Bork	Mattheis Ranch Field Day Newell County, AB	Practitioners, professionals, policy-makers, researchers, educators, students, general public	Jun 6, 2014
Prairie plant identification	Tastad			
Rangeland Research Institute: Research highlights and support of EG&S	Bork	Prairie Conservation Forum summer meeting Stettler, AB	Practitioners, professionals, general public	Jun 18, 2014
Rangeland Research Institute and plans for the Stavely Research Station	Bork	Nanton, AB	Practitioners, policy-makers	Jun 25, 2014
ASB Trade Show	Tastad	2014 Agricultural Service Board Tour Brooks, AB	Practitioners, professionals, general public	Jul 7, 2014
Rangelands stores of carbon and their value to society	Bork	Society for Range Management-International Mountain Section summer meeting Wainwright, AB	Practitioners, professionals, policy-makers, researchers, students	Jul 18, 2014
Tour; *Integration of energy extraction and livestock production in Alberta*	Bork, Tastad	Mattheis Research Ranch Newell County, AB	Practitioners, professionals, policy-makers	Jul 21, 2014
Rangeland Research Institute and plans for the Onefour Research Station	Bork	Manyberries, AB	Practitioners, policy-makers	Jul 22, 2014
Range research at the Kinsella Ranch; Rangelands as a source of environmental goods and services	Bailey, Bork, Carlyle, Stotz	Roy Berg Kinsella Ranch Field Day Kinsella, AB	Practitioners, professionals, policy-makers, researchers, general public	Aug 13, 2014
Research highlights from the Rangeland Research Institute	Bork	Alberta Research and Extension Council of Alberta – Forage Group Leduc, AB	Professionals, educators	Nov 5, 2014
WCGC Trade Show	Tastad	Western Canadian Grazing Conference Edmonton, AB	Practitioners, professionals, policy-makers, educators, students	Dec 9, 2014

4. Capacity Building

For the RRI to continue progressing towards its goal of becoming a foremost centre for rangeland research, the institute must continue growing its scientific and technical expertise, as well as its ability to translate research results effectively and deliver meaningful extension programs to members of its network. Further, since RRI-affiliated researchers benefit greatly from having regular access to a physical land base on which to carry out their research, the institute must ensure the integrity of, and seek out opportunities to expand on, the existing land base available for these activities, where and when appropriate. During 2014-15, the Faculty of ALES took the important step of placing a conservation easement on the Mattheis Research Ranch, thereby protecting the ranch from increases in future cultivation, drainage of natural wetlands, and subdivision of the primary ranch property. In addition to its high conservation value, this action ensured that the property will remain a working cattle ranch on which to conduct rangeland research in perpetuity. Thus, the long-term capacity of the RRI to carry out research over scales and contexts relevant to livestock producers and land stewards was solidified. Throughout the past year, the RRI has also been pursuing a promising opportunity to expand its research land base even further via an agreement in principle with the Government of Alberta. This agreement would involve securing access to the former Agriculture and Agri-food Canada (AAFC) rangeland research facilities at both Stavely and Onefour, Alberta. Both parties expect the agreement to be a significant asset in support of continued rangeland research in western Canada, as it would allow RRI-affiliated researchers to test questions in an even wider range of biophysical environments. Moreover, this agreement would allow the RRI to maintain a longstanding (as much as 83-year) tradition of range research on these lands for the benefit of local communities, including two research studies that date back to 1927 and 1949 at Onefour and Stavely, respectively.

Given the importance of transferring research results, and the current dearth of extension programming aimed at rangeland professionals and practitioners, the RRI continued to explore how best to increase its capacity in this area throughout 2014-15. By networking and collaborating with other groups who have identified similar needs, and by evaluating the relative success of various outreach tools, the RRI ultimately has positioned itself to become a key source of information for ranchers and other range users. In all likelihood, the number of RRI staff will have to increase to realize an expanded outreach strategy; however, the type of position that should be created—be it an extension scientist, dedicated outreach staff, or other—is not yet entirely clear.

5. Strategic Advisory Council

The RRI Strategic Advisory Council (SAC), which provides key insights and guidance to the institute's Director and staff, held one meeting in 2014-15. The SAC comprises a total of 20 individuals with diverse backgrounds and interests in the sustainable management of rangelands. Serving council members for the past year are listed in Table 7.

Table 7. Members of the RRI Strategic Advisory Council, March 2015

Name	Position, *Agency*	Location
Barry Adams*†‡	Head, Rangeland Resource Management Program, *Alberta Environment and Sustainable Resource Development*	Lethbridge, AB
Brian Berg	Producer	Duchess, AB
Dr. Stan Blade	Dean, Faculty of Agricultural, Life & Environmental Sciences, *University of Alberta*	Edmonton, AB
Dr. Edward Bork	Director, Rangeland Research Institute; Professor and Mattheis Chair in Rangeland Ecology & Management, *University of Alberta*	Edmonton, AB
Dr. Cameron Carlyle	Assistant Professor, *University of Alberta*	Edmonton, AB
Jordon Christianson	Director, Property Administration, *Special Areas Board*	Oyen, AB
Cherie Copithorne-Barnes	Producer and Chief Executive Officer, *CL Ranches Ltd.*	Jumping Pound, AB
Floyd George‡	Producer; Director, *Eastern Irrigation District*	Gem, AB
Joyce Gould†	Science Coordinator, *Alberta Parks*	Edmonton, AB
Joel Heese	Specialist, Environment, *Cenovus Energy Inc.*	Redcliff, AB
Eddy Isaacs	Chief Executive Officer, *Alberta Innovates – Energy & Environment Solutions*	Calgary, AB
Edwin Mattheis	Producer (Retired)	Calgary, AB
Ruth Mattheis	Producer (Retired)	Calgary, AB
Karen Raven	Agriculture Land Use Specialist, *Alberta Agriculture and Rural Development*	Edmonton, AB
Dr. Bill Shotyk	Professor and Bocock Chair in Sustainable Agriculture, *University of Alberta*	Edmonton, AB
Rich Smith	Executive Director, *Alberta Beef Producers*	Calgary, AB
Dr. Brad Stelfox	Founder and Landscape Ecologist, *ALCES Landscape & Land-Use Ltd.*	Calgary, AB
Josie Van Lent‡	Producer; Dean, Agricultural Sciences & Human Service, *Lakeland College*	Vermillion, AB
Dr. Walter Willms‡	Researcher (Emeritus), *Agriculture & Agri-Food Canada*	Lethbridge, AB
Dave Zehnder†	Producer; Program Coordinator, *Ecological Services Initiative*	Invermere, BC

* Chair of RRI Strategic Advisory Council; † Member of Communications Subcommittee; ‡ Member of Capacity Building Subcommittee

6. Financial Overview

The Rangeland Ecology and Management Fund (REMF) was established as an endowment in 2015, with an initial $1-M of revenue from powerline construction being transferred from the RRI account, and a $50,000 contribution being made by Alberta Beef Producers. Following the placement of a conservation easement on the Mattheis Research Ranch, which was purchased by Western Sky Land Trust for $3.8-M using a grant awarded through the Alberta Land Stewardship Fund, an additional $3.2-M contribution was made to the REMF. The balance of the revenue from the conservation easement will be deposited into the REMF over the next three years, as matching contributions from the University of Alberta allow for the release of the full amount. The newly-created REMF, with a current total principal of $4.2-M (see Appendix II), will serve as a critical source of long-term funding for rangeland research being conducted at the U of A, thus allowing the RRI to fulfill its mandate.

A summary 2014-15 financial statement for the RRI is provided in Appendix III. This statement includes a review of income, primarily surface lease revenue from oil and gas activity and utility development, as well as expenses. Expenses include costs associated with communications and the administrative operations of the RRI, legal services associated with capacity development activities, and the direct cost associated with the RRI Competitive Grants Program.

Appendix I. Summaries of RRI-funded research results

Ecological and agronomic consequences of Cicer milkvetch (*Astragalus cicer* L.) introduction into Mixed Prairie grassland

Cameron N. Carlyle, *Assistant Professor, Dept. of Agricultural, Food & Nutritional Science*

Humans depend on ecosystems for the goods and services (EG&S) they provide. In rangelands the primary EG&S is forage production, but the value of carbon storage and biodiversity are increasingly being recognized. Non-native plant species can impact native ecosystems in undesirable ways, by altering biodiversity or changing ecosystem function (such as carbon storage). Cicer milkvetch is an agronomic plant often used in pasture and hay fields in Alberta, but we have observed it invading the native grasslands of Southern Alberta. This could be perceived as beneficial as cicer milkvetch is a large nutritious plant that provides good forage to cattle. In order to determine the best course of action for managing such an invasion a more holistic approach that includes multiple EG&S is required, so we measured the impact of this invasive species on forage quantity and quality, plant diversity and carbon storage.

We sampled patches of grassland with cicer milkvetch, the patch immediately adjacent to it and a patch 5 meters away that was on the same ecosite. In each of these patches we measured the three different focal ecosystem goods and services. Forage quantity was measured by harvesting biomass from a 20 x 50 cm quadrat; the biomass was separated into grasses, forbs, shrubs and cicer milkvetch. Forage quality was assessed by measuring the amount of nitrogen in each of the different plant groups. Plant diversity was measured in the same plot using percent cover. Carbon storage was assessed by measuring the concentration of carbon in soil (soil bulk density was also measured), roots and litter.

As expected forage quantity and quality were highest in plots with cicer milkvetch, owing largely to the presence of the cicer milkvetch, but the nitrogen content of grasses increased in these plots. However, plant diversity was lowest in where there was cicer milkvetch and was associated with a decline in the biomass of grasses and other forbs. Soil carbon was not different between plot types, but there was a trend of cicer milkvetch plant size being negatively related to soil carbon the concentration of carbon in the litter of milkvetch was lower than that of native plants. Our data show that an invasive plant can have positive, neutral and negative impacts on different ecosystem goods and services. As these rangelands become increasing valued for EG&S other than

forage production land managers should begin monitoring and considering these other values.

Spatial patterns of and management effects on soil carbon in the Mattheis Ranch

Scott Chang, *Professor, Dept. of Renewable Resources*

Soils are the largest terrestrial carbon pool on earth. High heterogeneity in spatial distribution of soil carbon may cause great uncertainty in estimating soil carbon storage. Meanwhile, small changes in the soil carbon pool due to land cultivation may result in large fluxes in greenhouse gases between the soil and the atmosphere. In order to understand the role of soils in the global carbon cycle, it is essential to understand the spatial distribution of and cultivation effects on soil carbon in specific regions. In this study, we investigated both the spatial distribution of soil organic (SOC) and inorganic carbon (SIC) contents and the effect of land cultivation on SOC contents and densities in the Mattheis Ranch in southern Alberta, Canada. The SOC contents had a decreasing trend from north to south and a clustered spatial pattern throughout the grasslands of the ranch, with average values of 11.5 and 6.8 g kg–1 ranging from 8.9 to 22.4 g kg–1 and from 4.0 to 13.3 g kg–1 in the 0–10 and 10–30 cm layers, respectively. The SOC densities ranged from 1.23 to 2.78 kg C m–2 and from 1.21 to 3.62 kg C m–2 in the 0–10 and 10–30 cm layers, respectively, in the grasslands in the ranch. The SOC contents in both soil layers were significantly different ($P < 0.05$) among the paddocks or between the two soil layers in each paddock. However, nearly no SIC existed in the 0–30 cm soil layer. The SOC contents were significantly related to landscape positions with bottom > middle > top in the 0–10 and 10–30 cm layers while they were usually higher in shrub than in graminoid/ forb communities, which influenced the spatial distribution of SOC. We find that land cultivation did not significantly ($P > 0.05$) cause the loss of SOC in both bulk soils and particle-size fractions in the Mattheis ranch.

Baseline carbon monitoring for rangeland carbon sequestration

John Gamon, *Professor (cross-appointed), Depts. of Biological Sciences and Earth & Athmospheric Sciences*

The larger goals of our project are to determine how effectively Alberta rangelands absorb and store carbon dioxide, and to see how various factors (soils, moisture, weather, and grazing regime) affect that carbon storage. More specific, short-term project goals included 1) establishing baseline measurements of ecosystem carbon

uptake for representative locations at Mattheis Ranch, and 2) evaluation of automated sampling methods for assessing carbon uptake. We were particularly interested to see if we could detect differences in ecosystem carbon uptake for different ranch locations, and to see how well optical remote sensing compared to established flux methods (eddy covariance, a method for measuring photosynthetic carbon uptake of whole ecosystems). An additional goal included collection of airborne imagery for mapping of vegetation carbon uptake patterns.

To date, our findings have demonstrated that Mattheis ranch grasslands appear to be net carbon sinks, although a final annual carbon budget has yet to be completed. Of the two primary field sites (E3 and E5), one clearly had a greater carbon uptake, and this is likely related to the contrasting soil types, hydrology, vegetation types, and biodiversity of the two sites. Optical remote sensing does a good job of tracking carbon uptake patterns measured directly by eddy covariance or biomass accumulation, providing an important demonstration that remote sensing can be used to monitor rangeland carbon uptake. If this project is continued, future work could link carbon uptake to total ecosystem carbon balance and sequestration (including soil carbon), and could better examine factors causing spatial and temporal variability in carbon uptake. For example, the links between carbon uptake, species composition, and biodiversity, and management regimes could be further clarified.

Over the long term, this research can inform management practices to enhance carbon sequestration. A successful demonstration of effective and reliable carbon storage for rangelands is a first step towards developing financial incentives (e.g. carbon credits) for good rangeland management. A program of carbon credits could provide financial benefits for ranchers while providing other benefits.

Hay mulching for revegetation of Alberta native grasslands

M. Anne Naeth, *Professor, Director of the Land Reclamation International Graduate School and Associate Dean Research and Graduate Studies, Dept. of Renewable Resources*

Southern Alberta prairies have been extensively disturbed through oil and gas related activities. Disturbances include loss of vegetation, soil horizon mixing, soil compaction and soil contamination. Denuded dry mixed grass prairie is prone to erosion and encroachment of invasive plant species so rapid development of a vegetation cover is highly recommended. Seedling establishment in semiarid prairie sites under reclamation can be facilitated by mulch due to its effects on seedbed conditions. We

assessed whether seed germination and seedling emergence of broadcast seeds increases when the soil surface is mulched and whether there are differences in seedling recruitment between sites mulched with native hay and cereal straw.

The reclamation site is an abandoned irrigation area at Mattheis Ranch in the mixed grass prairie of southern Alberta. Soil was cultivated and the seedbed prepared through manual harrowing, then plots broadcast seeded with *Elymus trachycaulus*, *Bouteloua gracilis*, *Hesperostipa comata*, *Astragalus canadensis* and *Linum lewisii*. Hay and straw mulch were applied at two rates (300 and 600 g m^{-2}). Hay was mowed from a nearby field and composed of grass and forb plant material. The surface layers of one year old wheat straw bales were used for straw mulch. Seedling emergence and establishment were assessed through the first three growing seasons. Soil water content and canopy transmitted light were measured annually.

This research increases our understanding of the factors governing native species germination and establishment and helps to clarify best practices for revegetation of disturbed lands in the prairie regions of Alberta. Both hay mulch rates increased *Elymus trachycaulus* and *Linum lewisii* seedling emergence relative to bare ground. *Astragalus canadensis* seedling emergence was more than ten times higher with low straw and both hay rates than with bare ground. Straw mulch at a low rate facilitated seedling emergence but had a neutral to negative effect when applied at high rates. These results clearly show that low mulch rates can increase native plant establishment during the critical first year of prairie reclamation as they were able to overcome microsite limitations.

This research demonstrates that straw or hay mulch at low rates is an inexpensive method to conserve soil water and improve native grass and forb seedling establishment. High rates of mulch were detrimental to the reproductive success of *Bouteloua gracilis*. Hay is a finer textured mulch than straw and is a safer option to improve seedling establishment if applying at higher rates. The reliability of seeding can be improved by adding species able to colonize bare ground such as *Bouteloua gracilis* to the seed mix.

Impact of microsites on reclamation of Alberta native grasslands

M. Anne Naeth, *Professor, Director of the Land Reclamation International Graduate School and Associate Dean Research and Graduate Studies, Dept. of Renewable Resources*

Temperature grasslands in Canada have been reduced by 70 % since the 1930s. Continued urban and rural development, cultivation, livestock grazing and energy industry developments threaten and can continually decrease the area and health of grassland ecosystems. Efforts to reclaim grasslands after disturbance through seeding, however, often result in poor establishment of a diversity of native species. Increased germination may be achieved through creation of microsites and seeding a diversity of species. Microsites provide shelter from the elements and favourable changes in soil water, nutrients and light. This research investigated whether microsites and addition of soil amendments enhance emergence and establishment of seeded native forb and grass species.

The reclamation sites were an abandoned irrigation area in the mixed grass prairie (Mattheis Ranch) and a reclaimed well site (Devonian Botanic Garden) and a landfill (Elk Island National Park) in the aspen parkland. Depression, mound and flat plots were constructed and one of six amendments added (straw, hay, erosion control blanket, manure, hydrogel, no amendment). Manure and hydrogel were cultivated into the soil. Four native grasses and three forbs were each sown at 50 pure live seed m^{-2}. Erosion control blanket, straw and hay were applied following seeding and secured to ground. Seedling emergence was monitored every two weeks in the first growing season and in late June in the second growing season. Final plant density and cover were measured in August of each year. Soil samples were collected annually and analyzed for texture, major nutrients and salinity measures to characterize local site conditions and assess the influence of amendments on them.

Site differences were found. Only at Mattheis Ranch, a drier and more exposed environment, did pits enhance emergence in the first year. This effect was not found in the second year. Survival in pits was lower than in other microsites at all sites. Grass and forb species in flats at Mattheis Ranch had lowest cover supporting the hypothesis that micro topography enhanced environmental heterogeneity and plant productivity. Addition of hydrogel to the soil resulted in greater plant cover at Mattheis Ranch and should be considered as a reclamation amendment in dry environments. Straw, hay and erosion control blankets enhanced grass and forb seedling emergence and establishment on flats or mounds on all of the sites. The exception was at Mattheis Ranch where higher application rates were not as favourable to grasses, specifically *Bouteloua gracilis*.

We conclude from this research that straw and hay are good amendments to enhance early native grass and forb establishment as long as the sources are weed free and

application rates are not higher than 0.3 kg/ m^2; erosion control blankets improve revegetation success on flat or contoured topography; manure is not beneficial to native plant emergence or early establishment, however, if high plant cover is desired, its use with species tolerant of high nutrient loads would be appropriate; and a diversity of native grasses and forbs should be seeded on grassland reclamation sites regardless of microsites and/ or amendments used as this helps buffer variability in revegetation success caused by variation in environmental conditions.

Mapping patterns in the distribution and abundance of upland songbirds on the Mattheis Ranch

Scott E. Nielsen, *Associate Professor and Alberta Biodiversity Conservation Chair, Dept. of Renewable Resources*

In North America, grasslands have been suffering severe declines in area in response to human activity over the past two centuries. Remaining grasslands are often fragmented, polluted, overrun with invasive species or otherwise rendered unsuitable for grassland bird habitat. Remaining native prairie is also subject to anthropogenic substitutes for natural ecological drivers, and to pressures for development, oil and gas exploration, and recreation. Working landscapes such as cattle ranches play an important role in conserving what native prairie is left, and gaining knowledge of the biodiversity of an area of grassland is an important first step towards managing the land in a sustainable manner which is beneficial to many species.

The University of Alberta's Mattheis Ranch was donated by Edwin and Ruth Mattheis in 2010, and this was the first project to directly address wildlife since the University took possession. The intent of this project was to create an inventory of birds on the University of Alberta's Mattheis Research Ranch within a spatially referenced system. We conducted point count surveys on the 12-300-acre Mattheis Ranch in 2012 and 2013, detecting 100 species of grassland songbirds, shorebirds, ducks, and raptors. Twelve species made up 64 and 68 percent of species in 2012 and 2013, respectively: western meadowlark (encountered at nearly all sites in both years), Sprague's pipit, savannah sparrow, vesper sparrow, clay-coloured sparrow, brown-headed cowbird, marbled godwit, ring-necked pheasant, willet, red-winged blackbird, grasshopper sparrow, upland sandpiper, and eastern kingbird. To better understand patterns of species occurrence, we created maps of the survey area showing the spatial distribution of individual species, and total songbird richness across the ranch (see Fig. 2), and analyzed richness using random-effects panel linear regressions. We found that habitat

features such as power lines, wetland presence and shrub density affected bird richness on the ranch. In both years, the strongest influence was that of shrub cover which likely supports high species richness because it contributes to habitat heterogeneity by creating nesting cover, perch sites, and shelter from weather conditions and predators for some species. Shrub encroachment is a problem in many grassland areas, as it modifies the original plant communities. It does create habitat for some species, but potentially at the cost of habitat for other species, specifically grassland obligates. We have not analyzed individual responses to species such as grassland obligates, but this should be considered.

Future work on bird populations at the Mattheis Ranch could focus on between-year species turnover, management for species at risk, and specific effects of rotational grazing using more detailed management data and altered (experimental) grazing regimes. Detectability and interactions among factors should be considered in future analyses.

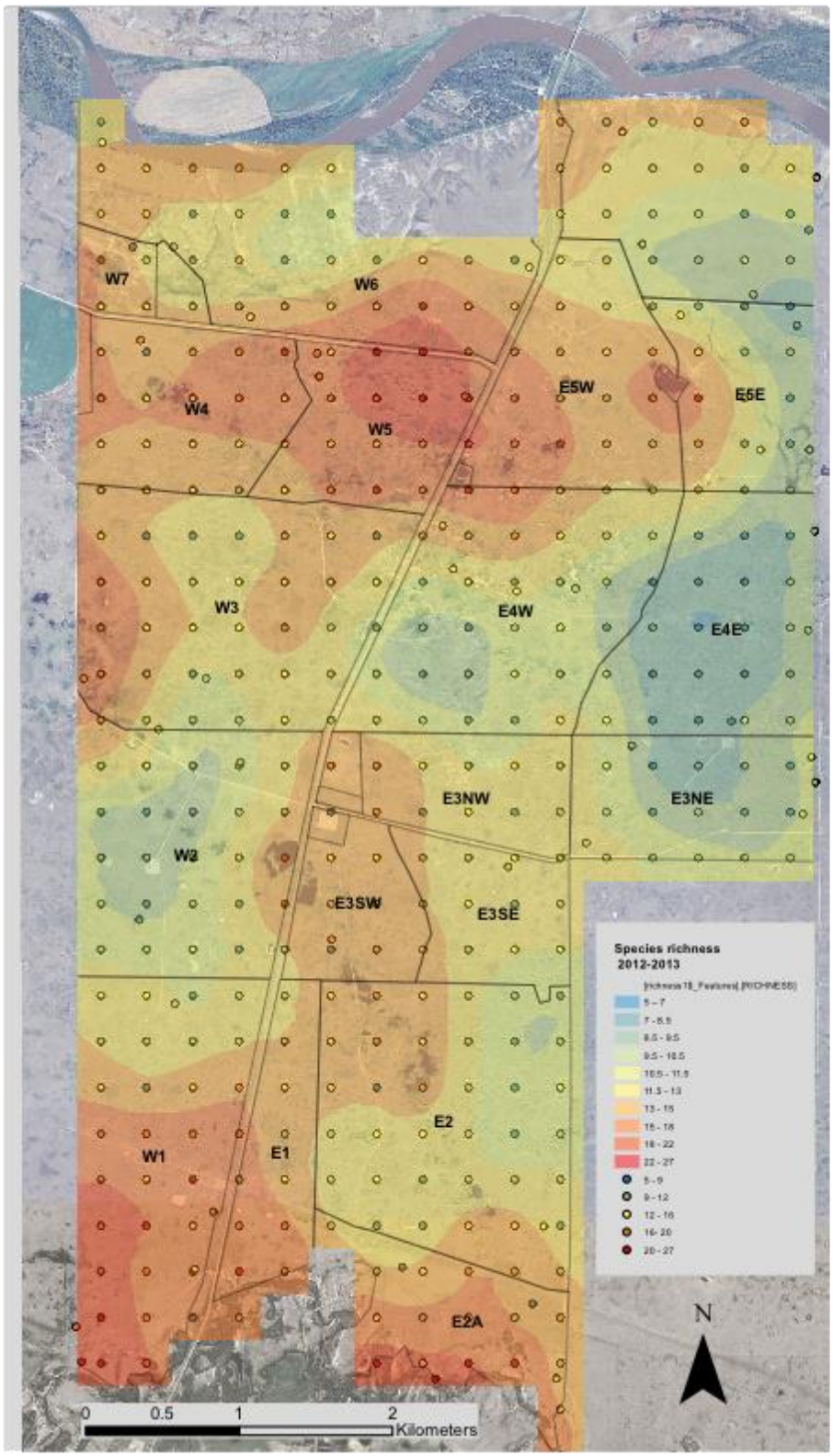

Figure 1. Map of average songbird richness observed across eastern portion of the Mattheis Research Ranch in 2012 and 2013.

Appendix II. Rangeland Ecology and Management Fund Financial Statement of Actuals, April 1, 2014 to March 31, 2015

	Actuals
Principal	
Opening Balance	$0
Contributions[1]	$4,218,789
Closing Balance	**$4,218,789**
Spending Allocation	
Opening Balance	$0
Current Year Endowment Spending Allocation[2]	$2,501
Current Year Expenditure	$0
Closing Balance After Encumbrances	**$2,501**

[1] Contributions: Conservation Easement (CE) Grant Transfer ($3,168,789), Utility Right of Way revenue ($1,000,000), Alberta Beef Producers donation ($50,000); the remaining $626,211 of the CE grant to be transferred to the Rangeland Ecology and Management Fund in 2015-16.

[2] Spending Allocation: 2014-15 spending allocation of $2500.87 is based on the principal amount being deposited into the endowment late in the fiscal year. 2015-16 spending allocation will be $124,867.92 in addition to $2,500.87carried over from 2014-15.

Appendix III. RRI Financial Statement of Actuals, April 1, 2014 to March 31, 2015

	Actuals
Opening Balance	$1,467,748
Revenue	
Lease Revenue/Other	$487,353
Utility Right of Way	$47,175
Total Revenue	**$2,002,276**
Expenditures	
Appraisal of Mattheis Ranch	$27,954
Legal Costs	$84,972
Property Taxes	$2,033
Transfer to Endowment	$1,000,000
Academic Assistant	$54,485
Temp Support Staff	$13,850
Benefits[3]	$14,513
Supplies	$10,383
Hospitality	$1,623
Travel Expenses	$9,772
Rentals and Leases	$4,919
Equipment	$8,637
Research Projects	$65,008
Total Expenditures	**$1,298,148**
Net	$704,128
Net Adjusted Benefits	$718,640

[1] University adjusts for benefit variance at year end

Note: This summary excludes U of A (in-kind) support to the RRI through academic staffing, which is currently valued at over $250,000 annually