

RANGELAND RESEARCH INSTITUTE (RRI)

2017-2018 Annual Report



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

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1. Introduction

The University of Alberta Rangeland Research Institute (RRI) was established in 2011 by the Faculty of Agricultural, Life and Environmental Sciences (ALES) resulting from the generous 5,000 ha land donation by U of A alumni Edwin and Ruth Mattheis. Now in its seventh year, the RRI continues to enable research related to rangeland management and ecology. RRI supports a wide array of research to improve our understanding of factors related to climate change, quantifying environmental goods and services, and impacts of cattle grazing, natural resource extraction and energy transmission, as well as grassland conversion into other land uses.

While supporting research is the primary objective, the RRI also participates in teaching and outreach activities that further the goals of educating students, stakeholders, and the general public about grassland ecology and issues related to industries that depend on these landscapes. The importance of social and cultural aspects of grasslands is also acknowledged by the RRI, as evidenced by its support for anthropological investigations and teaching activities, as well as engaged individuals who communicate scientific ideas and the importance of land stewardship through visual arts to reach a broader public audience.

This report summarizes key activities undertaken by the RRI from April 1, 2017 through March 31, 2018. The report includes a brief summary of research activities, including overviews of three recently completed projects conducted on Alberta rangelands; capacity building; a summary of communication and outreach activities for the RRI; a review of the RRI Strategic Advisory Council role and current membership; as well as a financial summary of the previous year.

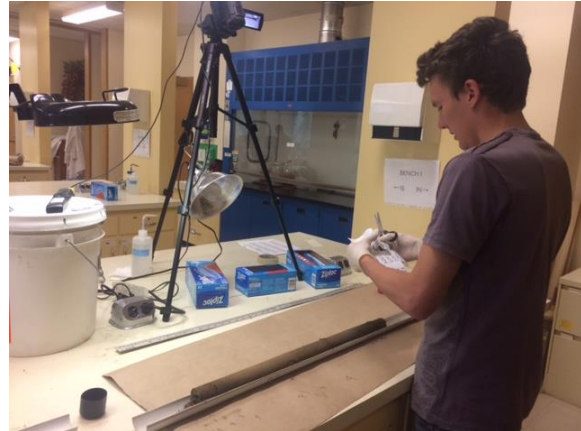


Purple prairie clover at Mattheis Ranch,
July 2017.

2. Research

The importance of rangelands came to the forefront in 2017 across Alberta and beyond when large areas of the province experienced fire during seasonal drought and warm temperatures. The tragic loss of life, cattle, wildlife, as well as forage and habitat for animals, was brought to the forefront by media, in turn highlighting the value of rangelands to society. While rangelands have co-evolved with fire and can be viewed as a necessary part of regenerating plant communities, larger human populations have come to rely on these lands for a wider variety of uses. Rangeland landscapes are areas where livestock production takes place, natural resources and energy is extracted and people carry out their livelihoods and build communities. Rangelands are equally valued for what they provide in terms of recreation, aesthetic beauty, are an important source of biodiversity, and their complex interactions of biological and abiotic factors provide clean water, air, soil microbial and vegetation communities, as well as wildlife. These environmental goods and services are not well understood or researched and have formed one of the main focal areas of research targeted by the RRI over the past several years.

In 2017-18, RRI-affiliated researchers and partners investigated topics related to rangeland management, sustainability and ecology. Research topics included those that pertain to human use and industrial impacts on the landscape such as carbon storage and greenhouse gas (GHG) mitigation, soil re-vegetation following high voltage powerline construction, effects of land use disturbance on birds, invasive species mapping, seedbank dynamics relative to disturbance history, as well as conducting baseline archaeological research. Research pertaining to grazing included assessing the impacts and interactions of drought and grazing, impacts of grazing management on biodiversity, pollinators, nutrient cycling, carbon storage, and GHGs, among others. A partial list of projects is shown in Appendix I.



Processing soil cores from year 1 of the adaptive, multi-paddock grazing study.

A total of 70 individual researchers, including 13 principle scientists, 16 graduate students, 26 undergraduate students, as well as 15 visiting scientists and senior technicians, spent time on the Mattheis Research Ranch during 2017-2018, spending 859 person-days at the facility. Researchers were mostly from the Faculty of ALES (Agricultural, Life and Environmental Sciences; Depts. of Agricultural, Food and Nutritional Sciences & Renewable Resources) as well as the Faculty of Science (Depts. of Biological Sciences & Earth and Atmospheric Sciences) and the Faculty of Arts (Anthropology). In 2017, Mattheis Ranch was proud to host Honorable Lieutenant Governor Lois Mitchell for the filming of the Western Sky Land Trust video production for Canada's 150th celebrations. Of note, two artists spent time on the ranch to observe landscapes where migratory birds fly as part of an art installment they are creating. Other groups using the Mattheis Ranch included the University of Calgary, Alberta Environment and Parks, Alberta Agriculture and Forestry, Agricultural Financial Services Corporation, St. Mary's University, and the Alberta Biodiversity Monitoring Institute.



Scenic overlook of the Red Deer River at Mattheis Ranch, June 2017. Photo by Cait Wills.

The majority of these research activities used the Mattheis and/or Kinsella Research Ranches as one of a few locations across western Canada. For some projects, one or both ranches represent the primary location. Both ranches provide unique and diverse habitats, plant and soil communities, or access to beef herds to answer particular research questions. Additionally, the Memorandum of Understanding between the U of A and Alberta Environment and Parks signed in 2016 allowed improved

opportunity for researchers to use the Onefour and Stavely Research Stations. Privately owned and public lands are also used across Alberta, Saskatchewan and Manitoba in order to broaden the land base and ensure research is conducted under a wide array of climatic and agro-ecological environments and applicable to ranchers and industry stakeholders.

3. Research Profiles

Grazing Mediated Impacts on Litter Decomposition May Help Alberta Grasslands be Managed to Mitigate Climate Change

Prepared by E.W. Bork, University of Alberta

Rising atmospheric CO₂ levels have created an unprecedented interest in developing mitigation strategies to increase carbon (C) storage and reduce agricultural greenhouse gases (GHGs). Grasslands are one of the most widely distributed biomes globally, and are known to store nearly three times the C found in the atmosphere, while also



Foothills study site. Photo from Sean Chuan.

supporting rural communities. Current market uses for rangelands in Canada are limited to forage and livestock production, while many of the secondary ecological goods and services (water storage, provision of biodiversity, consumptive wildlife, recreational pursuits and C storage) that they provide are undervalued in our economy.

While the role of intact native grasslands in provisioning C storage is well known, less is understood about how ongoing grazing alters C stores, including the mechanism by which this is likely to occur. One such mechanism is the rate of plant litter decomposition, as this provides a transformation pathway for C into soil organic matter. Moreover, grazing is known to alter plant community composition, and differences in plant chemistry induced by decades of use may therefore alter decomposition rates.

In 2014, Dr. Daniel Hewins (now an Assistant Professor of Biology at Rhode Island College), then post-doctoral fellow at the University of Alberta, helped initiate a study evaluating rates of litter mass loss from May 2014 through October 2016 at 15 locations distributed across three agro-climatic zones of south-central Alberta. Testing was further stratified into grazed and non-grazed areas, with a total of 7 different dominant grass species evaluated. Sean Chuan (MSc. 2017) was added to the project in 2014 to measure the

activities of 5 important extracellular enzyme activities (EEA) responsible for C, nitrogen (N) and phosphorus (P) cycling in litter and soil samples.

Findings indicate that rates of litter mass loss were greater in high rainfall Foothills Fescue grasslands of SW Alberta compared to more arid grasslands of the Mixedgrass Prairie. Additionally, litter situated in grazed environments tended to decay faster than the same litter situated in their non-grazed counterparts, particularly in mesic to high rainfall areas, and coincided with increases in the enzymes



Sampling litter bags. Photo from Sean Chuan.

responsible for C-liberation. In contrast, litter in non-grazed areas had greater levels of the EEAs responsible for nutrient (N and P) cycling, presumably due to the lack of direct effects of animals on vegetation breakdown. Marked differences in decomposition rates were also evident among many of the plant species tested, with Kentucky bluegrass, a common but productive introduced forage grass in the Fescue Grasslands of SW Alberta, decaying faster than other species at that location. Given that bluegrass is a well-known increaser under grazing, faster decomposition of this species may provide novel insight into how grazing-induced shifts towards this species are altering biogeochemical cycling, and potentially C storage. In the Mixedgrass Prairie, blue grama, a warm-season grass that normally is relatively resistant to decay, unexpectedly had the highest EEA. The widespread native species western wheatgrass had among the slowest decomposition rates.

Overall, these results highlight 1) that strong variation exists regionally in grass decomposition rates, and that these vary further with ongoing exposure to grazing and the identity of grass species, and 2) that the use of EEAs provided new insight into where, why, and how the decomposition of vegetation varies across these grasslands. When coupled with information on soil C storage, GHG emissions, and perhaps C labeling studies in the future, these data should provide significant insight into the development of beneficial management practices under grazing that can optimize C storage and reduce the agricultural GHG footprint.

Measuring the Carbon Storage of Rangelands

John A. Gamon and Ran Wang, University of Alberta

Rangelands, specifically grass and shrub-dominated landscapes, comprise over 40 percent of Alberta's land area. They provide a variety of important goods and services, including fodder for grazing animals, habitat for a diverse array of species, and carbon storage. They are also subject to disturbance, including periodic drought or overgrazing, which diminish their capacity to provide these essential goods and services. Good management can help maintain the essential functions of rangelands, ensuring productive and sustainable resources for future generations.

To better understand the role of grazing management in a variable climate, ongoing work at Mattheis Ranch is determining the capacity of the mixed-grass prairie, typical of southern Alberta's rangelands, to take up and store carbon dioxide through photosynthesis. Measurements utilize "eddy covariance," a method of measuring whole-ecosystem exchange of carbon dioxide and water vapor over large landscapes (Figure 1). Measurements of the net exchange of carbon dioxide can be used to derive estimates of "gross primary production" (GPP), a measure of the photosynthetic productivity of the ecosystem that provides a good estimate of biomass yield used as fodder. Eddy covariance is considered the "gold standard" for measuring the carbon dioxide exchange between terrestrial ecosystems and the atmosphere, and is used to monitor the health and function of large regions of the Earth's terrestrial biosphere. Data from Mattheis Ranch are now contributing to a growing global database of such measurements taken around the world.

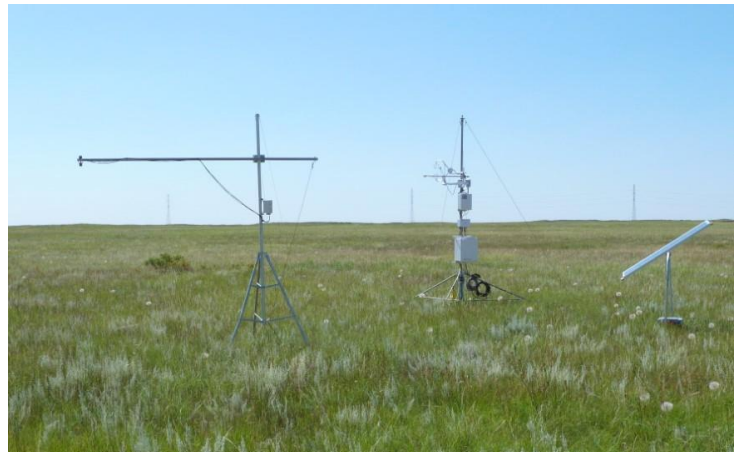


Figure 1. Eddy covariance measurements and surface reflectance measurements at the Mattheis Research Ranch. Photo from Ran Wang.

To extend these estimates to larger areas, eddy covariance is compared to satellite measurements of surface reflectance, providing an essential calibration for satellite-derived estimates of yield and productivity. Figure 2 compares a time series of primary productivity (GPP) measured by eddy covariance to NASA's MODIS satellite surface reflectance in various wavebands, expressed as "vegetation indices" depicting the relative productivity of the landscape. Together, these measurements reveal clear year-to-year variation in productivity (associated with changing temperature and rainfall patterns), and show a strong association between satellite-derived vegetation indices and eddy covariance measurements. This agreement between satellite data and ground-based measurements provide a foundation for large-scale monitoring of rangeland health and productivity.

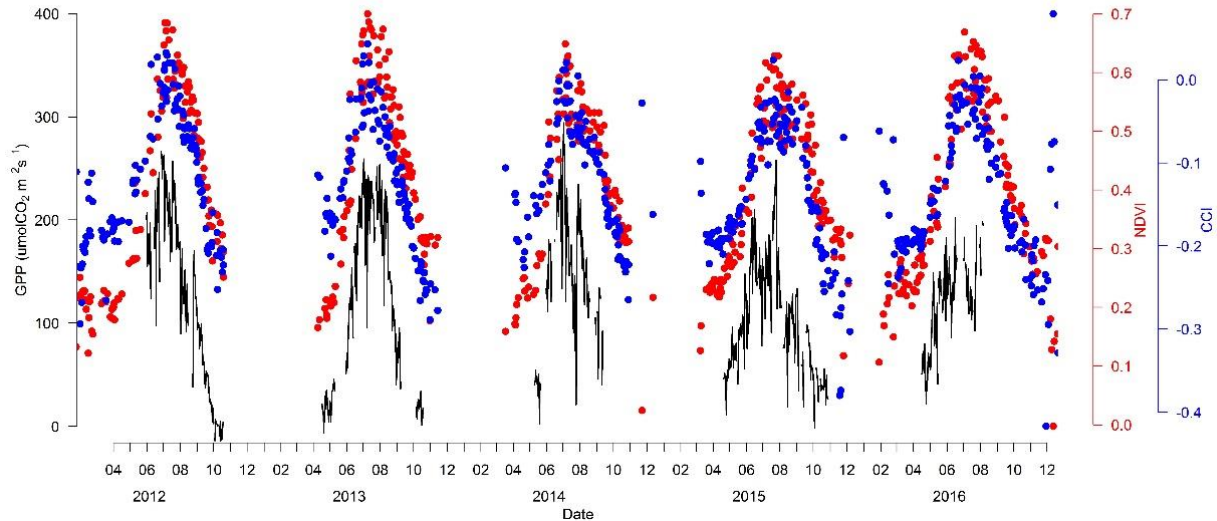


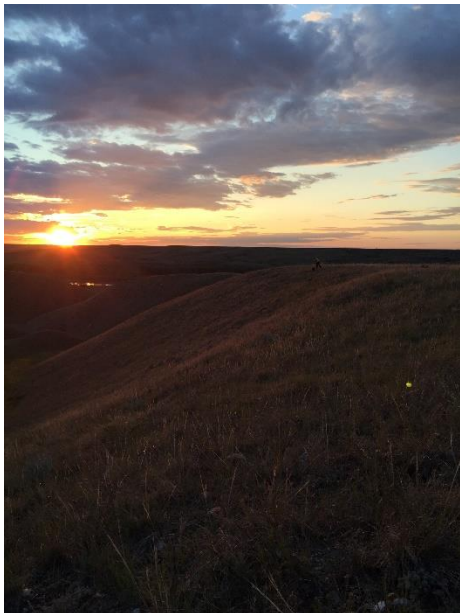
Figure 2. Five-year time-series of gross primary productivity (GPP, black line – measured with eddy covariance) and MODIS vegetation indices (NDVI and CCI) measured at site E3, Mattheis Ranch. NDVI (Normalized Difference Vegetation Index) has been used to detect green vegetation using satellite and ground remote sensing equipment. CCI (Chlorophyll/carotenoid index) monitors the seasonal changes in photosynthetic rates of evergreen species and showed a strong relationship with grassland productivity at the Mattheis Ranch sites.

Current work is extending this approach to include year-round measurements (allowing for annual budgets of carbon uptake and storage) and allowing comparisons to new satellite sensors, providing a basis for long-term analyses of rangeland conditions over time. In these studies, Mattheis Ranch is proving to be a valuable addition to a growing global database of rangeland health and productivity, under changing weather and climate conditions, as a basis for sustainable management of Alberta's rangelands.

Can Wet Areas Mapping (WAM) be Used to Predict Invasive Species in Dry Mixed Grass Prairie?

*Lori Schroeder and Ellen Macdonald, Department of Renewable Resources, University of Alberta
Joyce Gould, Alberta Environment and Parks*

Invasive species have been identified as one of the most serious threats to ecosystem health and to the conservation of biodiversity and endangered species. As such, the presence and abundance of invasive species is often used as an indicator of ecosystem health and of critical habitat, as defined under Endangered Species legislation. The rate of invasion of non-native species into ecosystems, however, often exceeds our ability to document their presence and, thus, protect vulnerable ecosystems. With less than 50% of Alberta's native grasslands remaining intact, their persistence, along with that of the high proportion of endangered species they contain, is of particular concern. For this reason, there is an urgent need to develop efficient and cost-effective tools to help identify areas where invasive species are likely to occur.



Mattheis Research Ranch. Photo by Lori Schroeder.



Transect near wetlands. Photo by Lori Schroeder.

The Wet Areas Mapping (WAM) tool uses remotely sensed Airborne Laser Scanning data [or Light Detection and Ranging (LiDAR) data] to characterize fine-scale topography. It then calculates an index of relative site wetness at 1m spatial resolution, which is an approximation of depth-to-water (DTW) at or below the surface (Fig. 3). We are exploring whether WAM can be used to predict patterns of invasion of non-native vascular plant species in grassland ecosystems of Alberta.

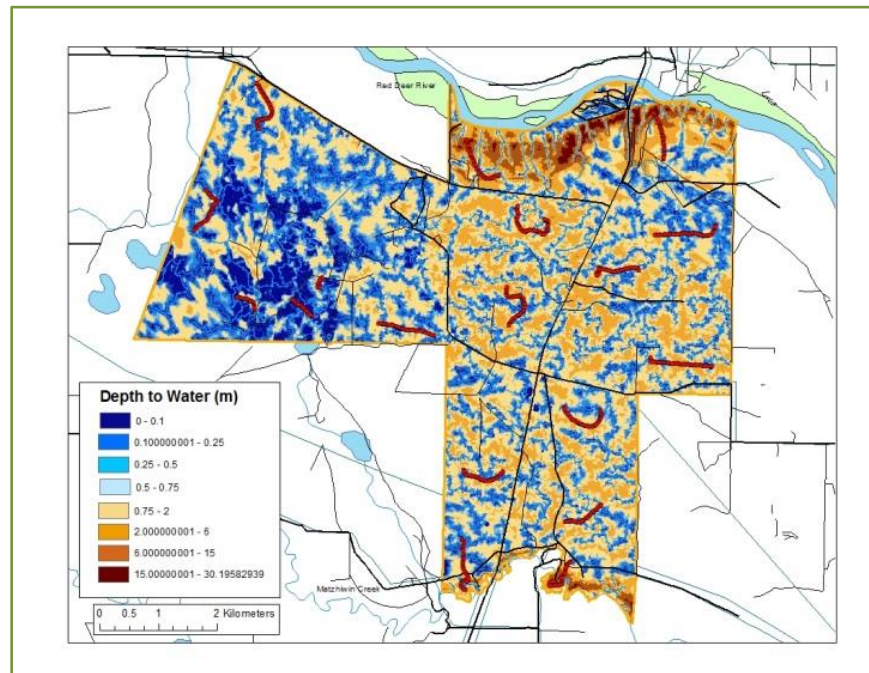


Figure 3. Map of the Mattheis Research Ranch showing depth-to-water and the transects (red lines) sampled for plant community and invasive species occurrence.

To test WAM's ability to predict the abundance and richness (number of species) of invasive plants, 18 transects (Fig. 3; average length = 873m) were established on the Mattheis Research Ranch in the Dry Mixedgrass prairie of south-eastern Alberta in summer 2015. In 2016 an additional nine transects were established in the nearby Dinosaur Provincial Park. Transects were designed to: i) be distributed as widely as possible across all uncultivated areas of the Ranch; ii) cover the greatest variation in depth-to-water values; iii) cover the greatest variety of ecosites; iv) cover a range of distances from known disturbance sources (pipelines, roads, etc.); and v) represent a range of variation in grazing histories. In total, 467 plots were established (at ~35m intervals) along these transects; within these, we collected information on the plant community, including invasive species.

We found that invasive species richness and abundance were both positively related to site wetness (decreasing depth-to-water) and inversely related to distance from disturbance. The strongest explanatory model for both invasive abundance and richness included depth-

to-water (WAM) along with proximity to oil and gas well sites; both predictors had a significant effect. The results also showed that grazing was an important predictor of invasive species, with the highest levels of grazing being associated with a higher abundance and richness of invasive species.

At a species level, Kentucky bluegrass (*Poa pratensis*), the most common invasive species in our study and a dominant species in 20% of our plots, was positively related to site wetness. On the other hand, for the noxious weed perennial sow thistle (*Sonchus arvensis*), grazing was a more important predictor, while the abundance of Canada thistle (*Cirsium arvense*) was most consistently related to the close proximity to well sites. Preliminary results indicate that plant communities also reflect the moisture gradient predicted by WAM. However, the dominance of invasive species in some communities in our study area complicates the interpretation of local community data as a predictor of the presence of invasives.



Fidget assists Lori with plant community and species assessments along a transect. Photo by Lori Schroeder.

From a management perspective, our results suggest that WAM has the potential to become a useful and relatively cost-effective tool to predict hotspots of invasive species occurrence at a landscape scale, but promises to be more effective for some species than others.

The authors gratefully acknowledge Jae Ogilvie, University of New Brunswick and Barry White, Alberta Agriculture & Forestry, for providing the WAM outputs used in this project. Funding was provided by the Rangeland Research Institute, Alberta Parks, and the Alberta Conservation Association.

4. Capacity Building

One of the primary goals of the RRI is to conduct leading edge research related to rangeland function and management. RRI accomplishes this goal by building a network of research-affiliates and collaborators through the provision of research funding. In 2017, RRI put out a call for Competitive Grant proposals and stipulated that project proposals with graduate student training would be given priority because it meets one of RRI's objectives of training highly qualified personnel (Table 4.1). In 2018, the RRI offered a larger sum and successfully attracted more proposals. The larger amounts enables researchers to fully cover graduate student salaries and following a peer-review process, six successful applications were supported (Table 4.2).

Additionally, the capacity to do research was enhanced by AltaLink's generous donation of a \$655,000 endowment to the Faculty of ALES. This new endowment provides funding each year for an M.Sc. student in Grassland Disturbance Ecology. In 2017, the award was given to M.Sc. student, Kristine Dahl, whose research project looks at different perspectives on grazing management and range health outcomes by beef producers in Alberta.

Kristine's research is a new approach where she is investigating whether the personal views of beef producers about grazing management affect range health outcomes on their land. This is a unique, interdisciplinary study using in-person rancher interviews as well as biophysical range health data to compare producers' values to landscape health. This research is also unique in that participants include producers using a wide range of grazing management practices, from holistic managers to continuous grazers, to represent a better overall picture of what grazing and range management looks like in Alberta. Kristine has ranches participating across Alberta.



Dr. Edward Bork speaks about the importance of rangeland research at the AltaLink endowment announcement in Oct 2016.

Table 4.1. Research projects funded by RRI in 2017

Researcher(s)	Project Title
Guan, Carlyle, Plastow	Assessment of rumen microbiota in beef cattle with different feed efficiency on grazing rangeland
Carlyle, Manson, Becker	Evaluation of grazing management practices that increase pollinators in Alberta's Dry Mixed Grass Prairie
Ives, Supernant	Comprehensive Study of the Human Prehistory and History of the Mattheis Ranch

Table 4.2. Research projects funded by RRI in 2018

Researcher(s)	Project Title
Cahill	Using plant traits to assist conservation and management of Alberta's rangelands
Carlyle, Church	Collaborative development of precision ranching to address climate change issues in cow-calf production
Carlyle, Haughland, Pino-Podas	Evaluating the contribution of lichens to Alberta's grassland biological soil crusts through baseline taxonomic research and manipulative grazing and drought experiments
Chang, Ma	Does defoliation affect carbon flow in rangelands? A test at two ecosites at the Mattheis Ranch
Frost	Interactive impacts of managed pollinators and invasive plants on native plant-pollinator networks and native plant reproductive success
Gamon	Quantifying rangeland carbon balance

5. Communications

In 2017, the RRI communicated research findings to our stakeholders including ranchers, rangeland managers, academics, students, government and industry at many venues throughout the year. While there was no formal mid-summer field day held at Mattheis Ranch in 2017, RRI-affiliated researchers and graduate students extended their research at various workshops, seminars, and conferences throughout the year (Appendix II). Some of the highlights are described below.

In early April 2017, several graduate students spoke about their research projects at the Mixed Grass Forum in Medicine Hat, Alberta. Additionally, the RRI was invited to give a plenary talk to introduce The Mattheis Ranch and the RRI as well as provide an update about research currently being undertaken. This talk generated interest from St. Mary's University in Calgary, where several instructors expressed interest in the ranch owing to its vast native grasslands and toured the ranch in late summer to explore the potential for using it as part of their plant and ecology course-related field trips.

The RRI had a table at Edmonton's Telus World of Science (TWOs): Research Day in partnership with the University of Alberta Community Volunteer Program and Faculty of Graduate Studies & Research. This provided a venue for RRI staff to interact with the general public (mostly young children) to talk about the importance of native grasslands, cattle grazing, and our research. The TWOs organizers remarked that the event was extremely successful and that over 2000 visitors had walked through their facility that Saturday. We had lots of interaction with young families who stopped at our table to check out our 'piece of the prairie', insect collection and look at some native grass seeds up close through the microscope.

In June, Dr. Jack Ives, Dr. Kisha Supernant, and Dr. Clive Coy teamed up to host a 'Stones & Bones' open house at the Mattheis Ranch providing an opportunity for the general public, local ranchers and residents, researchers, and undergraduate and graduate students to talk about local history and landscape, as well as look at historical



Tossing the atlatl at the Stones & Bones event. Mattheis Ranch, June 2017. Photo from Jack Ives.

artifacts and try their hand at throwing an atlatl. The Archaeology field school took place at the Mattheis Ranch in June and July for undergraduate teaching and research, as well as connecting with first nation's community members to learn about their cultural and traditional stories and knowledge. The Paleontology group used the ranch as a home-base during their nearby ongoing dinosaur dig from mid-May to July of 2017.

Approximately 40 members of the Western Stock Growers Association, mostly ranchers, toured Mattheis Research Ranch in August. Graduate students and researchers talked about the Mattheis Ranch history and the conservation easement, as well as current research projects taking place on the ranch, including industrial impacts on vegetation and soils, and adaptive multi-paddock grazing effects on plant and soil microbial communities. The tour was organized to coincide with the 4th year Range and Wildlife 'Capstone' course field school providing an opportunity for undergraduate students to interact with ranchers. Students spent additional time at the ranch learning how to conduct a riparian health assessment, and discuss concepts and issues related to native grasslands and agriculture, the beef industry, industrial development on the landscape, invasive species and shrub encroachment.



Western Stock Growers Association and U of A Capstone students tour at Mattheis Ranch, Aug 2017.

In November, the RRI partnered with the Society for Range Management (International Mountain Section) by having several affiliated researchers speak at the fall meeting in Lethbridge about managing industrial disturbance on grasslands. Approximately 50 people were in attendance. As a fitting wrap up to the meeting, the video production, "WSLT: Alberta Lands – Connecting Generations" created by Western Sky Land Trust was viewed. The video features Alberta Lieutenant Governor Honorable Lois Mitchell and several U of A students speaking at the Mattheis Research Ranch about their passion for the land; it celebrated and honored Edwin and Ruth Mattheis for their vision and generosity in the land donation and the younger generation who will

steward the land in the future. The video link is available on the RRI website (<http://rri.ualberta.ca/Resources/Presentations>).

Other outreach activities presented by the RRI-affiliated researchers in 2017-2018 are listed in Appendix II. This included presentations to the Alberta Native Plant Council, Canadian Society of Soil Science annual meeting, North American Forest Ecology Workshop, APAS Prairie Agriculture Carbon Summit, Foothills Forage and Grazing Association, Western Stock Growers Association, Emissions Reduction Alberta & Alberta Innovates – SPARK Conference, Foothills Restoration Forum, Western Canada Conference on Soil Health & Grazing, 71st International Annual Meeting of the Society for Range Management, Alberta Soil Science Workshop, and Mixed Grass Forum, among others. Participation in these events extend knowledge about rangeland ecology and grazing management to a wide variety of audiences and increases the profile of the RRI, the University of Alberta, and its Research Ranches.

6. Strategic Advisory Council

The Strategic Advisory Council (SAC) continues to provide important insight and guidance to the Rangeland Research Institute’s Director and staff on the vision, direction and activities of the RRI. The current composition of the SAC as of March 8, 2018 is provided in Table 6.1. There was no SAC annual meeting held in 2017, although an annual report was prepared and shared with SAC members. As of January 2018, Dr. Edward Bork has taken medical leave and Dr. Cameron Carlyle has stepped in as Interim RRI Director. The next Strategic Plan for the RRI is currently in draft form and is expected to be finalized over the next year.

Table 6.1. Members of the RRI Strategic Advisory Council, March 2018.

Name	Position, Agency	Location
Barry Adams*	Head, Rangeland Resource Management Program (Retired) <i>Alberta Environment and Sustainable Resource Development</i>	Lethbridge, AB
Dr. Stan Blade	Dean, Faculty of Agricultural, Life & Environmental Sciences, <i>University of Alberta</i>	Edmonton, AB
Dr. Edward Bork	RRI Director (on leave); Professor and Mattheis Chair in Rangeland Ecology & Management, <i>University of Alberta</i>	Edmonton, AB
Jerry Brunen	Executive Director, <i>Western Sky Land Trust</i>	Calgary, AB
Dr. Cameron Carlyle	Assistant Professor, Acting RRI Director, <i>University of Alberta</i>	Edmonton, AB
Cherie Copithorne-Barnes	Producer and Chief Executive Officer, <i>CL Ranches Ltd.</i>	Jumping Pound, AB
Edwin Mattheis	Producer (Retired)	Calgary, AB
Ruth Mattheis	Producer (Retired)	Calgary, AB
Karen Raven	Agriculture Land Use Specialist, <i>Alberta Agriculture and Rural Development</i>	Edmonton, AB
Karin Schmid	Beef Production Specialist, <i>Alberta Beef Producers</i>	Calgary, AB
Josie Van Lent	Dean, Agricultural Sciences & Human Service, <i>Lakeland College</i>	Vermillion, AB
Dr. Walter Willms	Researcher (Emeritus), <i>Agriculture & Agri-Food Canada</i>	Lethbridge, AB
Dave Zehnder	Producer; Program Coordinator, <i>Ecological Services Initiative</i>	Invermere, BC

* Chair of RRI Strategic Advisory Council

7. Financial Overview

Operations of the RRI are supported by funding generated by the Mattheis Research Ranch in SE Alberta. A summary of the 2017-2018 financial statement for the RRI is provided in Appendix III. This statement includes a review of revenue, primarily surface lease revenue from oil/gas activity and utility development, as well as expenses. Expenses include costs associated with outreach and communications, administrative operations of the RRI, ongoing secondary support of various research activities and capacity development, and the direct costs associated with the RRI - Competitive Grants Program. Operational costs appear lower in 2017-18 because some expenses were covered by the recently created Rangeland Ecology and Management Fund (REMF).

The Rangeland Ecology and Management Fund (REMF) was established as an endowment in 2015, and included funding contributions from powerline construction, a contribution from the Alberta Beef Producers, and significant contributions associated

with the placement of a conservation easement on the Mattheis Research Ranch. The current value of the REMF as of March 31, 2017 was \$5,761,324 (Appendix IV). The value of the endowment principle did not change in 2017-18 because funds were not transferred from the RRI Operations budget, but a contribution will be made in 2018-19. The spending allocation for the fund comes from the principle and allows the RRI to award research funding.

Appendix I. Summary of ongoing research projects led by RRI affiliates

All projects listed are being undertaken by various research affiliates associated with the RRI during 2017-18. * Indicates projects that have received support from the RRI Competitive Grants Program.

Project Title	Principle Investigators
A proposal to conduct baseline archaeological research on the Kinsella and Mattheis Ranches*	Jack Ives
Mitigation of high voltage powerline construction on mixedgrass prairie	Edward Bork, Cameron Carlyle & Sylvie Quideau
Tools to guide management of invasive species in rangeland ecosystems*	Ellen Macdonald & Joyce Gould
Seedbank dynamics in rangelands relative to disturbance history	Edward Bork & Linda Hall
Avi-fauna responses to land use disturbance in mixedgrass prairie	Scott Nielsen
Testing cow/calf feed efficiency under open-range grazing	Edward Bork, Graham Plastow, John Basarab, Colin Coros & Carolyn Fitzsimmons
Long-term monitoring of rangeland ecosystem functions on the Mattheis and Kinsella Research Ranches*	Cameron Carlyle
Agroforestry systems for reducing GHGs	Scott Chang, Edward Bork & Cameron Carlyle
Differentiating and understanding the roles of soil nutrient and soil community heterogeneity on plant growth, carbon storage and biodiversity*	James Cahill

Defoliation and altered precipitation effects on forage agronomy	Edward Bork
Defoliation and altered precipitation effects on soil microbial communities on the Mattheis Ranch*	Scott Chang
Assessment of altered precipitation and defoliation on rangeland EG & S	Cameron Carlyle, Scott Chang, James Cahill, Ben Willing & Edward Bork
Quantifying the carbon balance and associated ecosystem properties at the Mattheis Ranch*	John Gamon
Beef and biodiversity	Dan Farr, Edward Bork, Cameron Carlyle, James Cahill, Tim McCallister & Mike Alexander
GHG assessment in grasslands under contrasting grazing regimes	Cameron Carlyle, Edward Bork & Scott Chang
Effect of adaptive multi-paddock grazing on carbon storage and greenhouse gases	Mark Boyce, Richard Teague, Cameron Carlyle, Edward Bork & others
Biophysical quantification and mapping of soil quality at the Mattheis Ranch*	Guillermo Hernandez-Ramirez
Nutrient cycling in rangelands under grazing regimes	Daniel Hewins, Edward Bork, Cameron Carlyle & Scott Chang
Assessment of rumen microbiota in beef cattle with different feed efficiency on grazing rangeland*	Leluo Guan, Cameron Carlyle, & Graham Plastow
Evaluation of grazing management practices that increase pollinators in Alberta's Dry Mixed Grass Prairie*	Cameron Carlyle, Jessamyn Manson, & Marcus Becker
Comprehensive Study of the Human Prehistory and History of the Mattheis Ranch*	Jack Ives & Kisha Supernant

Appendix II. Select presentations by RRI affiliates in 2017-2018

Outreach and promotional activities undertaken in support of the RRI during 2017-2018.

Abbreviated title	Presenter(s)	Venue	Audience(s)	Date
Testing performance of RFI selected cattle under extensive cow-calf systems	Lansink, Bork, Plastow	Mixed Grass Forum: Restoring the Native Prairie; Medicine Hat, AB	Resource managers, ranchers, government	Apr 2017
Influence of producer management and industrial disturbance on grassland seed banks in AB	Pyle, Bork, Hall	Mixed Grass Forum: Restoring the Native Prairie; Medicine Hat, AB	Resource managers, ranchers, government	Apr 2017
Duration of access mat application influences Mixedgrass Prairie plant community cover and composition	James, Bork, Carlyle, Quideau	Mixed Grass Forum: Restoring the Native Prairie; Medicine Hat, AB	Resource managers, ranchers, government	Apr 2017
Recreational trail effects on rangeland ecology using Google Earth as a monitoring tool	Grenke, Cahill	Mixed Grass Forum: Restoring the Native Prairie; Medicine Hat, AB	Resource managers, ranchers, government	Apr 2017
Rangeland Research Institute: Introduction and research overview	Raatz, Bork	Mixed Grass Forum: Restoring the Native Prairie; Medicine Hat, AB	Resource managers, ranchers, government	Apr 2017
Effect of grazing on litter decomposition and microbial enzyme activity across AB	Chuan	MSc defense seminar; U of A, Edmonton, AB	Students, researchers	Apr 2017
Rangeland Research Institute: Importance of grasslands	Pyle, Raatz	Telus World of Science; Edmonton, AB	General public, children	Apr 2017
The influence of producer management and industrial disturbance on grassland seed banks in Alberta	Pyle, Bork, Hall	Alberta Native Plant Council: Biodiversity in Alberta's Changing Landscape; Ponoka, AB	General public, students, researchers	Apr 2017
Assessing diversity of prairie plants using remote sensing	Wang	PhD defense seminar; U of A, Edmonton, AB	Students, researchers	May 2017
Effect of different powerline construction methods on soils in the Mixedgrass prairie	Najafi, Bork, Carlyle, Thompson, Quideau	Canadian Soil Science Society Annual Meeting; Peterborough, ON	Researchers, students, resource managers, government	Jun 2017

The impacts of industrial disturbance on nitrogen-cycling soil microbial communities in Mixedgrass prairies of AB	Thompson, Bork, Carlyle, Quideau, James, Najafi	Canadian Soil Science Society Annual Meeting; Peterborough, ON	Researchers, students, resource managers, government	Jun 2017
Stones & Bones open house	Ives, Supernant, Coy	Paleontology and Archaeology open house; Mattheis Ranch, AB	General public, students, researchers	Jun 2017
Wine & Wildlife: Bees	Carlyle, Manson	Edmonton Valley Zoo event; Edmonton, AB	General public	Jun 2017
The evolution of grazing management within central AB aspen forests	Bork	North American Forest Ecology workshop; Edmonton, AB	Resource managers, government, researchers	Jun 2017
Rangeland ecological goods and services: A synoptic view of research efforts from Alberta grasslands	Hewins, Bork, Carlyle	APAS Prairie Agriculture Carbon Summit: Growing Sustainability; Saskatoon, SK	Government, resource managers, researchers	Jul 2017
Carbon capture & forages: Current research in Alberta	Irving, Bork, Carlyle, Hewins	Foothills Forage and Grazing Association: Carbon & Forages Field day; Didsbury, AB	Resource managers, ranchers, government	Jul 2017
Assessing native bee biodiversity in AB grasslands: Influence of relative grazing on bee community assemblages and prospective indicator strategies for native bees	Sturm	MSc defense seminar; U of A, Edmonton, AB	Students, researchers	Aug 2017
<i>Field Tour:</i> Adaptive multi-paddock grazing compared to continuous grazing: Effects on plant communities	Grenke, Cahill, Boyce, Bork, Carlyle	Western Stock Growers Association: Mattheis Ranch, AB	Ranchers, students	Aug 2017
<i>Field Tour:</i> The Mattheis Research Ranch: History and conservation easement - current industrial research on the ranch	Bork	Western Stock Growers Association: Mattheis Ranch, AB	Ranchers, students	Aug 2017
<i>Field Tour:</i> Adaptive multi-paddock grazing compared to continuous grazing: Effects on soil microbial communities	Hogberg, Carlyle, Bork	Western Stock Growers Association: Mattheis Ranch, AB	Ranchers, students	Aug 2017

Effects of environmental, landscape, and disturbance gradients on native bee diversity, abundance and composition in the Canadian Prairies	Kohler	MSc defense seminar; U of A, Edmonton, AB	Students, researchers	Sep 2017
<i>Field tour: Water use, industry on the landscape, and grazing on Mattheis Ranch</i>	Armitage, Raatz	U of C tour of Mattheis Ranch	Students, researchers	Sep 2017
Performance and methane emissions of RFI-selected cattle in drylot and under open range conditions	Lansink	MSc defense seminar; U of A, Edmonton, AB	Students, researchers	Oct 2017
Western Sky Land Trust – Alberta Lands: Connecting Generations	WSLT staff, Brunen, AB Governor General, Honorable Lois Mitchell	Video launch; Calgary, AB	Invited guests, philanthropists, students	Oct 2017
Managing Industrial disturbance: A land manager's perspective	Irving	Society for Range Management (SRM) – IMS Fall Meeting: Managing Disturbances on Native Grasslands; Lethbridge, AB	Resource managers, ranchers, researchers, government	Nov 2017
Duration of access mat application influences Mixedgrass prairie plant community cover and composition	James, Bork, Carlyle, Thompson, Quideau	SRM – IMS Fall Meeting: Managing Disturbances on Native Grasslands; Lethbridge, AB	Resource managers, ranchers, researchers, government	Nov 2017
The effect of different powerline construction methods on soils in the Mixedgrass prairie	Najafi, Bork, Carlyle, Thompson, Quideau	SRM – IMS Fall Meeting: Managing Disturbances on Native Grasslands; Lethbridge, AB	Resource managers, ranchers, researchers, government	Nov 2017
The influence of producer management and industrial disturbance on grassland seed banks in Alberta	Pyle, Bork, Hall	SRM – IMS Fall Meeting: Managing Disturbances on Native Grasslands; Lethbridge, AB	Resource managers, ranchers, researchers, government	Nov 2017
Recreational trail effects on rangeland ecology using Google Earth as a monitoring tool	Grenke, Cahill	SRM – IMS Fall Meeting: Managing Disturbances on Native Grasslands; Lethbridge, AB	Resource managers, ranchers, researchers, government	Nov 2017

Management of grasslands to reduce greenhouse gases	Carlyle, Bork, Hewins	Emissions Reduction Alberta and Alberta Innovates – SPARK Conference; Edmonton, AB	Government, researchers, policy makers, media	Nov 2017
Producer management and industrial disturbance influences on grassland seed banks in AB	Pyle, Bork, Hall	Foothills Restoration Forum Fall Information Session: Evolving Energy and Climate on the Grasslands; Claresholm, AB	Government, resource managers	Nov 2017
Rangeland Research Institute: Trade show table	Raatz	Western Canada Conference on Soil Health & Grazing: Profit above, wealth below; Edmonton, AB	Ranchers, researchers, government, policy makers	Dec 2017
Different perspectives on grazing management and range health outcomes by beef producers in AB	Dahl, Bork, Parkins	SRM: Empowerment through applied science; Sparks, NV	Ranchers, government, researchers, students	Jan 2018
The effects of clipping and compaction on microbial enzyme activity, vegetation, soil thermal properties and soil health in Alberta's rangelands	Barszczewski, Carlyle	Alberta Soil Science Workshop; Harnessing big data to advance soil science; Edmonton, AB	Researchers, government	Feb 2018
Rangeland habitat use and activity of cattle with divergent molecular breeding values for Residual Feed Intake	Carly Moore	MSc defense seminar; U of A, Edmonton, AB	Students, researchers	Mar 2018
Producer management and industrial disturbance influences on grassland seed banks in AB	Pyle, Bork, Hall	Mixed Grass Forum: Invasive species; Medicine Hat, AB	Researchers, government, ranchers, resource managers	Apr 2018
Impact of multi-paddock grazing on plant diversity and homogenization in Western Canada	Grenke, Boyce, Cahill	Mixed Grass Forum: Invasive species; Medicine Hat, AB	Researchers, government, ranchers, resource managers	Apr 2018
Invasive species related research at Mattheis Research Ranch	Raatz, Bork	Mixed Grass Forum: Invasive species; Medicine Hat, AB	Researchers, government, ranchers, resource managers	Apr 2018

Appendix III. RRI Financial Statement of Actuals, April 1, 2017 to March 31, 2018

	Actuals
Opening Balance	\$334,108.94
Revenue	
Lease Revenue	\$481,043.75
Utility (Powerline) Revenue	\$52,702.00
Total Revenue	\$533,745.75
Expenditures	
Transfer to Endowment	\$0
Property Taxes	\$2,437.52
Temp Support Staff	\$65.28
Supplies	\$4,415.43
Travel Expenses	\$4,684.38
Rentals and Leases	\$1,927.22
Research Projects	\$39,963.34
Total Expenditures	(\$53,493.17)
Net Balance	\$814,361.52

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

Appendix IV. Rangeland Ecology and Management Fund Financial Statement of Actuals, April 1, 2017 to March 31, 2018

	Actuals
Principal	
Opening Balance (April 1, 2017)	\$5,761,323.94
Contributions ¹	\$0
Closing Balance (March 31, 2018)	\$5,761,323.94
Spending Allocation	
Opening Balance (April 1, 2017)	\$253,264.54
Current Year Endowment Spending Allocation	\$174,480.60
Current Year Expenditure	(\$220,927.97)
Closing Balance After Encumbrances	\$206,817.17

¹ No transfer of funds was made in 2017/2018. However, a transfer is planned for May 2018/2019 from the RRI operating fund to increase the value of the REMF, consistent with the recommendation of the Strategic Advisory Council.