Rangeland Research Institute

2022-2023 Annual Report

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Rangeland Research Institute

Table of Contents

1.	Introduction 1
2.	Research
3.	Research Profiles
4.	Capacity Building13
5.	Communications & Teaching15
6.	Strategic Advisory Council23
7.	Financial Overview24
Арр	endix I. Summary of ongoing research projects led by RRI affiliates
Арр	endix II. Select presentations by RRI affiliates in 2022-2023
Арр	endix III. RRI Financial Statement of Actuals, April 1, 2022 to March 31, 2023 33
Арр	endix IV. Rangeland Ecology and Management Fund Financial Statement of
Act	uals, April 1, 2022 to March 31, 2023

Cover photo: Research in Action! Dr. Edward Bork and Katherine Johnson assess plant cover prior to simulated grazing treatments in a project led by Drs. Scott Chang and Xinli Chen. Researchers are tracing where and how quickly carbon moves within above- and belowground vegetation in response to varying intensities of defoliation at the Roy Berg Kinsella Research Ranch.

Photo by Lisa Raatz

1. Introduction

There is an increased awareness and focus on climate change that is being communicated through the media, government, environmental organizations, and the scientific community. The 2023 growing and grazing season in much of Alberta began with moisture deficits, below average precipitation, unseasonably hot temperatures, and early large-scale wildfires. Affected ranchers and farmers are faced with complex and stressful challenges around managing their land and livestock through drought, getting access to limited available feed supply in an already challenging economy, destocking or evacuating livestock due to wildfire, and in some cases, rebuilding lost infrastructure. Extreme and more frequent weather events can be related to long-term climate change and the effects of rising global temperatures. The Canadian government along with other funding agencies have committed to finding climate change mitigation solutions at a local and regional scale, as well as meet global climate targets.

The Rangeland Research Institute (RRI) promotes, facilitates, and in some cases provides direct funding to researchers evaluating diverse subjects that relate to rangelands, many with a focus on aspects of the environmental goods and services they provide. Many of the RRI-affiliated researchers investigate some aspect of climate change mitigation as it relates to rangeland ecology and management, including vegetation and soil recovery following disturbances such as ongoing grazing, wildfire occurrence, escalating drought, or industrial development. Research themes linking to climate change impacts include invasive species management, species biodiversity and conservation, management practices to enhance and stabilize forage production for livestock, assessing new grazing



Smooth blue beardtongue (*Penstemon nitidus*) at the Mattheis Research Ranch in May

technologies and practices to improve efficiencies and profitability in a more uncertain environment, among many other themes. These research projects improve our understanding of how rangelands and grasslands respond to climate change and subsequently refine ongoing best management practices with the goal of mitigating the collective impacts of land use, including livestock grazing, on associated environmental goods and services.

The primary mandate of the RRI is to facilitate research, teaching, and outreach. This report summarizes key activities undertaken by the RRI from April 1, 2022 through March 31, 2023 in support of that mandate. The report includes a summary of research activities, including three profiles of recently completed research projects; a summary of communication and outreach activities; capacity building; as well as a financial summary of the previous year.



Researchers take data on a Cicer milkvetch plant at the Mattheis Research Ranch as part of an MSc student project assessing the effect of Cicer milkvetch on soil carbon, nutrient availability, and the soil microbiome. Photo from Dr. Malinda Thilakarathna.

2. Research

In 2010, University of Alberta alumni, Edwin and Ruth Mattheis generously donated their 12,300-acre ranch to the University of Alberta. From that donation, the Rangeland Research Institute (RRI) was created. In the following years, the RRI placed a Conservation Easement on the Mattheis Ranch in partnership with Western Sky Land Trust to further the vision of Edwin and Ruth to protect the land from being subdivided or disturbed so that the ranch, which is mostly native grassland, would be used for research and teaching about rangelands. The funds generated from the easement were placed into the Rangeland Ecology and Management Endowment Fund which generates an annual spending allocation that is utilized for various RRI initiatives, including supporting direct grants to researchers through a Competitive Grants program. To date, 32 grants have been awarded totaling \$1.09M to further our understanding of rangeland ecology and management, an ongoing legacy that Edwin and Ruth have created.



Dr. Xinli Chen (right) and research assistant apply simulated grazing treatments at the Kinsella Research Ranch.

Since the RRI was created, one of the primary goals has been to facilitate and conduct research to enhance our understanding about rangelands and their associated land uses. This includes a wide variety of topics related to these lands: soil, plant, wildlife, cattle, pollinator, microbial community biology, basic ecology and applied management; as well as all associated human activities: historical and current livelihoods that rely on

rangelands, and industrial and recreational use. Each project relates to some aspect of rangeland ecology and management, with many focused on quantifying the magnitude and value of environmental goods and services provided by rangelands. Projects that are still ongoing are listed in <u>Appendix I</u>. Select projects that have recently been completed are summarized in the following <u>Research Profiles (Section 3)</u>.

Researchers affiliated with the RRI conduct research at many locations across the western Canadian prairies. The Mattheis Research Ranch is in the Dry Mixedgrass prairie ecoregion of southern Alberta, the heartland of the Alberta cattle ranching industry, and the Roy Berg Kinsella Research Ranch situated within the central Aspen Parkland ecoregion. Both ranches comprise the two primary land bases for rangeland research at the



Dr. Dianne Haughland (right) and three MSc students select research sites at the Mattheis Research Ranch to assess a DNA-based approach to monitoring plant, lichen and moss species.

University of Alberta and represent distinctly contrasting agroclimatic regions. However, research also takes place on many private and public land locations across Alberta and the western prairie provinces. Additionally, in 2016, the University of Alberta signed a Memorandum of Understanding with the provincial government to continue the research legacy at the Onefour and Stavely Research stations. Having access to all of these land bases is invaluable for conducting research across a wide spectrum of environments, consistent with the diversity of rangeland landscapes found in Alberta.

Mattheis Ranch experienced increased research activity in 2022-2023 compared to the previous two years because researchers were no longer restricted from traveling due to COVID-19. A total of 53 individuals spent 189 person-days at the Mattheis Ranch in 2022-23, including 10 principal scientists and post-doctoral researchers, 8 graduate students, 27 undergraduate students, and 8 senior technologists and other staff. Researchers using the ranch and housing were from the University of Alberta, mostly from the Faculty of ALES (Agricultural, Life and Environmental Sciences; Depts. of Agricultural, Food and Nutritional Sciences and Renewable Resources). Other U of A users included those from the Faculty of Science (Dept. of Biological Sciences). External organizations included Agriculture and Agri-Food Canada, Concordia University, and the Alberta Biodiversity Monitoring Institute.

The Roy Berg Kinsella Ranch had a high volume of use in 2022-2023 due to the large multifaceted Precision Ranching project. The ranch was used by a total of 33 individuals for 549 person-days, including 8 principal scientists and post-doctoral researchers, 10 graduate students, 13 undergraduate students, and 4 senior technologists and other staff. Researchers using the Kinsella Ranch and housing were from the University of Alberta, mostly from the Faculty of ALES (Agricultural, Life and Environmental Sciences; Depts. of Agricultural, Food and Nutritional Sciences and Renewable Resources), as well as the Faculty of Science (Dept. of Biological Sciences). External organizations included Thompson Rivers University, Lakeland College, and Olds College.

The RRI made a call for Competitive Grant proposals in Feb 2022 and awarded five grants (Table 2.1 lists successful applications in 2022). Each group has completed one field season at the ranch locations indicated. However, there was no call for Competitive Grant proposals in 2023. As in some prior years, funds were recapitalized to build the endowment principle with the intent of increasing the available spending allocation for future years. The RRI yearly spending allocation depends on annual interest rates, and in the past several years, has been used by the faculty to make up for budget shortfalls. The strategy to build the endowment rapidly will ensure there are funds available in the long-term to be awarded to researchers.

Researcher(s)	Project title	Location(s)
Holden, Cahill	Using network analyses to better predict ecosystem goods and services in Alberta rangelands	Mattheis & Kinsella Ranches
Batbaatar, Carlyle, Cahill	The resilience of Alberta's grasslands to the combined effects of drought and defoliation	Mattheis Ranch
Chang, Chen	Do defoliation intensity and time since defoliation affect plant carbon transfer and soil carbon accumulation?	Kinsella Ranch
Silva	In Vitro ruminal fermentation characteristics of different pasture types found at the Dry Mixedgrass natural subregion of Alberta	Mattheis Ranch
Thilakarathna, Carlyle	Effect of Cicer milkvetch on soil carbon, nutrient availability, and soil microbiome in mixed prairie grassland	Mattheis Ranch

Table 2.1. Competitive Grant proposals that were awarded funding from the RRI in March 2022.

Silvopastures Contribute to Valuable Carbon Storage in the Canadian Prairies

Prepared by Edward Bork, University of Alberta

Recent work at the University of Alberta led by Dr. Scott Chang documents the important role that agroforests play in carbon (C) storage. Agroforests are agricultural landscapes that include the deliberate integration of forests with herblands on the same land base. Common agroforests in Alberta include planted tree shelterbelts or naturally occurring forest hedgerows at field margins, and silvopastures that combine livestock grazing with forest retention and/or production. Zhengfeng An, a PhD student challenged with the task of assessing changes in C stock across agricultural regions of central Alberta, used a combination of field data and geographic information systems to quantify patterns of land use change between 2001 and 2020, including agroforest loss on C release. Across an area of 9.5 M ha of central Alberta, agroforests were found to contain nearly 700 M tonnes of C valued at an estimated \$102.7 B Cdn based on 2021 valuation levels.

A key finding was that relative C densities were greater in agroforests, including forested pastures (368.4 t/ha) than croplands (198.9 t/ha) of the agricultural landscape. Moreover, while silvopastures represented 21.0% of central Alberta by area, they contained 32.9% of total ecosystem C, thereby contributing disproportionately more to the offset of atmospheric CO₂. In



Cattle graze in a silvopasture landscape at the Kinsella Research Ranch, a mix of aspen stands and grassland meadows.

contrast, and despite their widespread abundance by area (54.1%), croplands contained only 45.8% of C stocks, thus contributing less to this important ecosystem service.

Land use change patterns over the 20-year period encompassed by the study revealed that forests, mostly hedgerows and in particular, forested silvopastures, declined annually by an average of 2425 ha (80% of the total loss). The overall loss of more than 48,500 ha of forest due to land use conversion was found to have led to a net loss of 8.4 M tonnes of C, valued at more than \$1.2 B Cdn. These results highlight the importance of conserving existing agroforests, particularly silvopastures and their associated perennial grasslands due to their widespread area, and identified significant opportunities to increase C storage through the establishment and enhancement of agroforests.

Detailed results of this study can be found in:

An, Z., Bork, E.W., Duan, X., Gross, C.D., Carlyle, C.N., Chang, S.X. 2022. Quantifying past, current, and future forest carbon stocks within agroforestry systems in central Alberta, Canada. GCB-Bioenergy (doi.org/10.1111/gcbb.12934).

Long-Term Cattle Grazing Increases Grassland Soil Carbon

Prepared by Dr. Edward Bork, University of Alberta

Grasslands are widely recognized for their role in storing soil carbon (C), and growing interest exists in understanding how common land use activities like livestock grazing affect soil C. While previous studies examining grazing impacts on soil C are often limited to a handful of study sites, or lack long-term information on grazing history, including stocking rate, this restricts our understanding of whether and how grazing impacts soil C stocks.

A recent study led by Dr. Edward Bork at the University of Alberta, utilized a set of archived data from a wide-ranging network of community pastures across the Mixedgrass Prairie of southern Saskatchewan, to quantify soil C and relate those stocks to long-term (up to 22 yr) stocking levels of cattle.

Roughly one-third of soil C was inorganic C that did not vary in abundance with grazing history. In contrast, soil organic C mass increased with cattle stocking rates in the topsoil, even when normalized for localized growing conditions (including rainfall). This unexpected finding provides evidence that cattle grazing is consistent with maintaining, and even increasing, soil C in grasslands. Equally important, the study provided insight into the mechanism responsible for the observed increase in C, as soil organic C



Location of the nine community pastures evaluated across south-central Saskatchewan, Canada (black squares). Map provided courtesy of the Government of Saskatchewan (2020)

trends in the top 15 cm of mineral soil coincided with a distinct change in grassland species composition.



Cattle on a private ranch situated within sprawling grasslands of the Mixedgrass Prairie of SE Alberta

Elevated intensities of grazing specifically led to a greater presence of grazing-tolerant introduced plant species, in particular Kentucky bluegrass, a common agronomic forage grass known to be invading into Mixedgrass Prairie. This encroachment was associated with marked increases in soil organic C and is consistent with other studies in the northern Great Plains of the USA.

Ultimately, these findings support

the notion that grazing can be used as a tool to improve soil organic C stocks and adds clarity on the potential mechanisms regulating where and how grazing is likely to achieve this, for example in mesic regions that are prone to invasion by highly productive, introduced agronomic plant species. This information will help develop innovative policies rewarding grazers for the storage of soil C, thereby mitigating impacts of climate change.

Detailed results of this study can be found in:

Bork, E.W., Raatz, L.L., Carlyle, C.N., Hewins, D.B., Thompson, K.A. 2020. Soil carbon increases with long-term cattle stocking in northern temperate grasslands. Soil Use & Management. 36(3): 387-399 (DOI: 10.1111/sum.12580).

Dr. Edward Bork University of Alberta edward.bork@ualberta.ca

Non-Native Plant Invasions in Prairie Grasslands of Alberta

Prepared by Dr. Viktoria Wagner, Zoey Zapisocki, and Raytha Murillo

Prairie grassland provides important ecosystem goods and services, such as forage for livestock, habitat for plants and wildlife, and recreational space. However, following decades of wide-scale conversion to cropland, only 26% of the native grasslands in Alberta remain. One of the most urgent challenges that these grasslands face is the invasion by non-native plants and the associated loss of native flora. In Alberta, a total of 350 non-native vascular species (16% of the flora) have been reported as naturalized outside of cultivation. Although not all introduced species are invasive, some can displace native plants and change how grasslands function. Owing to their ecological and economic impacts, invasive non-native plants are a major obstacle for native grassland management and conservation. A high abundance of non-native plants that are unpalatable for cattle can also increase operating expenses for weed control and decrease the value of rangeland properties.

Efficient policy and control options of invasive non-native plants require an understanding of the factors that facilitate invasions. In theory, a good water or nutrient supply in more mesic prairie could benefit highly competitive invasive plants more than native ones. Human disturbance may also facilitate invasion if it facilitates an influx of non-native seeds. Transportation corridors, oil and gas activity, and intentional seeding of agronomic forage

plants have all been linked to elevated levels of invasion in native plant communities. Improperly timed or prolonged heavy grazing, as well as prolonged protection from grazing, are known to promote non-native plant invasion. Although the impacts of invasive plants in Alberta grasslands have been relatively well researched, few studies have examined the factors enhancing invasions, and none have surveyed non-native plant invasions across a large regional gradient.



Assessing plant cover at one of the semiarid research locations. Photo from Dr. Viktoria Wagner.

To quantify the state of non-native plant invasions in Alberta prairie grasslands and disentangle possible factors facilitating invasions, we surveyed 139 native grassland plots in Alberta, along a

938 km southeast-northwest gradient from the border with Montana to the Peace River region (Figure 1). Our objectives were to 1) identify the most common non-native plant species, 2) determine which predictors influence non-native plant abundance and richness, and 3) test whether non-native plant invasions differ between mesic and semiarid grasslands and are facilitated by similar factors. We hypothesized that moisture and anthropogenic factors, like agricultural activity and grazing, play a large role in the patterns of non-native plants given their previously documented effects on plant biodiversity patterns.



Figure 1. Research locations across Alberta.

A striking result was that Kentucky bluegrass (*Poa pratensis* subsp. *angustifolia*), commonly used for agronomic purposes, was by far the most frequent and abundant non-native plant in the surveyed grasslands. Looking at species cover, smooth brome (*Bromus inermis*) and crested wheatgrass (*Agropyron cristatum*) occupied the next ranks. While dandelion (*Taraxacum officinale*) and goat's beard (*Tragopogon dubius*) occurred frequently throughout the province, their within-site footprint was relatively small. Across the survey region, the abundance and richness of non-native plants was generally higher in mesic than semi-arid grasslands, and also more pronounced in lower topographic positions and areas with increased agricultural activity. Meanwhile, levels of invasion decreased in grasslands with sandy soils and did not significantly change across different grazing intensities.

In summary, non-native plant invasions vary foremost due to climatic conditions, and to some extent agricultural activity, soil texture, and topography. Given that agronomic grasses were the most frequent and dominant invaders, future policy should consider the development of tools to strengthen the screening of intentionally introduced agronomic species, some of which have larger footprints throughout grasslands compared to provincially tracked and regulated invasive plants. The spread and influx of invasive non-native plants into native grasslands could be

decreased by prioritizing the usage of native seed material in forage and turf development and utilization, as well as in land management. In addition, control of invasive species may be warranted at the local scale, especially in native prairie remnants of the Central Parkland, which are not only highly fragmented, but also have the highest levels of invasion. Established invasions could be managed using improved rangeland management practices. Since many invasive grasses are inherently palatable, invaded areas should preferably be grazed or hayed early in the season when grasses are high in nutrients. In late summer/fall, after their active growth ends, grazing could be shifted to more grazing sensitive native pastures. Finally, our study provided a glimpse into the general state of non-native plant invasions in Alberta's prairie grasslands, but did not capture locally restricted or emergent invasions, such as cheatgrass (*Bromus tectorum*). A proactive approach of monitoring and early detection will help mitigate future invasions in prairie grasslands.

Dr. Viktoria Wagner

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Zoey Zapisocki, Project Lead & former MSc student Raytha Murillo, PhD student

Detailed results of this study can be found in:

Zapisocki, Z., Murillo, R.D., Wagner, V. 2022. Non-native plant invasions in prairie grasslands of Alberta, Canada. Rangeland Ecology & Management. 83: 20-30. (DOI: 10.1016/j.rama.2022.02.011)

4. Capacity Building

The Rangeland Research Institute continually seeks to build capacity by collaborating with other organizations to increase our exposure and access to additional resources. These collaborations are always mutally beneficial and synergistic. For example, along with 102 countries and over 331 international organizations, the RRI is involved in planning for the 2026 International Year of Rangelands and Pastoralists (IYRP). In 2022, The Food and Agricultural Organization of the United Nations General Assembly declared 2026 as the IYRP following a strong bid initiated in

2015 by Mongolia and partnering nations and organizations. Partners are encouraged to focus on delivering key range-focussed stories in 2026 to send a unified and consistent message to media agencies and the public, and raise the profile of rangelands and those who depend upon them. The RRI participated in planning activities at the Society for Range Management annual meeting in Boise, Idaho in February 2023 with other Canadian groups and plans to deliver extension events to focus on these themes. While many of these efforts will focus on the challenges that pastoralists encounter in developing nations, the North American, and more specifically western Canadian, groups will highlight the ranching community and their successes and challenges. Participation in the IYRP raises the profile of the RRI and its



Global framework for monthly themes. For more information: https://iyrp.info/

ability to network with other organziations to celebrate rangelands.

Two large multi-disciplinary and producer-centred projects will involve the U of A and RRIaffiliated researchers at the Mattheis and Kinsella Ranches as part of a national network of Living Labs. The <u>Living Labs</u> concept was initiated by Agriculture and Agri-Food Canada (AAFC) to create "regional collaboration hubs on farms", where "farmers and farm groups will be at the centre of decision making, innovation and on-farm activities". Funding has recently been awarded for large-scale projects in western Canada to identify agricultural practices that mitigate climate change. Producers commit to making management changes at the ranch or farm scale, and researchers are tasked with identifying, measuring and showing agricultural climate solutions based on before and after assessment of various key targets, such as carbon cycling and storage, nutrient use efficiency, greenhouse gas emissions, profitability, and other parameters.

Both Living Lab projects are multi-disciplinary and collaborative. <u>South of the Divide</u> <u>Conservation Action Plan (SODCAP)</u> is leading one of the Living Labs projects involving researchers from AAFC, Environment and Climate Change Canada, the University of Saskatchewan, University of Alberta, University of Waterloo, Carleton University, Bird Studies Canada, Canadian Wildlife Federation and the Royal Saskatchewan Museum, in cooperation with ranchers. Management practices being adopted include the avoided conversion of land from perennial cover to other uses, improved grazing management, and enhanced use of perennial species or annual cover crops for cattle grazing. The project involves ranches across Alberta and Saskatchewan, including the Mattheis and Kinsella Research ranches. The <u>Alberta Agrisystems</u> <u>Living Labs</u> is led by the Alberta Beef Producers, and similarly examines a wide range of onfarm best management practices, including the expanded use of rotational grazing and overseeding of perennial pastures with legumes, both of which could have environmental and economic benefits. Both projects will significantly expand the capacity of the RRI to conduct research through 2027 that relates directly to ranchers and farmers across Western Canada.

5. Communications & Teaching

One of the three mandates for the RRI is to communicate research through outreach, extension, and teaching. This occurs in diverse ways: Researchers affiliated with the RRI publish their work in peerreviewed journals, but also in interviews for popular press articles, such as those for Alberta Farmer Express or the Western Producer, for example. They also give oral presentations or posters of their work at conferences, workshops, symposia, seminars, webinars, and field tours. Extension efforts aim to communicate research findings to diverse audiences including farmers and ranchers, members of the public, students, government and non-government organizations, policy makers, land managers, as well as to other researchers and the academic community. A list of select rangerelated peer-reviewed publications from 2022-2023 are listed in Table 5.1 where at least one author is affiliated with the RRI (i.e. received funding from the RRI,

Imagine moving your cattle with just a swipe on a smartphone

Nofence is already in use in Europe and now researchers are putting it to the test here



The tire tracks on the right are at the edge of the virtual fence. The Notence collar chimes when an anima comes near the virtual tence and gives a small electrical shock if it crosses the GPS boundary. Photo:

Alberta Farmer Express, Mar 7, 2023 https://www.albertafarmexpress.ca/lives tock/imagine-moving-your-cattle-withjust-a-swipe-on-a-smartphone/

collaborates with U of A rangeland scientists, or conducts research at the Mattheis or Kinsella Ranches). Publications with at least one research location at the Mattheis or Kinsella Research Ranches are also noted. Select outreach and extension activities are listed in <u>Appendix II</u>, however, a few highlights from 2022-2023 include the following:

 In July 2022, the Rangeland Research Institute partnered with Livestock Gentec to host a Field Tour at the Roy Berg Kinsella Ranch which highlighted the large collaborative and multi-faceted Precision Ranching project. The theme for the day was *Precision Management Tools: Innovations in Land and Animal Stewardship to Build Climate Resilience,* and was attended by over 100 ranchers, producers, students, researchers from multiple post-secondary schools, land managers, funding agency representatives, as well as government and non-government personnel. An excerpt from the Society for Range Management, International Mountian Section Fall 2022 Newletter article written by Diego Martinez Mayorga and Jacqui Gironella captures the enthusiasm for the day:



Dr. Gleise Silva, the Hays Chair in Beef Production Systems at U of A, discusses her project assessing heat stress in cattle.



Dr. Edward Bork introduces the Precision Ranching project at the field tour: "Putting the right cow, in the right place, at the right time".

The field day was an excellent way to bridge the gap between researchers and the agricultural community and encourage discussion. "You can tell this is very valuable to producers as they are engaged and asking questions" said Mark Redmond, CEO of Results Driven Agriculture Research (RDAR). This is the first time many researchers and producers have been face-to-face since COVID-19 began.

One of the Field Day's main goals was to demonstrate to producers the research being done by U of A investigating precision ranching technologies, their benefits, drawbacks, and development, all for the benefit of the beef industry. The event was also used to showcase the collaboration of institutions that share the commitment to improve the productivity of the beef industry. Researchers from different organizations had the opportunity to present their work.

One cow/calf and backgrounding producer expressed his appreciation, declaring that this was a "very useful day". He was excited about the new technologies in development and saw the applications for his own operations today. As a multi-generational farmer, he expressed his eagerness for his children and grandchildren to put to use the tools seen at this Field Day to real life: "I wish I had 20 more years to see it all happen," he said.

Read the Full article on page 8 of the <u>SRM IMS Fall 2022 Newsletter - Kinsella Research Ranch</u> <u>Field Day</u>.

- The RRI also partnered with the Society for Range Management International Mountain Section and Montana State University to present free online winter webinars targeting rancher and producer audiences to communicate current research taking place at University-owned
 - ranches: The Roy Berg Kinsella and Mattheis Research Ranches (University of Alberta) and the Red Bluff Ranch (Montana State University). The webinars were well-attended and posted on YouTube so that they can be accessed and shared. For example, the Virtual Fencing live presentation was attended by 40 people, but the YouTube video has been viewed and



Alex Harland talks about Virtual Fencing. Watch it on YouTube: <u>https://youtu.be/14Y02ddZczs</u>

shared almost 200 times (and counting!), which increases the RRI's profile and capacity to extend information.

The RRI continues to support teaching activities for both undergraduate and graduate students. Dr. Edward Bork (Director of the RRI), Dr. Cameron Carlyle (member of the RRI Strategic Advisiory Council) and Lisa Raatz (RRI coordinator) all teach courses in the Wildlife & Range program and give guest lectures in other ALES courses. Additionally, graduate students and RRI-affiliated researchers teach range-related content during the fall and winter terms at the U of A. Their collective instruction motivates and inspires students to learn about rangelands and furthers the Teaching goal adopted by the RRI. Additionally,



The University of Alberta undergraduate student Range Team won high honours at the SRM annual meeting in Boise, Idaho in Feburary 2023. Learn more about the Range Team on the RRI website: https://rri.ualberta.ca/for-students/range-team/

other organizations use the ranches for training and instruction. Of note, the Mattheis Ranch hosted Concordia University for an undergraduate biology field school exposing students to hands-on learning about rangelands and grasslands specifically focusing on soil health, identifying plants and plant communities, the role of grazing, and challenges around climate change. These teaching and communication activities increase the profile of the RRI, the University of Alberta and the Research Ranches. They underscore the importance of rangelands, grasslands, grazing and highlight the research that is happening at the U of A and throughout the RRI, including in affiliation with partner institutions.

A researcher collects plants for DNA-network analysis at the Mattheis Research Ranch. Photo from Emily Holden.

Table 5.1. Select peer-reviewed publications authored by RRI affiliated researchers between April 2022 and March 2023

- Vera-Velez, R., Grover, S.A., Bischoff, B.K., Carlyle, C.N., Lamb, E.G. Mar 2023. Wildfire-grazing impact on forage quality assessed with Near-Infrared Spectroscopy and Generalized Partial Least Squares Regression. Rangeland Ecol & Management. 87: 132-140.
 DOI: 10.1016/j.rama.2023.01.003
- Kong, Y.S., Zhang, H.K., Tian, L.L., Yuan, J.J., Chen, Y.C., Li, Y., Chen, J. Chang, S.X., Fang, Y.Y., Tavakkoli, E., Cai, Y.J. Mar 2023. Relationships between denitrification rates and functional gene abundance in a wetland: The roles of single- and multiple-species plant communities. Science of the Total Environment. 863: 160913. DOI: 10.1016/j.scitotenv.2022.160913
- Daly, E.J., Kim, K., Hernandez-Ramirez, G., Klimchuk, K. Feb 2023. The response of soil physical quality parameters to a perennial grain crop. Agriculture Ecosystems & Environment. 343: 108265. DOI: 10.1016/j.agee.2022.108265
- *James, K.S., Thompson, K.A., Carlyle, C.N., Quideau, S.A., Bork, E.W. Feb 2023. Mixedgrass vegetation is tolerant to a short-term but not season-long access mat use during mitigation of industrial traffic. Land Degradation & Development. 34(3): 653-664. DOI: 10.1002/ldr.4483
- *Liu, C., Groff, T., Anderson, E., Brown, C., Cahill Jr., J.F., Paulow, L., Bennett, J.A. Jan 2023. Effects of the invasive leafy spurge (*Euphorbia esula* L.) on plant community structure are altered by management history. Neobiota. 81: 157-182. DOI: 10.3897/neobiota.81.89450
- *Rieke, E.L., Bagnall, D.K., Morgan, C.L.S., Flynn, K.D., Howe, J.A., Greub, K.L.H., Mac Bean, G., Cappellazzi, S.B., Cope, M., Liptzin, D., Norris, C.E., Tracy, P.W.,... Bruhjell, D., Carlyle, C.N., ...Dyck, M.F., Ellert, B.H., Entz, M.H.,... Geddes, C.M.,... Hao, X.Y., ...May, W.E.,... Honeycutt, C.W. Dec 2022. Evaluation of aggregate stability methods for soil health. Geoderma. 428: 116156. DOI: 10.1016/j.geoderma.2022.116156
- Erland, B.M., Thorpe, A.K., Gamon, J.A. Dec 2022. Recent advances toward transparent methane emissions monitoring: A review. Environmental Science & Technology. 56(23): 16567-16581. DOI: 10.1021/acs.est.2c02136
- *Ma, Z.L., Bork, E.W., Attaeian, B., Cahill, J.F., Chang, S.X. Dec 2022. Altered precipitation rather than warming and defoliation regulate short-term soil carbon and nitrogen fluxes in a northern temperate grassland. Agricultural & Forest Meteorology. 327:109217. DOI: 10.1016/j.agrformet.2022.109217
- *Khatri-Chhetri, U., Thompson, K.A., Quideau, S., Boyce, M.S., Chang, S.X., Kaliaskar, D., Bork, E.W., Carlyle, C. Nov 2022. Adaptive multi-paddock grazing increases soil nutrient availability and bacteria to fungi ratio in grassland soils. Applied Soil Ecology. 179:104590. DOI:10.1016/j.apsoil.2022.104590.
- Ng, J.W., Wellicome, T.I., Leston, L.F.V., Bayne, E.M. Oct 2022. Home-range habitat selection by Ferruginous Hawks in western Canada: implications for wind-energy conflicts. Avian Conservation & Ecology. 17(2): 33. DOI: 10.5751/ACE-02255-170233
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- * Research that includes U of A research ranches for at least one location
- § Project funded by the RRI

Prairie crocus blooming at the Mattheis Research Ranch, early spring 2023

6. Strategic Advisory Council

The Rangeland Research Institute continues to be active in fulfilling its mandate to conduct research, engage in outreach and extension, and participate in teaching activities. Several SAC members assist with providing objective and critical feedback on research proposals that are submitted to the RRI and assist with making decisions on how to award research funding. The current composition of the SAC as of March 31, 2023, is provided in Table 6.1.

Position, Agency	Location
Head, Rangeland Resource Management Program (Retired)	Lethbridge, AB
Alberta Environment and Sustainable Resource Development	
Dean, Faculty of Agricultural, Life & Environmental Sciences, University of Alberta	Edmonton, AB
RRI Director; Professor and Mattheis Chair in Rangeland Ecology & Management, University of Alberta	Edmonton, AB
Associate Professor, University of Alberta	Edmonton, AB
Producer (Retired)	Calgary, AB
Producer (Retired)	Calgary, AB
Research and Production Manager, Alberta Beef Producers	Calgary, AB
Producer, Staden Farms	Manville, AB
Researcher (Emeritus), Agriculture & Agri-Food Canada	Lethbridge, AB
Producer; Program Lead, Farmland Advantage	Invermere, BC
	Position, Agency Head, Rangeland Resource Management Program (Retired) Alberta Environment and Sustainable Resource Development Dean, Faculty of Agricultural, Life & Environmental Sciences, University of Alberta RRI Director; Professor and Mattheis Chair in Rangeland Ecology & Management, University of Alberta Associate Professor, University of Alberta Producer (Retired) Producer (Retired) Research and Production Manager, Alberta Beef Producers Producer, Staden Farms Researcher (Emeritus), Agriculture & Agri-Food Canada Producer; Program Lead, Farmland Advantage

Table 6.1	Members	of the RR	I Strategic Advisor	y Council,	, March 2023.
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* Chair of RRI Strategic Advisory Council

7. Financial Overview

The Rangeland Research Institute (RRI) 2022-23 financial statement is shown in <u>Appendix III</u> and summarizes revenue and expenses. The RRI operational revenue is largely generated from ongoing oil and gas extraction surface leases and utility (powerline) activity at the Mattheis Research Ranch. The RRI expenses include costs associated with outreach and extension, and RRI operating and administration costs. As in prior years, most of the research costs have been transferred to the Rangeland Ecology and Management Fund (REMF) spending allocation to maximize the funds that can be recapitalized back into the endowment principal (listed as Transfer to Endowment in <u>Appendix IV</u>).

The REMF is an endowment that was created in 2015. Most of the principal comes from revenue received upon construction of the major powerline that runs parallel to Hwy 36 bisecting the 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. As in previous years, \$500,000 was transferred from the RRI Operations budget to the REMF in 2022-2023 to continue growing the endowment principal. The market value of the REMF as of March 31, 2023 was \$10,665,763.25 and the annual spending allocation generated by this fund is also listed (Appendix IV). Because the Faculty of Agricultural, Life and Environmental Science is taking a proportion of the endowment spending allocation to offset ongoing budget constraints starting annually in 2018 (i.e., using the fund to increasingly pay for staff salaries), the RRI began to recapitalize funds into the endowment. This strategy will build the endowment so that the annual spending allocation will cover salaries as well as provide long-term access to research funding, the latter of which was the original intent.

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 2022-2023. * Indicates projects that have received support from the RRI Competitive Grants Program.

Project Title	Principle Investigators
Alberta Agrisystems Living Lab	Bork, Santos, Carlyle, da Silva, Fitzsimmons, Cahill, Basarab, Plastow, Dyck, Quideau, Chang, and others
Central Plains Living Lab	Carlyle, Bork, and others
Mapping of carbon stocks in forage lands of Saskatchewan	Carlyle, Bedard-Haughn, Bork, and others
*Long-term monitoring of rangeland ecosystem functions on the Mattheis and Kinsella Research Ranches	Carlyle
*Differentiating and understanding the roles of soil nutrient and soil community heterogeneity on plant growth, carbon storage and biodiversity	Cahill
Economic and C-capture benefits of including forages in long-term crop rotations at Breton	Bork, Dyck, Quideau, Jeffrey, & Puurveen
Site specific control of Canada thistle by drone	Webber, Bork, Church, Pettyjohn, & others
Assessment of altered precipitation and defoliation on rangeland EG & S	Carlyle, Chang, Cahill, Willing & Bork
*Quantifying the carbon balance and associated ecosystem properties at the Mattheis Ranch	Puurveen, Coates, & Gamon
Use of plant growth regulators for enhancing forage grass seed production in NW Alberta	Khanal & Bork

Precision ranching of cattle: Integrating cattle genomics, grazing behavior, and production	Bork, Fitzsimmons, Carlyle, Plastow, Cahill, Lamb, Church, Basarab, Guan & Li
Effect of adaptive multi-paddock grazing on carbon storage and greenhouse gases	Boyce, Bork, Carlyle, Chang, Cahill & others
Quantifying the effects of adaptive multi-paddock grazing on soil carbon sequestration and soil organic matter quality	Schneider, Mandell, Longstaffe, Bork, Byrne & Voroney
Survey of cattle rumen microbiome under different grazing systems: Linkage to grazing behavior and productivity	Guan, Plastow, Bork & Basarab
*Using plant traits to assist conservation and management of Alberta's rangelands	Cahill
*Collaborative development of precision ranching to address climate change issues in cow-calf production	Carlyle & Church
*Evaluating the contribution of lichens to Alberta's grassland biological soil crusts through baseline taxonomic research and manipulative grazing and drought experiments	Carlyle, Haughland, & Pino-Podas
Evaluating the efficacy of herbicide indaziflam applied in fall and spring to control invasive annual brome in southern Alberta rangeland	Bork, Dombro, Raatz, & Adams
*Using network analyses to better predict ecosystem goods and services in Alberta rangelands	Holden & Cahill
*The resilience of Alberta's grasslands to the combined effects of drought and defoliation	Batbaatar, Carlyle, & Cahill
*Do defoliation intensity and time since defoliation affect plant carbon transfer and soil carbon accumulation?	Chang & Chen

*In Vitro ruminal fermentation characteristics of different pasture types found at the Dry Mixedgrass natural subregion of Alberta	Da Silva
*Effect of Cicer Milkvetch on soil carbon, nutrient availability, and soil microbiome in mixed prairie grassland	Thilakarathna & Carlyle

Appendix II. Select presentations by RRI affiliates in 2022-2023

Abbreviated title	Presenter(s)	Venue	Audience(s)	Date
Non-native Cicer milkvetch effects on soil microbiome and ecosystem goods and services on Canadian dry mixedgrass prairie.	*Tran, Lumactud, Carlyle, Thilakarathna	University of Alberta ALES GSA Graduate Research Symposium – poster	Researchers, students	Mar 28, 2023
Application of Virtual Fencing to Rotationally Graze Cattle	*Harland, Fitzsimmons, deNovais, Bork	NoFence Technologies Researcher Seminar – online presentation	Producers, researchers, industry	Mar 22, 2023
Containment/restoration of annual-brome invaded Mixedgrass Prairie using the herbicide indaziflam	*Dombro, Bork, Raatz	Grassland Restoration Forum - webinar	Gov't and non- gov't, land managers, industry, policy makers	Mar 22, 2023
Habitat selection by commercial beef cattle grazing heterogenous Aspen Parkland range Watch it on YouTube: https://youtu.be/VdVrcf_cC_Q	*Lopes, deNovais, Carlyle, Fitzsimmons, Bork	Society for Range Management - International Mountain Section & Rangeland Research Institute & Montanan State University winter webinar series	Ranchers, producers, land managers, government and non- government, researchers	Mar 17, 2023
Highlights of recent and current rangeland research at the University of Alberta	Bork	Alberta Forage Industry Network (AFIN); Leduc, AB – In person presentation	Gov't, industry, policy makers	Mar 9, 2023
Annual bromegrass control using indaziflam on AB rangeland: Results from 3 years post- treatment	*Dombro, Bork, Raatz	Canadian Land Reclamation Association Alberta AGM and Conference – in person presentation	Industry, government, land managers	Feb 23, 2023
Cicer Milkvetch effects on soil microbiome and ecosystem goods and services on Canadian dry mixed-grass prairie	*Tran, Lumactud, Carlyle, Thilakarathna	Alberta Soil Science Workshop; Calgary, AB – in person presentation	Researchers, students, land managers, government and non-government	Feb 22, 2023

Outreach and promotional activities undertaken in support of the RRI during 2022-2023

Non-native Cicer milkvetch on Canadian dry mixed-grass prairie CQESTER modelling of soil organic	*Tran, Lumactud, Carlyle, Thilakarathna *Achtymichuk,	U of A Bentley Soil Science Lecture - poster	Researchers, students, land managers, government and non-government	Feb 15, 2023
matter evolution at the Breton plots	Dyck, Puurveen, Quideau, Bork			
How does indaziflam affect annual brome invaded northern mixed grassland in the field and greenhouse?	*Dombro, Bork, Raatz	76th annual Society for Range Management meeting: Boise Idaho - Rangelands without borders – poster	Ranchers, producers, students, researchers, land managers, gov't and non-gov't	Feb 13, 2023
Virtual fencing for grazing cattle: Lessons learned Watch it on YouTube: <u>https://youtu.be/14Y02ddZczs</u>	*Harland, Fitzsimmons, deNovais, Bork	Society for Range Management - International Mountain winter webinar series	Ranchers, producers, land managers, government and non- government,	Feb 3, 2023
Are feed efficient beef females more weather resilient?	Silva	ABP research showcase; Calgary – hybrid presentation	researchers Ranchers, producers, researchers, industry	Feb 2023
Precision ranching: Applying precision farming to free-range beef cattle	*Bork, Fitzsimmons, deNovais, Basarab, Cahill, Carlyle, Church, Guan, Li, Lamb, Plastow, Harland, Lopes, Oloyede, Udeh	Gateway Research Organization; Morinville, AB – in person presentation	Ranchers, producers, industry	Jan 14, 2023
Using virtual fencing for rotational grazing: Lessons learned	*Harland, Fitzsimmons, deNovais, Bork	_		
Precision ranching: Can cow-calf production efficiency be explained by maternal habitat selection and dietary composition in diverse pastures	*Bork, Fitzsimmons, deNovais, Basarab, Behrouzi, Cahill, Carlyle, Church, Guan, Harland, Li, Lamb, Lopes, Oloyede, Plastow, Udeh	RDAR Research Showcase; Nisku, AB – invited poster	Funding agency, researchers, ranchers	Jan 10, 2023

Precision ranching: A brief introduction	Bork	RDAR Research Showcase; Nisku, AB – in person presentation	Funding agency, researchers, ranchers	Jan 10, 2023
Virtual fencing for grazing cattle: Lessons learned	*Harland, Fitzsimmons, deNovais, Bork	Lakeland College – online presentation	students, researchers, producers	Jan 9, 2023
Rangeland Research Institute Trade Show Booth	Raatz	Western Canadian Soil Health and Grazing Conference – in person	Ranchers, producers, producer groups	Dec 13-15, 2022
Characterizing adaptive, multi- paddock (AMP) grazing and its impact on grassland vegetation and soils in western Canada	*Bork, Carlyle, Döbert, Hewins, Shrestha, Ma, Cahill, Chang, Thompson, Quideau, Grenke, Khatri- Chhetri, Kaliaskar, Sobrinho, Boyce	-		Dec 15, 2022
Annual bromegrass control using indaziflam on Alberta rangeland	*Dombro, Raatz, Broadbent, Bork	ENVU Crop Science Industry Update	Industry partners	Dec 14, 2022
Combating climate change with grazing: Fallacy or reality?	*Bork, Carlyle, Döbert, Hewins, Shrestha, Ma, Cahill, Chang, Thompson, Quideau, Grenke, Khatri- Chhetri, Kaliaskar, Sobrinho, Boyce	On-Farm Climate Action Fund; Moncton, NB – online presentation	Ranchers, producers, Gov't, non-gov't, researchers	Nov 30, 2022
Using virtual fencing for rotational grazing: Lessons learned	*Harland, Fitzsimmons, deNovais, Bork	Lakeland Agricultural Research Association Rancher Innovation Workshop; Ashmont, AB – in person presentations	Producers, industry, researchers	Nov 23, 2022
Precision ranching: Applying precision farming to free-range beef cattle	*Bork, Fitzsimmons, Novais, Basarab, Cahill, Carlyle, Church, Guan, Li, Lamb, Plastow, Harland, Lpes, Oloyede, Udeh	-		

Soil, plant, and microbiome responses to industrial disturbance in the Canadian Prairie	*Thompson, Quideau, Carlyle, James, Najafi, Bork	International Institute for Environmental Studies; Ho Chi Minh University, Vietnam – oral presentation	Researchers, students, gov't, industry, producers	Oct 24, 2022
Overview of Agricultural Climate Solutions and Alberta Beef Producers - Living Labs	Bork	Range research group weekly seminar	Students, researchers	Oct 22, 2022
Redefining Home on the Range Watch it on YouTube: <u>https://youtu.be/nPTUq0aD3Yc</u>	Bork	Olds Cultivate Youth Summit: Inside Education – in person presentation	Students	Oct 21, 2022
Overview of recent, current and pending rangeland research at the University of Alberta.	Bork	Saskatchewan Ministry of Agriculture – online webinar	SK range agrologists	Oct 13, 2022
Annual bromegrass control using indaziflam on AB rangeland: Results from 3 years post- treatment	*Dombro, Bork, Raatz	Society for Range Management – Pacific Northwest Section - Fall webinar series – online presentation	Ranchers/ producers, land managers	Oct 11, 2023
NoFence virtual fencing collars	*Harland, Fitzsimmons, deNovais, Bork	NAIT student group – hybrid presentation	Students	Sep 26, 2022
Trait similarity does not influence competition in a grassland plant community	Holden*, Cahill	ESA/CSEE Annual Meeting; Montreal, QC – poster	Students, researchers	Aug 14, 2022
A case for the grazing optimization hypothesis: Intensive grazing increases plant productivity	*Grenke, Bork, Carlyle, Boyce, Cahill	in person presentation		
Virtual fencing for grazing cattle: is the technology at your fingertips?	Harland, Fitzsimmons, Bork	AgSmart Conference at Olds College – in person presentation	Students, researchers, producers, industry	Aug 9, 2022
Agroforestry and biochar for climate change mitigation: Carbon storage, soil carbon cycling, and greenhouse gas emissions	Gross	U of A PhD defense seminar – online presentation	Academics, students	Aug 9, 2022

Precision Ranching: Coordinating the placement of the right cow, in the right pasture, at the right time.	Bork <i>,</i> Fitzsimmons	Field Tour: Livestock Gentec & RRI Precision management tools: Innovations in land and animal stewardship to build climate resilience – Kinsella Panch – in	Field Tour: Livestock Gentec & RRI Precision management tools:	Ranchers, producers, government and	Jul 20, 2022
Measuring habitat selection using GPS collars, ear tags & pedometers	Bork, Lopes, Oloyede		non-government organizations, policy makers, researchers		
Measuring greenhouse gas emissions with greenfeed	Behrouzi	person presentations	students		
Evaluating virtual fencing in western Canada	Harland, Fitzsimmons, deNovais, Bork				
Potential risks of heat stress in western Canada grazing beef cattle	Silva				
Using drones for precision ranching: Collecting real-time actionable data to manage plants and livestock	Church (Thompson Rivers University)				
Overview of Kinsella Ranch: Using GrowSafe system	Fitzsimmons				
Replacement heifer selection checklist: Promising technology to aid your decisions	Markus (Lakeland College)				
Genomic tools for terminal sire selection	Mayorga, Basarab (Livestock Gentec)				
Using DNA barcoding to characterize free-range beef cattle diets	Bork, Udeh	_			
Rangelands/Grassland ecoregion field trip	Springer (Concordia University)	Field School: - Bio/ENCS 318 undergraduate students (Concordia University) – in person	Students	May 7, 2022	
Vegetation resilience to ungulate herbivory in Elk Island National Park	Handel	U of A Undergraduate student seminar – hybrid presentation	Students, Gov't & Non-gov't organizations; land managers, researchers	Apr 14, 2022	

* indicates the primary presenter where projects have multiple authors credited, but a single speaker.

	Actuals
**Opening Balance	\$0.00
Povonuo	
Losso/Litility (Poworline) Povenue	¢ 525 385 81
	\$ 525,365.61 \$ 525 295 91
Total Revenue	φ 525,365.61
Expenditures	
Transfer to Endowment	\$500,000.00
Property Taxes	\$ 998.98
Supplies, Services	\$ 16,994.83
Communications (telephone)	\$612.00
Travel	\$3,639.89
Total Expenditures	(\$522,245.70)
Net Balance	\$3,140.11

Appendix III. RRI Financial Statement of Actuals, April 1, 2022 to March 31, 2023

^{**} In 2021-2022, the closing balance for the RRI Operating Budget was \$30,024.56. Due to the Government of Alberta's directive that funds can not be carried forward, the opening balance is shown as \$0.00. While these funds are not lost, they remain unavailable to the RRI.

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, 2022 to March 31, 2023

Principal	
Opening Balance (April 1, 2022)	\$8,412,843.85
Current Year Contributions	\$500,000.00
Principal Subtotal	\$8,912,843.85
Capitalized Investment Earnings	\$1,752,919.40
Closing Balance/Market Value (March 31, 2023)	\$10,665,763.25
Spending Allocation (Revenue)	
Opening Balance (April 1, 2022)	\$235,310.87
Current Year Endowment Spending Allocation	\$354,294.53
Total Revenue	\$589,605.40
Current Year Expenditures	
Faculty salary ¹	\$121,294.00
Support staff	\$103,302.04
Rental Expenses	\$3,718.24
Research Projects	\$132,388.34
Supplies, Services & Sundries	\$5,910.38
Total Expenditures	(\$367,283.00)
Closing Balance After Encumbrances (March 31, 2023)	\$222,322.40

Actuals

¹ A proportion of faculty staff salary was taken out of the endowment in order to remove it from the Department of AFNS operational budget (starting in 2018/19), and from the Faculty of ALES operating budget (since 2020/21) and account for budget shortfalls. As expected, the proportion has increased in subsequent years and will continue to increase over time.

Rangeland Research Institute

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