

RANGELAND RESEARCH INSTITUTE (RRI)

2019-2020 Annual Report



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

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Cover photo: Cows at Stavely Research Station

Photo by Sara Barszczewski

1. Introduction

In 2019-20, rangelands have arguably been at greater risk than ever in the history of Alberta's existence. The Government of Alberta announced its intention to close many Provincial Parks and reduce services in others. Sales of provincially held land have occurred, including tracts of diverse native grasslands that have been advertised as suitable for annual crop production. As these lands are often in arid areas of the province, lands purchased at high capital cost require conversion to crop agriculture and irrigation to be profitable. Newly emerging weed invasions in Alberta rangelands include species like downy brome (also known as cheatgrass in the U.S.) and Japanese brome, and are being flagged as a serious risk to grassland economic and ecological sustainability. Financial pressures and depressed cattle markets resulting from the COVID-19 pandemic are also threatening grasslands as producers look to diversify their operations, spread out economic risk, and may be faced with difficult decisions to plow pastures for crop production. More broadly, native grasslands are globally threatened ecosystems, but also rapidly disappearing in our own province as land is converted for urban, agricultural or industrial uses. Once these grassland ecosystems are lost, it is highly unlikely that they can be restored to their previous condition.



A Japanese brome invaded grassland in southern Alberta, now part of an RRI-AEP-AAFC collaborative research project. Photo by Lisa Raatz.

University of Alberta alumni Edwin and Ruth Mattheis recognized that native grasslands are highly unique and valuable for the goods and services they provide to society, and as a result are worthy of long-term protection as large contiguous and unfragmented tracts of land for sustaining beef cattle production and providing wildlife

habitat. In 2011, they generously donated their 5000 ha ranch, of which 80% is native grassland, to the University of Alberta (U of A). From this donation, the Faculty of Agricultural, Life and Environmental Sciences (ALES) established the Rangeland Research Institute (RRI) and the Mattheis Research Ranch. In 2015, the U of A placed a Conservation Easement on the ranch in partnership with Western Sky Land Trust that will protect this important land base from development and fragmentation even in uncertain economic times.

The RRI continues to fulfill a three-part mandate: to conduct research, teaching, and promote outreach activities. Researchers affiliated with the RRI conduct a wide range of research related to rangeland ecology and management that includes investigating the value of many goods and services provided by rangelands, including forage production and livestock grazing, as well as human created disturbance and industrial impacts.



Prickly pear cactus (*Opuntia polyacantha*) flowering at the Mattheis Research Ranch, July 2019. Photo by Lisa Raatz.

The RRI participates in teaching by having students visit Mattheis and Kinsella Research Ranches as well as private ranches and public lands as part of laboratories and field schools, which collectively provide students with hands-on learning experiences and better prepares them for careers related to rangeland management. The RRI also engages in outreach and extension activities by partnering with other organizations to extend research findings to our many stakeholders, including farmers and ranchers, government and non-government organizations, industry, other researchers, and the public. All of these activities promote the RRI and contribute to advancing rangeland science as well as societies' understanding of the socioeconomic role and ecological benefits of healthy rangelands.

This report summarizes key activities undertaken by the RRI from April 1, 2019 through March 31, 2020. The report includes a brief summary of research activities, including three profiles of recently completed research projects; capacity building; a summary of communication and outreach activities for the RRI; current Strategic Advisory Council membership; as well as a financial summary of the previous year.

2. Research

One of the primary objectives of the RRI is to conduct research. This is accomplished by providing grant funding to researchers through the Competitive Grants Program, where at least one research site is to be located on the Mattheis Research Ranch in the Dry Mixedgrass prairie in southeast Alberta. Researchers also use the Roy Berg Kinsella Research Ranch, in the Central Parkland, as well as the heritage research stations Stavely and Onefour, located in the Foothills Fescue and the Dry Mixedgrass Prairie of southern Alberta, respectively. In order to test research questions under a broad range of soil and climate conditions, researchers also use private and public land spanning a large geographic region of western Canada.

Researchers affiliated with the RRI currently conduct projects at one or more of the Research Ranches and many of these projects are listed in Appendix I. While all of the research is associated with rangeland management and ecology, many projects have a



M.Sc. student, Sydney Worthy looks for pollinators at the Mattheis Ranch. Photo from Dr. Carol Frost.

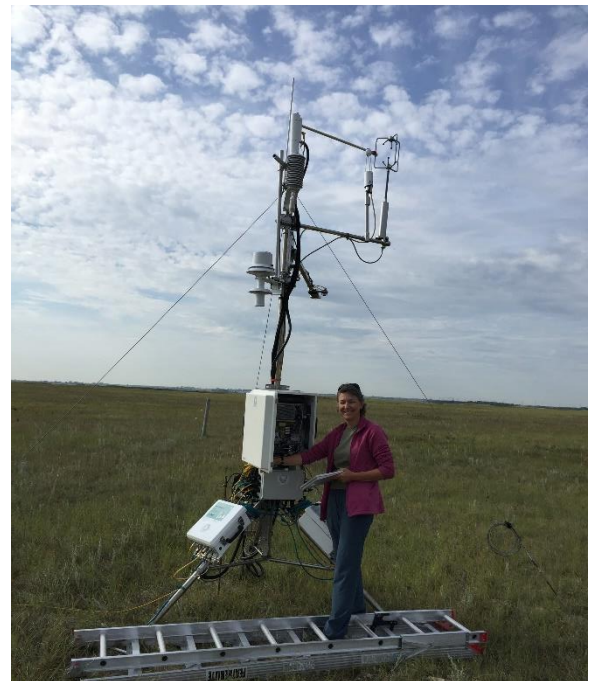
focal theme of quantifying the value of goods and services provided by rangelands. Researchers are evaluating the effects of climate change such as drought on long-term ecosystem functions, forage production, plant and soil microbial communities, and biodiversity under grazed and ungrazed conditions. Some research seeks to quantify carbon storage in grasslands as well as assess greenhouse gases, carbon flow and nutrient cycling, while other studies are quantifying rangeland pollinators including the relationship between introduced plants and insect pollinators. Yet other lines of enquiry are evaluating the impact of various disturbance regimes on rangeland function, including monitoring wildfire impacts and subsequent recovery within native grasslands, as well as the development of strategies to

mitigate industrial development impacts on bird, plant and soil communities.

Historically, these investigations have received less attention than those that link directly to forage production and grazing; however, they all provide important

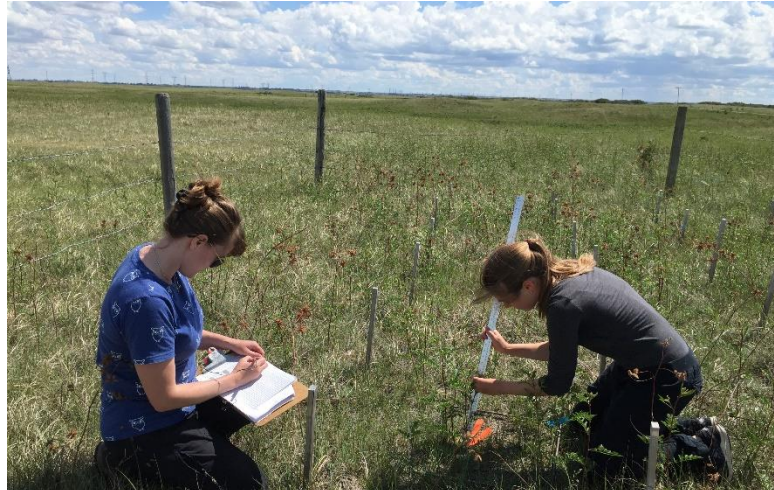
fundamental information that supports the ecological function of intact grasslands, and in turn, a healthy beef industry and ranching community whose livelihoods rely on this natural resource.

Researchers who have not directly received funding from the RRI or those from outside organizations also use Mattheis and Kinsella Research Ranches, thereby expanding the research network and the scope of investigations being conducted. For example, in 2019, Dr. Chris Herd from Faculty of Science, Dept. of Earth and Atmospheric Sciences approached the RRI to install a 'Fireball' meteorite camera at the Mattheis Research Ranch as part of their network of cameras observing the sky for meteor showers across the province in areas with long-term access to dark sky and limited light pollution (To read more about their project, see the 2018 U of A story by Katie Willis, <https://www.ualberta.ca/science/news/2018/november/meteorites-fireball-network.html>). In addition, Dr. Shawn Dergousoff, a livestock insect pest scientist at Agriculture and Agri-Food Canada based in Lethbridge used Mattheis Ranch to survey for tick and biting fly populations that affect beef cattle that are predicted to increase in areas where they have not previously been observed. Dr. Sigrid Dengel, a researcher from Ameriflux, spent time at Mattheis Ranch validating data from the new CO₂ flux tower that was established on the ranch in 2019. Dr. John Gamon began the project to determine the carbon balance from this grassland and data have been collected and made available to researchers via the Ameriflux website since 2012. The new tower will remain on the ranch to collect long-term data, much like a weather station. These scientists and many others use Mattheis and Kinsella Research Ranches, as well as Stavely and Onefour Research Stations because they are uniquely situated to provide long-term land bases for conducting research within intact grassland ecosystems. In the process, they help raise the profile of the RRI by advancing range science and associated sustainable management.



Dr. Sigrid Dengel next to the Ameriflux data validation CO₂ flux tower.

The Mattheis Research Ranch continues to be a highly valuable resource for many research groups. A total of 91 individuals spent 991 person-days at the Mattheis Ranch in 2019-20, including 15 principle scientists, 16 graduate students, 43 undergraduate students, and 17 post-doctoral researchers, visiting scientists, senior technologists, and other staff. The majority of



Summer research assistants, Mary Villeneuve and Anabel Dombro, take data on wild licorice at the Mattheis Ranch, July 2019.

researchers are from the University of Alberta, mostly from the Faculty of ALES (Agricultural, Life and Environmental Sciences; Depts. of Agricultural, Food and Nutritional Sciences & Renewable Resources) but also from the Faculty of Science (Depts. of Biological Sciences & Earth and Atmospheric Sciences) and the Faculty of Arts (Anthropology). Various external organizations used the Mattheis Ranch including Agriculture and Agri-Food Canada - Lethbridge Research Centre, Alberta Environment and Parks, the Alberta Biodiversity Monitoring Institute, Thompson Rivers University, the University of Manitoba, Curtin University (Perth, Australia), Tannas Conservation Services and Ameriflux.

The Roy Berg Kinsella Ranch was used by 46 individuals for a total of 234 person-days. Researchers included 8 principle scientists, 6 graduate students, 18 undergraduate students, and 4 senior technicians and staff. Most researchers were from the Faculty of Science (Dept. of Biological Sciences) and Faculty of ALES (Depts of Agricultural, Food and Nutritional Sciences). Other groups using Kinsella Ranch include Thompson Rivers University, Nutrien, Agriculture and Agri-Food Canada, the Soil Health Institute, and the Royal School of Veterinary Medicine (Scotland).

3. Research Profiles

Impacts of reintroduced wood bison on arid grassland diversity in the Yukon

Prepared by Dr. Edward Bork, University of Alberta

Wood bison historically occupied a range that was known to extend across most of northwestern Canada, including into the Yukon where they utilized, among other habitats, pockets of sparse arid grassland habitats on mountain slopes. After many decades of having no bison, wood bison were reintroduced into this region in the late 1980's, increasing the exposure of these grasslands to grazing. While globally grasslands are well known to increase in diversity under moderate rates of grazing, this response is most commonly observed in mesic environments, particularly those that co-evolved with ample large ungulate herbivory. Given the arid nature of remnant grasslands in the Yukon and uncertainty over the historical intensity of grazing, it was hypothesized that these grasslands may decline in diversity in response to increasing contemporary bison use.



M.Sc. student, Lori Schroeder evaluating the effects of bison grazing at Site 11 in the Yukon. Photo from Lori Schroeder.

Lori Schroeder, an MSc student working with Drs. Fiona Schmiegelow and Edward Bork, recently completed an investigation evaluating the composition of these Yukon grasslands and their response to bison grazing. An initial study used an archived data set evaluating these grasslands to assess compositional changes from prior to bison introduction to post-introduction, with no evidence that plant species of high conservation concern were under threat due to bison. A

second study employed an expanded data set of 70 grasslands to assess the relationship between plant community diversity and composition, and metrics of bison use, where the latter were based on either fecal pat counts or global positioning system data obtained from collared bison. In contrast to expectations, most grassland attributes, including plant species richness, diversity, and the abundance of forbs and graminoids,

increased in response to indices of bison grazing intensity. Select functional groups appeared to be favored the most, including small statured, grazing tolerant sedges. Interestingly, grassland composition was also found to be impacted by other factors as well, including the activity of arctic ground squirrels, together with precipitation itself.

Overall, the findings of this study highlight the grazing tolerance of these rare



Lori taking plant community data in one of her plots.
Photo from Lori Schroeder.

grasslands to herbivory, and reinforce the compatibility of bison grazing with grassland conservation and biodiversity promotion in the region at present bison stocking rates. Equally important, these findings generally clarify our broader understanding of grassland diversity responses to herbivory to include those grasslands of the world representing arid grasslands in a fragmented environment that may have co-evolved with large herbivores.



Site 11 in the Yukon. Photo by Lori Schroeder.

Breaking down grazing effects on vegetation and soil biological activity

Prepared by Sara Barszczewski, University of Alberta

Grasslands provide numerous vital ecosystem goods and services (EG&S) that are important for both ecosystem and human health, such as providing forage for livestock, and facilitating nutrient cycling, air and water purification, and carbon sequestration. Grassland management is key to supporting EG&S; recent attention has been focused on adaptive multi-paddock grazing, which partly attributes its success to the effects seen in the soil and plant community through trampling and compaction of litter into the soil surface. This has raised questions about the relative importance of different mechanisms through which cattle affect grasslands, specifically trampling, defoliation and subsequent depletion of litter. Although grassland EG&S rely on microbial function and the vegetation community, the individual mechanistic effects by which cattle affect both of these remain largely unknown.



M.Sc. student, Sara Barszczewski, taking data at her research site located at Stavely Research Station.

M.Sc. student, Sara Barszczewski, recently explored the relationship among soil biological activity, vegetation production and diversity, and the mechanisms by which grazing may alter Alberta grasslands under the joint supervision of Drs. Cameron Carlyle and Xiyang Hao (Agriculture and Agri-Food Canada) at the University of Alberta. Sara conducted a plot-level study that simulated cattle trampling and defoliation as well as litter depletion at three

well-known grassland research locations in southern Alberta: Stavely, the Animal Disease Research Institute (ADRI) near Lethbridge, and Onefour. Litter, which generally decreases with heavy grazing, was removed (or retained) on plots in the first year of study. In the first and second year of the study, plots were clipped and compacted (or not) in either spring or fall to simulate seasonal defoliation and trampling. Extracellular enzyme activity (EEA), a measure of the availability of protein

complexes used to decompose organic matter by plant and soil microbes, was used as a proxy of microbial community function in soil and litter samples.



Stavelly Research Station. Photo by Sara Barszczewski.

Litter removal was found to have a strong influence on EEA in both soil and litter, as litter presence affected moisture, though this effect varied between sites. Defoliation and compaction did not have consistent effects on soil or litter EEA. Vegetation was affected by defoliation, particularly in the fall, which reduced plant biomass and diversity. These changes were likely driven by

plant species sensitivity to grazing, which showed lower cover in defoliated treatments. Interestingly, species that responded positively to grazing had increased growth to litter removal on its own, suggesting that litter in particular, not just defoliation, plays an important role in regulating cattle effects on vegetation. From this study, it was determined that the individual mechanisms attributed to grazing, such as litter reduction and direct defoliation, have important yet distinctly unique roles on grassland function and community composition. In particular, the study highlights the key role of plant litter in modifying these processes, and supports the maintenance of litter as a key management recommendation for ensuring rangeland sustainability.



Research plots at the Onefour Research Station. Photo by Sara Barszczewski.

Using Range Health Scores to Evaluate Grassland Plant Diversity

Prepared by Craig DeMaere, Alberta Environment and Parks

Grassland conversion to other land uses is a leading cause of decline in biodiversity in western Canada. Within remaining grasslands, grazing can have positive or negative effects on biodiversity, and the ability to assess grazing effects is critical to apply informed conservation decisions. One way to measure grazing impacts is with rangeland health, an operational measure of grassland function. Rangeland health in Alberta is evaluated using a scoring system that evaluates community integrity, structure, hydrological function, nutrient cycling, site stability and noxious weed presence. It is assumed that by maintaining rangeland health, biodiversity is conserved; however, this has not been broadly tested.



Dan Knop samples biomass at one location in southern Alberta. Photo by Craig DeMaere.

This study, completed by Craig DeMaere under the joint supervision of Drs. Cameron Carlyle and Edward Bork, investigated relationships between plant diversity and Alberta's Rangeland Health Assessment tool at two different scales of spatial investigation at multiple grassland locations across a broad range of agro-ecological conditions. The first study assessed plant diversity-range health relationships at the plant community scale. While plant

diversity did not relate to overall rangeland health scores, various diversity metrics were related to sub-components of the health assessment that reflected specific attributes of soil erosion, nutrient cycling / hydrological function, plant community structure and noxious weed abundance. Over and above range health, plant diversity metrics were strongly influenced by environmental factors such as topography and moisture gradients. In the second study, plant community patchiness was related to rangeland health across the larger scale of individual pastures. Average health scores and their range (min-max) were both found to reflect community patchiness within

pastures. Furthermore, the relationship between patchiness and range health was influenced by abiotic factors (soils and climate).



Hundreds of vegetation samples were assessed for vegetation cover and clipped for biomass. A transect runs through the grass. Photo by Craig DeMaere.

These findings have implications for grassland conservation and management in Alberta. Although no direct relationship was found between plant diversity and total rangeland health at the community level, plant diversity remained sensitive to sub-components of the health assessment, and therefore provide utility in tracking vegetation diversity.

Additionally, when completed at multiple locations within a pasture, rangeland health can be used to identify community

patchiness, which has important implications for enhancing broad-scale biodiversity by providing a wider range of habitat types that support wildlife, including species at risk.



Cattle pass a grazing enclosure in the Forest Grazing Reserve, one of Craigs research locations in the Foothills.

4. Capacity Building

The Rangeland Research Institute did not solicit Competitive Grant proposals in 2019; however, one invited proposal was peer-reviewed and accepted for funding in 2019 – 2021 (Table 4.1).

Ongoing and recent provincial government imposed cuts to post secondary institution funding has negatively affected many colleges and universities in Alberta, and the University of Alberta is no exception. In turn, these cuts are affecting the Faculty of Agricultural, Life and Environmental Sciences and all of our associated departments including the Department of Agricultural, Food, and Nutritional Science, as well as the RRI. In order to make up for budget shortfalls the U of A is seeking avenues to reduce costs while maintaining research capacity. This includes incrementally transferring faculty salaries from operational budgets to endowments such as the Rangeland Ecology and Management Fund, which would normally be used for funding research projects. In light of this decision, the RRI's strategy to preserve our capacity to conduct research in the long-term is to reinvest the endowment interest and build the principle as rapidly as possible. As a result, no call for proposals was made in 2020 in order to maximize the investment.

In 2016, AltaLink generously donated \$655,000 as an endowment to the Faculty of ALES, which continues to increase research capacity by funding an M.Sc. student in Grassland Disturbance Ecology for two years. In 2019, the award was given to M.Sc. student Megan Lewis, whose research project, 'Resolving taxonomic uncertainty in *Cladonia* grassland lichens to evaluate grazing effects on biological soil crust biodiversity', is being conducted at several locations across Alberta, including the Mattheis Research Ranch. Megan's research focuses on grassland lichen taxonomy and

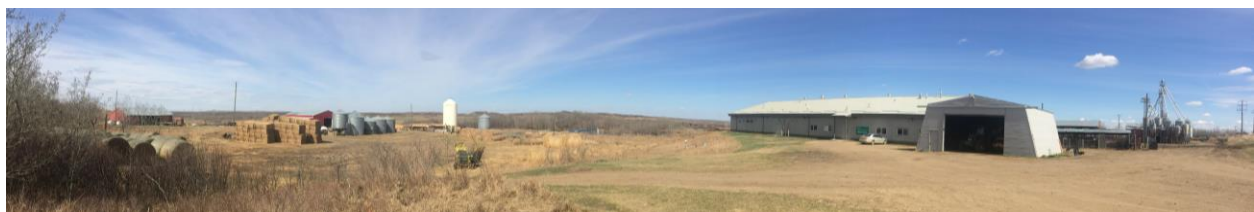


The lichen research project uses infrastructure from the drought study at the Mattheis Research Ranch, May 2019.

effects of grazing on biocrust lichen communities. Because biocrusts are critical to grassland ecosystem function, it is important to understand how they may be affected by grazing management systems and changes in climate. Megan is being co-supervised by Drs. Cameron Carlyle and Diane Haughland.

An estate donation was generously bequeathed to the RRI in 2019 intended for Mattheis Research Ranch as a capital investment or improvement. Decisions about the use of these funds (approximately \$100,000) are still being made, although the intention is to invest in equipment for capturing long term greenhouse gas fluxes, particularly methane, on this working cattle ranch. Our understanding of methane production by cattle in pasture settings and the uptake of greenhouse gases by grassland soil microbes is limited. Collecting long term data in this environment could provide evidence that these grasslands are valuable as a net greenhouse gas sink rather than a source.

The Faculty of ALES in partnership with generous funding from the Hays family in Alberta, are seeking to hire a cow-calf researcher in 2020. This position fills a large gap within the AFNS department for a researcher working to support the beef industry and address beef industry issues. This will build our capacity to conduct rangeland research from a cow-calf perspective, increase activity at our Roy Berg Kinsella and Mattheis Research Ranches, and also provide critical support for student learning and outreach to the ranching community. While this decision is still being made, we are excited about the potential for collaboration.



Roy Berg Kinsella Research Station, May 2019. Photo by Lisa Raatz.

Table 4.1. Research projects funded by the RRI in 2019

Researcher(s)	Project Title
Wagner	An assessment of non-native plant invasions in Alberta rangelands at the local and regional scale

5. Communications

The Rangeland Research Institute participated in many outreach and extension events in 2019-2020. Researchers communicated their findings to a diverse audience of stakeholders including fellow researchers, students, ranchers, farmers, government and non-government groups, land and resource managers, policy makers, and the general public. Many of these outreach events were in partnership with other organizations at field tours, symposia, conferences, online webinars, media interviews, workshops, and seminars. A list of communications is provided in Appendix II and a subset of these events are described below.



Dr. Jack Ives and M.Sc. student Katherine Gadd at their nearby archeological dig site. Photo by Lisa Raatz.

The Department of Anthropology and The Institute of Prairie Archeology under the leadership of Drs. John (Jack) Ives and Kisha Supernant held their well-attended field school at the Mattheis Research Ranch in May and June 2019. The school was attended by undergraduate and graduate students learning field skills, GIS mapping and remote sensing methodologies at their nearby bison kill site discovery. Students were also able to experience key cultural interactions with indigenous and community leaders to learn more about the human history and pre-history of the region. The field school included a Stones & Bones Open House at Mattheis Ranch in collaboration with the Department of Paleontology which was open to members of the public.

The Faculty of ALES celebrated 90 years of research at the Breton Plots Field Day on June 20, 2019. University researchers, alumni, industry, government, producers and the public gathered to learn about the legacy of soils research in the faculty, as well as many carbon sequestration projects. RRI affiliated researcher, Dr. Guillermo Hernandez-

Ramirez and his graduate students spoke about their research investigating soil carbon sequestration under annual and perennial rye crops.



Breton Field Day: Celebrating 90 Years of Soil Science. L: local ranch families and others joined the tour. R: Dr. Guillermo Hernandez-Ramirez and his graduate students talk about their research. Photos by Lisa Raatz.

Dr. Edward Bork, Director of the RRI, gave the opening keynote address at the Grassland Conservation Markets Symposium held in Calgary, Alberta, on “Grassland ecosystem services and values at risk”. Attended by more than 125 attendees from all over North America, this think-tank event was designed to bring together a wide range of expertise, including industry and non-government organizations, to identify, define and promote policies that further develop markets in support of ecosystem goods and services derived from grasslands. Dr. Bork also was an invited panelist to present and address questions at the University of Saskatchewan Beef and Forage Research Forum, a collaborative seminar series coinciding with the International Year of Plant Health.

The RRI hosted Calgary artists, Eric Moschopedis and Mia Rushton, for a second year as they explore and seek inspiration in order to communicate about ecology and conservation through the visual arts. Eric and Mia are working on a project about the importance of native grasslands; their work reaches a different audience than those who seek out conventional



Calgary-based artists, Mia and Eric.

scientific sources of information. We look forward to seeing what they create. To view previous projects by Mia and Eric, visit their website: <http://miaanderic.ca/>



Dr. Edward Bork leads a discussion about industrial disturbance on grasslands with ENCS 471 students.

Undergraduate and graduate students attended the Range and Wildlife field school led by Dr. Edward Bork in late August. Students spent a day at Mattheis Ranch learning about several research projects including native and introduced bee species intraspecific competition for floral resources, mitigation of industrial disturbance on native grasslands, invasive species, carbon sequestration, as well as

ranch management and rotational grazing practices. Students also gained experience conducting a riparian health assessment along Matzhiwin Creek and toured the Ducks Unlimited wetland complex.

The Canadian Weed Science Society invited RRI SAC member, Dr. Cameron Carlyle, to organize and participate in a weeds focussed rangeland management concurrent session at their annual meeting held in Kelowna, BC in November. Researchers across western Canada presented their work including Dr. Cameron Carlyle and his M.Sc. student, Brendan Bischoff, and RRI Coordinator, Lisa Raatz. CWSS organizers expressed an interest in continuing to include a session to highlight weed management issues in rangelands.

The RRI had an information table at the Western Canadian Soil Health and Grazing conference held in Edmonton in December. The sold-out conference was attended by ranchers (including many young families), producers, land managers, government and non-government organizations. Dr. Timm Döbert and Lisa Raatz had opportunity to speak one-on-one with many ranchers and students about current research being conducted at Mattheis Ranch and other locations.

Dr. Edward Bork and PhD student Jessica Grenke worked with Derek Leahy, the Director of Rural Routes to Climate Change, to record a pod-cast of the role of grazing practices, including adaptive-multipaddock rotational grazing, as a potential solution to help combat rising atmospheric CO₂ and associated climate change. This pod-cast is available at: <https://rr2cs.ca/ep24-amp-grazing/>

Additional outreach activities presented by our RRI-affiliated researchers are listed in Appendix II. Several graduate students completed their projects and successfully defended their research; their seminars are also listed in Appendix II. In addition to extension and outreach events, researchers also communicated their research in peer-reviewed journals in 2019-2020. Many of these publications are listed in Table 5.1. Each of our communication activities increases the profile of the RRI, the University of Alberta and the Research Ranches, and expands our knowledge about the importance of grasslands and rangelands to a wide audience.



L: Dr. Timm Döbert speaks to a rancher, R: at the RRI information table at the Western Canadian Soil Health and Grazing Conference, Dec 2019.

Table 5.1. Select peer-reviewed publications authored by RRI affiliated researchers between April 2019 and March 2020

- Bork, E.W., Raatz, L.L., Carlyle, C.N., Hewins, D.B., Thompson, K.A. Mar 2020. Soil carbon increases with long-term cattle stocking in northern temperate grasslands. *Soil Use and Management*. DOI: 10.1111/sum.12580
- Kiani, M., Hernandez-Ramirez, G., Quideau, S.A.M. Feb 2020. Spatial variation of soil quality indicators as a function of land use and topography. *Can J. Soil Sci.* DOI: 10.1139/cjss-2019-0163
- Chuan, X.Z., Carlyle, C.N., Bork, E.W., Chang, S.X., Hewins, D.B. Feb 2020. Extracellular enzyme activity in grass litter varies with grazing history, environment and plant species in temperate grasslands. *Science of the Total Env.* 702: UNSP 134562. DOI: 10.1016/j.scitotenv.2019.134562
- Thompson, K.A., Bent, E., James, K., Carlyle, C.N., Quideau, S., Bork, E.W. Jan 2020. Access mats partially mitigate direct traffic impacts on soil microbial communities in temperate grasslands. *Applied Ecology*. 145: UNSP 103353. DOI: 10.1016/j.apsoil.2019.09.003
- Zhang, F., Wang, Y.N., Mukiibi, R., Chen, L.H., Vinsky, M., Plastow, G., Basarab, J., Stothard, P., Li, C.X. Jan 2020. Genetic architecture of quantitative traits in beef cattle revealed by genome wide association studies of imputed whole genome sequence variants: I: feed efficiency and component traits. *BMC Genomics*. 21(1): Article 36. DOI: 10.1186/s12864-019-6362-1
- Wang, Y.N., Zhang, F., Mukiibi, R., Chen, L.H., Vinsky, M., Plastow, G., Basarab, J., Stothard, P., Li, C.X. Jan 2020. Genetic architecture of quantitative traits in beef cattle revealed by genome wide association studies of imputed whole genome sequence variants: II: carcass merit traits. *BMC Genomics*. 21(1): Article 38. DOI: 10.1186/s12864-019-6273-1
- Stotz, G.C., Cahill, J.F. Jr., Bennett, J.A., Carlyle, C.N., Bork, E.W., Askarizadeh, D., Bartha, S., Beierkuhnlein, C., Boldgiv, B., Brown, L., et al. Dec 2019. Not a melting pot: Plant species aggregate in their non-native range. *Global Ecology and Biogeography*. 29: 482-490. DOI: 10.1111/geb.13046
- *Bork, E.W., Lyseng, M.P., Hewins, D.B., Carlyle, C.N., Chang, S.X., Willms, W.D., Alexander, M.J. Dec 2019. Herbage biomass and its relationship to soil carbon under long-term grazing in northern temperate grasslands. *Can J of Plant Sci.* 99(6): 905-916. DOI: 10.1139/cjps-2018-0251
- Pyle, L.A., Hall, L.M., Bork, E.W. Dec 2019. Soil properties in northern temperate pastures do not vary with management practices and are independent of rangeland health. *Can J Plant Sci.* 99(4): 495-507. DOI: 10.1139/cjss-2019-0076
- Bao, T., Carlyle, C.N., Bork, E.W., Becker, M., Alexander, M.J., DeMaere, C., de Souza, D.M., Farr, D., McAllister, T.A., Selin, C., Weber, M., Cahill, J.F. Dec 2019. Survey of cattle and pasture management practices on focal pastures in Alberta. *Can J Animal Sci.* 99(4): 955-961. DOI: 10.1139/cjas-2018-0110
- Najafi, F., Thompson, K.A., Carlyle, C.N., Quideau, S.A., Bork, E.W. Oct 2019. Access matting reduces mixedgrass prairie soil and vegetation responses to industrial disturbance. *Env Management*. 64(4): 497-508. DOI: 10.1007/s00267-019-01193-4
- Wang, R., Gamon, J.A. Sept 2019. Remote sensing of terrestrial plant biodiversity. *Remote Sensing of Env.* 231: UNSP 111218. DOI: 10.1016/j.rse.2019.111218
- Brown, C., Cahill, J.F. Sept 2019. Vertical size structure is associated with productivity and species diversity in a short-stature grassland: Evidence for the importance of height variability within herbaceous communities. *J Vegetation Sci.* 30(5): 789-798. DOI: 10.1111/jvs.12785
- Frost, C.M., Allen, W.J., Courchamp, F., Jeschke, J.M., Saul, W.-C., Wardle, D.A. Sept 2019. Review: Using network theory to understand and predict biological invasions. *Trends in Ecol & Evol.* 34(9): 831-843. DOI: 10.1016/j.tree.2019.04.012

- Komatsu, K.J., et al. Sept 2019. Global change effects on plant communities are magnified by time and the number of global change factors imposed. *Proceedings of the Nat Acad Sci.* 116(36): 17867-17873. DOI: 10.1073/pnas.1819027116
- Brown, C., Oppon, K.J., Cahill, J.F. Aug 2019. Species-specific size vulnerabilities in a competitive arena: Nutrient heterogeneity and soil fertility alter plant competitive size asymmetries. *Functional Ecology.* 33(8): 1491-1503. DOI: 10.1111/1365-2435.13340
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* 2019 Best Paper award in Canadian Journal of Plant Science.

6. Strategic Advisory Council

As in 2018, there was no Strategic Advisory Council (SAC) annual meeting held in 2019, although a 2018-2019 Annual Report was prepared and shared with SAC members. The RRI continues to be active; however, changes made to the RRI funding model in the last two years have altered the ability to fulfill some goals that were included in the Draft Strategic Plan previously developed by the 2016 SAC members. Revisions to the plan are required and will be shared with the SAC in due time. The current composition of the SAC as of March 31, 2020 is provided in Table 6.1.

Western Sky Land Trust (WSLT) hosted a land naming ceremony to honor former WSLT CEO and fellow SAC member, Jerry Brunen. Alberta's Lt. Governor, Honorable Lois Mitchell spoke with admiration of Jerry and a plaque was unveiled at The Jerry Brunen Bow River Views heritage land near Calgary, AB on June 27, 2019. This is a permanent and fitting tribute to Jerry's passion and legacy for land conservation; the event was attended by several members of the SAC. Photos of the day can be viewed at the link on the WSLT website: <http://www.westernskylandtrust.ca/jerry-brunen-land-naming-ceremony.html>.



L: The Jerry Brunen Bow River Views heritage property in Aldersyde, AB; R: Attendees mingle around 'Jerry's rock' after the ceremony. Photos by Lisa Raatz.

Table 6.1. Members of the RRI Strategic Advisory Council, March 2020.

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; Professor and Mattheis Chair in Rangeland Ecology & Management, <i>University of Alberta</i>	Edmonton, AB
Dr. Cameron Carlyle	Assistant Professor, <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
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



Pincushion cactus (*Escobaria vivipara*) flower and pollinator at the Mattheis Research Ranch. Photo by Lisa Raatz.

7. Financial Overview

The RRI 2019-2020 financial statement is shown in Appendix III and summarizes revenue and expenses. The majority of the RRI operational revenue continues to be generated from oil and gas extraction surface leases and utility (powerline) activity resulting from the Mattheis Research Ranch. Expenses include costs associated with outreach and extension, RRI operating and administration costs, and support for research activities and capacity building.

In 2015, the Rangeland Ecology and Management Fund (REMF) was created as an endowment and the majority of the principle is derived from revenue received following the major powerline construction at Mattheis Ranch, a generous donation from the Alberta Beef Producers, and a large contribution from the conservation easement placed on the Mattheis Research Ranch in partnership with Western Sky Land Trust. In 2019-20, \$850,000 was transferred from the RRI Operations budget to the REMF in order to build the principle as rapidly as possible thereby increasing our long-term capacity to conduct research. Of note, starting in 2018-19, the Department of AFNS began taking a proportion of the spending allocation (the amount annually generated as interest received on the principle) to offset ongoing budget constraints. The proportion increased in 2019-20 and is expected to increase further over time. The current value of the REMF as of March 31, 2020 was \$7,692,570.20 (Appendix IV).

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 2019-2020. * Indicates projects that have received support from the RRI Competitive Grants Program.

Project Title	Principle Investigators
Mitigation of high voltage powerline construction on mixedgrass prairie	Edward Bork, Cameron Carlyle & Sylvie Quideau
Avi-fauna responses to land use disturbance in mixedgrass prairie	Scott Nielsen
Long-term monitoring of rangeland ecosystem functions on the Mattheis and Kinsella Research Ranches*	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
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, Carol Frost, Jessamyn Manson, & Marcus Becker
Comprehensive study of the human prehistory and history of the Mattheis Ranch*	Jack Ives & Kisha Supernant
Using plant traits to assist conservation and management of Alberta's rangelands*	James Cahill
Collaborative development of precision ranching to address climate change issues in cow-calf production*	Cameron Carlyle & John Church
Evaluating the contribution of lichens to Alberta's grassland biological soil crusts through baseline taxonomic research and manipulative grazing and drought experiments*	Cameron Carlyle, Diane Haughland, & Raquel Pino-Podas
Does defoliation affect carbon flow in rangelands? A test at two ecosites at the Mattheis Ranch*	Scott Chang & Zilong Ma
Interactive impacts of managed pollinators and invasive plants on native plant-pollinator networks and native plant reproductive success*	Carol Frost
Evaluating the efficacy of herbicide indaziflam applied in fall and spring to control downy and Japanese brome in southern Alberta rangeland	Edward Bork, Lisa Raatz, Tanner Broadbent, & Darren Bruhjell

Appendix II. Select presentations by RRI affiliates in 2019-2020

Outreach and promotional activities undertaken in support of the RRI during 2019-2020.

Abbreviated title	Presenter(s)	Venue	Audience(s)	Date
A reconsideration of grazing impacts on soil carbon in northern temperate grasslands	Bork	Agricultural Producers Association of Saskatchewan; Regina, SK	Ranchers, producers, government, industry	Apr 2019
Grasslands of Inner Mongolia and their management challenges	Han	U of A Range seminar; Edmonton, AB	Researchers, students, staff	Apr 2019
<i>Field tour:</i> Stones & Bones Open House	Ives, Gadd	Mattheis Research Ranch	Researchers, students, public	May 2019
Grassland vegetation diversity responses to the reintroduction of Wood Bison (<i>Bison bison athabasca</i>) in Aishihik, Yukon	Schroeder	MSc defense; Edmonton, AB	Researchers, students	Jun 2019
<i>Field tour:</i> Greenhouse gas emissions in perennial grains in central AB	Hernandez-Ramirez	Breton Plots Field Day; Breton, AB	Researchers, students, government, industry, public	Jun 2019
Guardians of the Grasslands	Lynch-Staunton and discussion panelists: Bork, White, Döbert	University of Alberta Sustainability Week; Edmonton, AB	Researchers, students, public	Oct 2019
Grassland carbon: A review of current research efforts in support of biological carbon storage in Canada	Bork	Society for Range Management: Honouring rangelands for their service to the environment and society; Olds, AB	Ranchers, producers, resource managers, NGOs, industry, government	Nov 2019
Are grasslands part of the cure for climate change?	Bork	Farmfair International; Edmonton, AB	Ranchers, producers, resource managers, public	Nov 2019
Grassland ecosystem services and values at risk	Bork	C Grassland Conservation Markets Symposium; Calgary, AB	Researchers, government, resource managers, industry	Nov 2019

Understanding the role of grasslands in carbon storage and GHG mitigation	Bork	Regenerative Agriculture Workshop at Annual Meeting for Manitoba Forage and Grassland Association; online webinar	Government, NGOs, ranchers, resource managers, researchers, industry	Nov 2019
Effect of non-native plants on rangeland ecosystem goods and services	Carlyle	Canadian Weed Science Society; Kelowna, BC	Researchers, government, resource managers, industry	Nov 2019
Forage recovery following wildfire in the northern dry mixedgrass prairie	Bischoff*, Carlyle, Lamb, Bork	Canadian Weed Science Society; Kelowna, BC	Researchers, government, resource managers, industry	Nov 2019
Efficacy of four herbicides on wild licorice applied at two growth stages in mixedgrass prairie	Raatz*, Bork	Canadian Weed Science Society; Kelowna, BC	Researchers, government, resource managers, industry	Nov 2019
Recovery of legumes in northern temperate pastures following the application of broadleaf herbicides	Miller*, Bork, Hall	Canadian Weed Science Society; Kelowna, BC	Researchers, government, resource managers, industry	Nov 2019
Rangeland Research Institute: Information Table	Raatz, Döbert	Western Canadian Soil Health and Grazing Conference; Edmonton, AB	Ranchers, producers, resource managers, industry	Dec 2019
Grassland carbon: A review of current research efforts in support of biological carbon storage in Canada	Bork	Biological Carbon Canada, Grass and Carbon Conference; Edmonton, AB	Ranchers, producers, resource managers, industry	Dec 2019
Simulated livestock soil compaction, plant defoliation and litter removal on extracellular enzyme activity	Barszczewski	MSc defense; Edmonton, AB	Researchers, students	Dec 2019
Chemical characterization and photochemical evolution of biomass burning particles in the atmosphere	Loebel Roson, Wang, Lima Amorim, Abel, B. Zhao, Harynuk, Jäger, R. Zhao*	American Geophysical Union Conference; San Francisco, CA	Researchers, students, government, NGOs, industry	Dec 2019
Assessment of rumen microbiota in beef heifers with different feed efficiency and managed under different feeding systems	Lui	MSc defense; Edmonton, AB	Researchers, students	Jan 2020

Understanding the role of grasslands in carbon storage and greenhouse gas mitigation	Bork	Alberta Federation of Agriculture Conference and AGM; Leduc, AB	Industry, government, NGOs, resource managers	Jan 2020
Effects of managed pollinators (<i>Apis mellifera</i>) on native plant-pollinator networks and native plant reproductive success	Worthy, Acorn, Frost	18 th Bentley Lecture in Sustainable Agriculture: Farming on a Warming Planet; Edmonton, AB	Researchers, students, producers, public	Feb 2020
Post-wildfire recovery in the dry mixedgrass prairie, Canada	Bischoff*, Carlyle, Lamb, Bork	SK PCAP: 7th native prairie restoration and reclamation workshop & 5th transboundary grassland partnership workshop; Regina, SK	Researchers, resource managers, government, NGOs, industry	Feb 2020
Grassland carbon: Current research in support of biological carbon storage in Canada	Bork	Gateway Research Organization Annual meeting; Barrhead, AB	Government, NGOs, resource managers	Feb 2020
Forests reduced the structural and thermal stability while increased the quality of soil organic carbon in hedgerow agroforestry systems	An*, Chang, Ma, Baah-Acheamfour, Bork, Carlyle, Michaelis, Bernard, Plante	Alberta Soil Science Workshop; Lethbridge, AB	Researchers, government, resource managers, industry	Feb 2020
Integrating forage into environmentally sustainable beef production: A research perspective	Bork	Beef and Forage Research Forum, International Year of Plant Health Collaborative Seminar Series; University of Saskatchewan, Saskatoon, SK	Researchers, students, government, NGOs, industry	Feb 2020
The influence of precipitation and management variance on plant communities across Western Canada	Grenke, Carlyle, Bork, Apfelbaum, Teague, Cahill, Boyce	Extreme Climate Events Symposium 2020; Toronto, ON	Students, researchers	Feb 2020
Source-process partitioning of soil N ₂ O and CO ₂ production: nitrogen and simulated exudate additions	Daly, Hernandez-Ramirez	Alberta Soil Science Workshop; Lethbridge, AB	Researchers, government, resource managers, industry	Feb 2020
Does the Adaptive Multi-Paddock grazing system increase carbon sequestration in Canadian grassland soils?	Sobrinho*, Chang, Boyce, Bork, Carlyle, Döbert	Alberta Soil Science Workshop; Lethbridge, AB	Researchers, government, resource managers, industry	Feb 2020

Water-Energy-Food connections in agriculture	Grenke	Inside Education: Cultiv8 2020; Olds, AB	High school students, teachers	Mar 2020
Opportunities to achieve grassland conservation through ecological goods and services	Bork	Prairie Habitat Joint Venture Policy Committee, online webinar	Government, NGOs, policy makers, resource managers	Mar 2020
Response of biocrust to drought and simulated grazing in Alberta native grasslands	Lewis*, Amgaa, Rajpur, Carlyle, Haughland, Miller, Hill	ALES Graduate Student Research Symposium; Edmonton, AB	Researchers, students	Mar 2020
Patterns of non-native plants in Alberta's native grasslands.	Zapisocki, Wagner	R.E. Peter Biology Conference, U of A; Edmonton, AB	Researchers, students, academics	Mar 2020

Appendix III. RRI Financial Statement of Actuals, April 1, 2019 to March 31, 2020

	Actuals
Opening Balance	\$441,681.00
Revenue	
Lease/Utility (Powerline) Revenue	\$522,370.70
Total Revenue	\$964,051.70
Expenditures	
Transfer to Endowment	\$850,000.00
Property Taxes	\$2,584.86
Supplies	\$9,263.23
Travel	\$5,420.76
Communications (telephone)	\$613.94
Rentals and Leases	\$13,243.96
Total Expenditures	(\$881,126.75)
Net Balance	\$82,924.95

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, 2019 to March 31, 2020

	Actuals
Principal	
Opening Balance (April 1, 2019)	\$ 6,561,476.09
Current Year Contributions	\$851,367.76
Capitalized Investment Earnings	\$279,726.35
Closing Balance (March 31, 2020)	\$7,692,570.20
Spending Allocation (Revenue)	
Opening Balance (April 1, 2019)	\$64,512.19
Current Year Endowment Spending Allocation	\$262,329.96
Total Revenue	\$326,842.15
Current Year Expenditures	
Faculty salary ¹	\$46,680.00
Support staff	\$95,391.08
Rental Expenses	\$464.40
Research Projects	\$119,055.00
Advertising Expenses (Trade Show Booth)	\$1,000.00
Total Expenditures	(\$262,590.48)
Closing Balance After Encumbrances	\$64,251.67

¹ A proportion of faculty staff salary was taken out of the endowment starting in 2018/19 in order to remove it from the Department of AFNS operational budget and account for budget shortfalls. The proportion has and will increase over time.