Relationships of Range Health Scores with Grazing Management Practices and Producer Perspectives in Alberta, Canada

By

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ABSTRACT

Livestock management systems are becoming an increasing focus of attention in scientific study. Two areas of study that have not been heavily investigated in grazing management are differences in the range health of pasture lands subject to contrasting grazing systems, and the social factors that influence producers using divergent grazing systems. This study was designed to investigate these two questions. Ranches involved in this study represent the Boreal, Rocky Mountain, Parkland and Grassland Natural Regions of Alberta, Canada, and fall in to one of four distinct groups of grazing management systems: Holistic Management, Fast Rotational, Slow Rotational and Continuous grazing. The first study investigates if there are differences in range health outcomes of grazing lands managed under different grazing systems, and attempts to identify the main factors that influence range health scores. The second study interprets interview data obtained from producers using ethnographic research methods to identify key themes within the ranching community. Our research revealed new understandings on both the range health and the social aspects of grazing management in Alberta. Key findings in range health were that grazing system alone or in combination with our other factors did not significantly influence range health scores. A second outcome was that range health scores were more influenced by aridity and current percent forage use than stocking rate. Regarding the social aspects of grazing, although four systems of grazing management were identified during the study, there were far more commonalities in philosophy and mindsets between producers from the various systems than there were differences. We identify four key social themes in common out of the interview data with producers. Our findings add new information and understanding to the accepted body of literature available on grazing management from both the range health and sociological aspects and provides a starting point for future research. Overall, we added details to the current body of knowledge on grazing management from both the biophysical and sociological standpoints.

PREFACE

This thesis is an original work by Kristine Marie Dahl. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name "Identifying different perspectives on beef producer grazing management systems", No. Pro00073612_AME1, August 11, 2017.

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List of Abbreviations

AB – Alberta

AC – Acres

AHM – Annual heat:moisture index

AMP – Adaptive multi-paddock grazing

ANOVA – Analysis of variance

AUD – Animal unit days

AUM – Animal unit months

C – Carbon

CAP – Canadian agricultural partnership

CG – Continuous grazing

FRG – Fast rotation grazing

GHG – Greenhouse gas

GM – Genetically modified

HA – Hectares

HILF – High intensity – low frequency grazing

HM – Holistic management

KM – Kilometers

LFH – Litter/fibric/humic

LLD – Legal land description

M – Meters

MAP – Mean annual precipitation

MAT – Mean annual temperature

MIG – Management intensive grazing

RH – Range health

RHS – Range health scores

SAS – SAS software

SR – Stocking rate

SRG – Slow rotation grazing

SRM – Society for range management

SRP – Stocking rate at pasture scale

SRR – Stocking rate at ranch scale

UTM – Universal transverse mercator

Chapter 1. An Introduction to Grazing Systems, Range Health and Rancher Attitudes in Alberta, Canada

Differences in grazing management on beef and forage production, including grazing systems and stocking rates, have been widely studied across North America and beyond. Grazing systems in particular have fallen under intense scrutiny and evaluation by scientists for their impacts on grassland landscapes and associated production potential (Mann and Sherren, 2018). This area of study is of interest to the scientific community due to the increased demand in North America and other new markets for beef products, and the highly publicised claims surrounding specific beef production systems impacts on soil degradation and loss, as well as environmental goods and services such as carbon (C) storage and greenhouse gas (GHG) sequestration. As meat consumption continues to rise with increasing standards-of-living around the world (OECD, 2018), more focus is placed on how this product is brought to market, with increased consumer awareness of, and interest in, sustainable red meat production practices. Thus, grazing management systems are becoming an increasing focus of attention in scientific study (Briske et al., 2008; Teague et al., 2013; Chuan et al., 2018).

As one of the top beef exporting, production and consumption countries in the world, Canada is at the forefront of this changing demand for a more efficient product that meets the needs of these markets and responds to changing attitudes of animal livestock production standards (Canadian Beef, 2017). Alberta is the top beef-producing province in Canada, with 41% of the country's breeding beef cattle and the largest average herd size per farm (Canadian Beef, 2017). This makes Alberta a good place to evaluate grazing system influences on the health of the rangelands being used to produce these animals for consumption by the local and global market. The objectives put forth by this research project aim to address two important beef production questions: 1. Does the grazing system used on a ranch lead to a better range health outcome on the land? 2. What are the personal motivations behind why beef producers choose to use different systems of grazing management to raise their cattle?

1.1 Grazing Systems

Grazing systems vary widely due to inherent diversity in their operational attributes. The term grazing system refers to the approach a grazier applies to managing the intensity, frequency and timing of when their animals have access to grazing lands. There are very few examples of grazing systems that are constant and repeating, as individual systems are typically highly customized by producers based on their environment (soils, landscape, forage resources) and socio-economic objectives (Nuthall, 2012). Grazing systems also vary between habitat types, which in Alberta, include tame pasture (comprised primarily of seeded introduced forage species), native grassland (herbaceous plant communities that co-evolved with native herbivores on the prairies) and forests (relatively continuous tree cover).

Related to grazing system are the terms growing season and grazing season. Growing season refers to the typical number of days over the spring, summer and fall when plants are actively growing and producing seed. This varies widely, but generally the growing season is between 60 and 90 days in Alberta. Grazing season refers to the number of days a manager can move their animals over their available landscape. This is longer than the growing season, as most plants, and especially native grassland species, can be safely grazed after senescence in the fall, which extends the amount of time a producer can graze instead of relying on stored feed. Overall, grazing systems commonly found in western Canada can be grouped into four main categories: continuous grazing (CG), slow rotation grazing (SRG), fast rotation grazing (FRG) and holistic management (HM). The practical (i.e., operational) differences among these systems requires clarification to ensure that the distinctions between these grazing systems are clear.

1.1.1 Continuous Grazing

According to the definition provided by the Society for Range Management (SRM) (2017), continuous grazing (CG) is recognized as a system where livestock have open access to a pasture throughout the grazing season. CG has been shown to increase individual weight gains on livestock over the grazing period, as animals that are allowed free choice will generally re-graze lush new growth on plants, thereby ensuring optimal nutrient uptake, but can lead to the eventual death of preferred forage species with repeated grazing events (Heady, 1961; Hormay, 1970; Holechek et al., 1999; Derner et al., 2008). CG is generally recognized as a cause of deterioration of vegetation and soils (Brummer and Moore, 2000; CSF, 2002; Teague and Dowhower, 2003; Bailey et al., 2010), and increased establishment of weedy species in rangelands (DeBruijn and Bork, 2006; Bailey et al., 2010). However, this response is also dependent on stocking rate, as evidence shows that range condition trends upward under CG provided stocking rates remain light (Holechek et al., 1999). Research into the efficacy and outcomes of continuously grazed rangelands has been widely pursued and concludes with varied results (Brummer and Moore, 2000; Briske et al., 2008). A 25-year study by Rogler (1951) indicated that moderate stocking rates of young cattle on continuously grazed pastures was sustainable provided the range was in a healthy condition to begin with. Increases in stocking rates, and therefore grazing intensity, on continuously grazed rangelands have been shown to have an increasingly negative effect on the condition of land compared to those grazed under light stocking rates (Derner et al., 2008), highlighting the overriding impact of stocking rate over grazing systems in regulating rangeland sustainability. Livestock densities on continuously grazed pastures must be kept low to moderate to prevent overgrazing and associated reductions in pasture production (Hubbard, 1951; Holecheck et al., 1999; Teague and Dowhower, 2003).

1.1.2 Slow Rotation Grazing

Slow rotation grazing (SRG) as defined by the SRM (2017), is a system of grazing where livestock are moved between a minimum of two pastures throughout the grazing season. SRG has been highly studied for its effectiveness in grassland management and promoting animal gains in rangelands across North America (Hubbard, 1951; Rogler, 1951; Heitschmidt et al., 1987; Gibson and Brown, 1992; Chorney and Josephson, 2000; Teague and Dowhower, 2003; Briske et al., 2008; Teague et al., 2013). SRG has long been shown to increase pasture production by allowing plants a rest/recovery period between grazing events (Hormay and Evanko, 1958; Hormay, 1970; Popp et al., 2004). Most studies indicate that grazing in native and tame pasture conditions requires some degree of livestock management to prevent overgrazing effects (Teague and Dowhower, 2003), reduce weedy species populations (DeBruijn and Bork, 2006), sustain animal growth, and improve vegetation, soil, and wildlife habitat conditions (Dormaar et al., 1997; Donkor et al., 2001; Popp et al., 2004). Rotational grazing is thought to be a tool to help graziers improve range condition and vegetative production on rangelands that have previously been damaged by overgrazing or other factors (Hubbard, 1951; Dormaar et al., 1997; Teague and Dowhower, 2003; Holechek et al., 2004; Popp et al., 2004). Additionally, rotational systems sometimes provide an entire year of rest to a pasture, known as rest-rotation grazing (Dormaar et al., 1997; Holechek et al., 2004).

1.1.3 Fast Rotation Grazing

The term fast rotation grazing (FRG) is loosely applied to more intensive systems of grazing management that attempt to increase production or utilization per unit area or production per animal through localized increases in stocking rates, forage utilization, labour, resources, or capital (SRM, 2017), and which are balanced with extended recovery periods for vegetation between grazing events. This system of grazing management has been given a wide variety of other names: Adaptive Multi-Paddock (AMP), Management-intensive Grazing (MIG), Conservation Grazing, High-Intensity, Low-Frequency (HILF), among others (Taylor et al., 1980; Conant et al., 2003; Gerrish, 2004; DeBruijn and Bork, 2006; Teague et al., 2016; Teague and Barnes, 2017).

Generally speaking, the difference between SRG and FRG is primarily in the number and frequency of movements of livestock between successive pastures as they progress through the land base. Whereas SRG can be thought of as a relatively extensive form of grazing management with pasture moves every few weeks, FRG management consists of more frequent movements of animals through smaller pastures, typically every few days or even once per day, depending on the time of year and other management factors. Reliable access to water and the willingness and ability to create smaller pasture sizes by adding fencing are generally the main barriers to the adoption of FRG management systems (Heady, 1961; Gerrish, 2004). Reported benefits and changes associated with FRG are similar to those attributed to SRG, including increased pasture production (Dormaar et al., 1997; Gerrish, 2004), increased GHG sequestration (Teague et al., 2016), increased soil development including improved fertility (Dormaar et al., 1997; Conant et al., 2003), and more uniform grazing pressure reducing overgrazing impacts (Heady, 1961; Hormay, 1970; Taylor et al., 1980; Barnes et al., 2008; Oñatibia and Aguiar, 2018). In general, both SRG and FRG systems have been shown to lead to lower individual animal gains over the grazing season, as livestock cannot graze as selectively as they would under CG, and therefore they consume less nutritious and lower palatability forages (Rogler, 1951; Heady, 1961; Taylor et al., 1980; Derner et al., 2008).

1.1.4 Holistic Management

Holistic Management (HM) is a practical, goal-oriented approach to the management of rangeland ecosystems, including the human, financial and biological resources (SRM, 2017). HM (which has also been known as 'The Savory Grazing Method', and holistic resource management) has been promoted as a strategy to achieve overall ranch recovery by using specific goal setting and monitoring methods, and herd effect to facilitate these goals and increase forage and livestock production (Savory and Parsons, 1980; Stinner et al., 1997; Savory, 2013a). HM, as described by Savory (1983, p.155), is 'a method of managing livestock on ranges or on planted pastures whereby greater production can be achieved both from the land and the animals and with greater profitability than conventionally'. The method includes the following factors: consideration of the rangeland landscape as a whole, not in pieces or by pasture (systems thinking); developing and adapting management goals, be they financial, animal, or range health based; looking to maintain and/or enhance ecosystem processes, using the tools, tests, guidelines and planning available; and then following up with monitoring and feedback (Stinner et al., 1997; Savory, 1999; Mann and Sherren, 2018). This system of grazing management became popular in North America during the 1980's and was enthusiastically adopted by many producers with little formal training. Results from the adoption of the HM model during that time were highly mixed, and the method subsequently fell out of general favour in the ranching community, but many committed and successful operators are still found. As recently as 2013(b), Savory was promoting HM as a grazing method capable of reversing desertification across North America and beyond. HM can best be described as a grazing philosophy and not as a prescription for grazing management, as the focus of producers operating under HM principles will have individual and unique goals, but the methodology behind achieving those goals will be focused on systems thinking, including flexible adjustment of the timing and duration of grazing events, planned rest and recovery periods, and monitoring (Stinner et al., 1997; Savory, 1999; Sherren and Kent, 2017; Mann and Sherren, 2018).

1.2 Producer Perceptions of Grazing Management

An important and unfortunately little understood factor in grazing management stems from the human component, the producer themselves. Grazing management is a personalized undertaking, with each ranch and manager having their own set of landscape challenges, monetary and time restrictions, and numerous other conditions to deal with. Researchers are just beginning to investigate how producer perception impacts grazing decision making. This line of questioning is usually explored in qualitative research (Mayan, 2009; Creswell, 2013; Moon et al., 2016; Sherren and Darnhofer, 2017); however, attitude and perception data can be either qualitative or quantitative in nature. Producers adapt to challenges and make changes depending on what they perceive the impacts, benefits and costs of various changes may be, and these perceptions can vary regionally (Nuthall, 2012; Cox et al., 2015). Regional variability is especially critical to recognize in grazing management, as ranchers across western Canada and beyond manage very large tracts of land in some cases, and therefore individual management decisions made, or innovations adopted, can have very real impacts on ecosystem services (Didier and Brunson, 2004).

An underlying theme throughout grazing management is the issue surrounding Holistic Management (HM). This practice was officially brought to North America in the 1980's by Allan Savory, author of many books and articles, but few peer reviewed scientific papers (Sherren and

Kent, 2017). Adopters of HM practices have reportedly been subject to socially imposed stigma for their grazing and landscape management methodologies, which can vary substantially from the presumed conventional ‘norms’ (Mackie et al., 2015) as they apply to grazing management (Sherren et al., 2012; Abson et al., 2019). Gaining an understanding into which producers adopt HM, and alternatively, understanding why others do not, has not been thoroughly investigated in the body of research at this time but is beginning to see some attention in the literature (Sayre, 2004; Mann and Sherren, 2018). Additionally, very little work has been done to assess whether the HM system works in relation to the individual goals set out by producers, which would be the primary talking point of HM proponents (Savory, 2013a). Overall, understanding what influences HM and conventional producers and why they choose to manage their grazing the way they do has the potential to make significant gains in our understanding of this small but important cohort of ranching society. Increased knowledge and understanding of producers in this way could translate into improved communication between government and ranchers, and if substantiated, potentially increase production or sustainability at the ranch and landscape levels (Sayre, 2004; Briske et al., 2011).

1.3 Range Health

Evaluation of range health and trends therein has had a storied background. Rangelands are defined by Holechek et al. (2004, p.1) as ‘uncultivated land that will provide the necessities of life for grazing and browsing animals. This includes all areas that are not bare soil, rock, concrete, or ice, and includes areas such as deserts, forests and natural grasslands. Until relatively recently, the common form of assessment of rangelands was range condition. This assessed the composition of a plant community based on what percentage of natural species were found within the current vegetation after exposure to a particular disturbance, including grazing (Dyksterhuis, 1949). Rangelands were given a descriptive label of either Excellent, Good, Fair, Poor or Very Poor condition based on their similarity to the historical climax. The climax successional theory was presented by Clements (1936), as a means of understanding the ecological health of a landscape based on the evaluation of current dominant species compared to historical dominance in that landscape and climate.

In 2003 the province of Alberta moved away from using climax-based range condition as a tool of assessment and adopted the currently used range health protocol for three habitat types: tame pasture, native grassland and forested communities (Government of Alberta, 2018). Range health now focuses on the ability of rangelands to perform key ecosystem functions including net primary production, maintaining soil and site stability, facilitating the capture, storage and desirable release of water, supporting nutrient and energy cycling, and maintaining a functional diversity of vegetation (Government of Alberta, 2018). Range health assessments for the three habitat types address five or six primary component scoring fields (i.e., questions), each of which addresses one or more of these ecosystem functions. Other data collected with range health includes site location information such as latitude/longitude, elevation, legal land location, observations on ongoing grazing management, long-term estimated grazing intensity, and observed current percent forage utilization. Range health scores are assigned based on the observations of the trained assessor in the field, in conjunction with the use of range plant community guides available for each of the Natural Subregions within the province, which provide ‘reference communities’ to which existing vegetation can be compared for comparable ecosites (i.e., areas of similar growing potential). While no specific certification agency for range heath exists, the Government of Alberta does periodically offer free training seminars on the proper understanding and use of the range health tools. Range health scores are considered a ‘snap-shot’ in time of functionality of rangelands, and only indicate trend when repeated over several years at the same location.

1.4 Application

Scientific studies throughout the previous 60+ years have shown each of the grazing systems in use across western Canada to be effective at either land conservation, supporting animal and forage production, or both. This has created a division among practitioners, and even scientists, wherein each faction steadfastly defends their published results, creating confusion and animosity among the grazing and research community (Briske et al., 2011, 2013, 2014; Sherren et al., 2012; Savory, 2013a; Teague et al., 2013; Sherren and Kent, 2017). One of the major hurdles of comparison between grazing management systems is that each biophysical location, operational situation, and management history are unique, and therefore direct comparisons among different ranches utilizing different grazing systems are nearly impossible. How each of these systems impacts the rangeland landscape has therefore not been widely investigated, and even when comparisons are made, these are often confounded by variation in stocking rate (Teague et al., 2013), making drawing conclusions problematic. Past research conducted by range ecologists including Dormaar et al. (1989), Heidtschmidt et al. (1982; 1987), Pluhar et al. (1987), Willms et al. (1985) in Alberta and Texas have confounded stocking rate and grazing systems, and therefore prevented the ability to separate these two effects and draw firm conclusions on either. Moreover, even fewer studies assess different grazing systems and outcomes using contemporary range health criteria (Pyle et al., 2018).

Considering the diversity of grazing management systems and rangeland evaluation tools available, the objectives of this research were to conduct a field study identifying the different groups of grazing systems employed on ranches across a large geographic region in the province of Alberta, Canada, representing a diversity of agroclimatic conditions (Chapter 2). We sought to compare range health therein by conducting a standardized series of range health evaluations across these ranches. This process controlled for extraneous factors such as precipitation and aridity, accounted for localized variation in stocking rates, and determined how the current grazing management system was associated with the range health scores for each group of practitioners (Chapter 2).

Further to the field study, a series of in-depth personal interviews with this group of producers were conducted to gain insight into their personal perspectives on grazing management and characterize those factors influencing their grazing management decisions (Chapter 3). Based on the results, our overall goal was to formulate answers to the over-arching questions, ‘Is there a grazing management system that provides consistently better outcomes in range health scores than the other systems?’, and, ‘What are the social factors influencing grazing management?’ This type of large-scale (i.e., regional) evaluation of grazing systems, motivations and corresponding range health metrics have not been conducted to date in the current literature and could prove a valuable resource to the grazing community, land management officials, and range management and livestock production communities beyond Alberta.

In order to facilitate this research using both quantitative range health data as well as qualitative interview data, a mixed-methods approach was warranted. Instead of focusing on a narrow view of the ranching community, we endeavoured to develop a research method that would allow for equal weight to be given to both approaches. As such, the two following substantive chapters follow as stated above, Chapter 2 detailing the quantitative data and findings of the research, followed by the qualitative data and findings in Chapter 3. This division of research data and findings was required in order to give equal credence to the unique sets of data retrieved by these two different methodologies. These are followed by Chapter 4 which outlines the learnings, limitations and future research possibilities provided by both preceding chapters and links those aspects with the research objectives set out by the study.

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Chapter 2. Exploring the Association Between Range Health and Grazing Systems: A Case Study from Northern Temperate Grasslands

2.1 Introduction

The growing demand for animal protein associated with economic expansion in developing countries, combined with the increasing awareness of the greenhouse gas emissions (GHG) associated with livestock production, have created a new demand for scientific research into livestock production systems, both to increase production efficiencies, as well as reduce environmental impacts (Monteny et al., 2006; Allard et al., 2007; Briere, 2017). As part of this, grazing systems have become an increasing focus of attention in scientific study (Chiaviello, 2000; Briske et al., 2008; Laca, 2009; Teague et al., 2013). Despite this, we lack a clear understanding of how these systems alter ecosystem responses across these landscapes, including environmental health, creating uncertainty as to the extent and magnitude of benefits these management systems may provide.

Livestock management in Canada, and specifically Alberta, is mostly determined by individual animal and land owners. A plethora of grazing systems exist for producers to choose from, and as independent operators, they are free to make their own decisions regarding these grazing systems based on personal preference. Interest within the scientific community revolves around the growing chasm between the efficacy of each system, from low management (i.e., continuous) grazing to the use of more sophisticated (i.e., rotational) grazing systems, with each system having a substantive background of supporting research reinforcing their merits (Rogler, 1951; Heady, 1961; Hormay, 1970; Taylor et al., 1980; Dormaar et al., 1997; Brummer and Moore, 2000; Conant et al., 2003; Gerrish, 2004; Briske et al., 2008; Derner et al., 2008; Teague et al., 2016). Overall, continuous grazing systems have been found to be superior for individual animal production (Holechek et al., 1999; Derner et al., 2008), while rotational grazing systems have been advocated as being superior with respect to forage production (Holechek et al., 1999), although both of these claims are refuted in various other publications (Heitschmidt et al., 1987; Dormaar et al., 1997). Recent survey data suggest that more than 80% of producers in western Canada utilize some form of rotational grazing (Chorney and Josephson, 2000). Findings from Pyle et al. (2018) across a smaller study area around a major metropolitan area in the Aspen Parkland indicated that over half of pastures (57%) were subject to some form of rotational grazing rather than continuous grazing.

Grazing systems commonly found in the province of Alberta, Canada can generally be grouped into one of four categories: continuous (extensive) grazing (CG), slow (i.e., management non-intensive) rotational grazing (SRG), fast (i.e., management intensive) rotational grazing (FRG) and holistic management (HM). CG in Alberta is associated with livestock producers who own, rent or lease large tracts of land throughout the province where animals are grazed together throughout the grazing season, with minimal management from the producer, and moved off these landscapes infrequently, typically at the end of the season (Brado, 1984; Savory, 1999; Holechek et al., 2004; Teague et al., 2013; Hawkins, 2017). This grazing system requires little infrastructure and minimal interventions on the part of the producer and is generally an extensive form of grazing management. SRG requires more effort on the part of the landowner to move herds around a basic series of predominantly large pastures throughout the grazing season, with the intent being to more effectively harvest the ongoing forage production from pastures as animals are rotated through, and as much as possible encourage further vegetation production during recovery periods (Briske et al., 2011).

Fast rotational grazing is a more sophisticated version of SRG that employs an increased number of smaller pastures in which cattle are moved through a rotation with relatively short grazing periods to increasingly limit the impacts of grazing on vegetation at any one point in time, encourage rapid regrowth of forage species during subsequent rest periods, and enhance animal performance (Teague and Barnes, 2017). Holistic management is a relatively specific FRG management method that focuses on adaptive and flexible landscape and livestock management and is promoted as a method to increase livestock production, regenerate landscapes, and balance the use of pasture with livestock economics at the ranch level (Savory, 1999; Holechek et al., 2004; Holistic Management Canada, 2016; Hawkins, 2017; Sherren and Kent, 2017).

A common stumbling point between comparison of these different grazing systems is how to compare outcomes of key production and environmental metrics. Stocking rates (Briske et al., 2011), weight gains on calves, steers and heifers (Rogler, 1951; Heitschmidt et al., 1982), range condition (Government of Alberta, 1998), and clipping studies (research done which compares plant biomass within and outside of enclosures designed to prevent grazing) (Milchunas and Lauenroth, 1993) are all metrics that have been commonly used in previous research. A frequent issue with these metrics is that because each ranching operation and rancher is inevitably different, and grazing systems are uniquely customized for each operation, comparison of their effectiveness across ranches is difficult (Briske et al., 2008; Teague et al., 2013).

In 2003, the province of Alberta moved away from using climax-based range condition (Clements, 1936; Dyksterhuis, 1949) as a tool of pasture assessment and adopted the range health protocol, which in turn, was customized for three habitat types: tame pasture, native grassland and forested communities (Government of Alberta, 2018a). Rather than addressing strictly vegetation composition as range condition did, range health focuses on the ability of grazing lands to perform key ecosystem functions, including nutrient and energy cycling, maintaining soil and site stability, facilitating the capture, storage and release of water, providing net primary production, and maintaining a functional diversity of vegetation (Government of Alberta, 2018a). Range health assessments for the three habitat types address five or six primary component scoring fields (i.e., questions), addressing one or more of these ecosystem functions. Previous studies reporting on the range health of pastures are relatively rare, with a recent investigation (Pyle et al., 2018) reporting range health values for 102 pastures across north central Alberta and identifying key ecosystem functions in need of improvement. However, the Pyle et al. (2018) study did not conduct an in-depth assessment of different types of grazing systems and was limited largely to the assessment of tame pastures in relatively mesic environments (Parkland and Boreal transition).

The objective of this research was to categorize a sample of beef producers across a wide variety of environments in northern temperate areas of western Canada into grazing management system cohorts based on interview data, and then test whether and how their grazing systems impacted the range health scores of pastures situated within those ranches. This approach is unlike many previous studies in which controlled experimental field studies have been used to assess vegetation responses to management (Heitschmidt et al.,1982; Willms et al., 1985; Walker et al., 2002), and which often have limited replication and therefore do not reflect the real-world variability commonly found among ranch operations (Teague et al., 2013). As such, this approach simultaneously characterizes producer behaviour with respect to the grazing system used, and allows for testing of landscape level outcomes, which thus far has not been undertaken in grazing management studies. This research is expected to provide an improved foundation for understanding grazing system impacts on range health, with implications for using grazing systems to affect rangeland sustainability.

2.2 Methods

2.2.1 Study Area

This study was conducted on ranches distributed across four natural regions and nine natural subregions throughout the province of Alberta, Canada. Natural regions included the Boreal, Parkland, Grassland and Rocky Mountain, while natural subregions included the Dry and Central Mixedwood, Central and Foothills Parkland, Northern Fescue, Dry Mixedgrass, Mixedgrass, Foothills Fescue and Montane (Natural Regions Committee, 2006). The total landmass of the study area is approximately 180,000 km^2 (18,000,000 ha). Each natural subregion contains a unique set of plant communities adapted to the soil and climatic conditions in the area, and which are documented by the Alberta government as Range Plant Community Guides available to the public (Government of Alberta, 2018b). Study sites therefore ranged widely in biophysical characteristics across the study area, with diverse precipitation, temperature and aridity, associated soils, and landscape features (Table 2.1; Appendix A). Vegetation across the natural regions also varies markedly, with Boreal landscapes including mostly treed communities of pine (*Pinus* sp.), spruce (*Picea* sp.) and aspen/poplar (*Populus* sp.). Parkland landscapes generally feature grasslands with intermingled pockets of aspen forest. Grassland landscapes feature large, open native grassland communities, and the Rocky Mountain region contains foothill and montane grasslands and forested communities.

2.2.2 Climate Data

Climate data are particularly important in understanding rangeland productivity (Smoliak, 1986), and therefore are considered an essential covariate in the assessment of grazing impacts. This is particularly true given that aridity is a major constraint regulating livestock grazing opportunities (Willms and Jefferson, 1993), and climate in turn, is considered an important factor dictating where and how specialized grazing systems may impact grassland sustainability under HM, under the terms '*brittle'* and '*non-brittle'* environments (Savory, 1999). Brittleness, as used by Savory (1999), is defined as a scale, rather than a clear brittle/non-brittle classification. Brittle environments are those which are likely to experience dry periods in the middle of the growing season and a long dry or dormant season, while non-brittle environments are those that have more reliable precipitation and humidity throughout the growing season producing greater nutrient cycling.

Climate data for the study area was obtained using the methodology described by Mbogga et al. (2010) and Alberta Environment (2005) from the ClimateAB v3.21 software package (Wang et al., 2008). The software output provided mean annual (30 year) temperature (MAT), mean annual (30 year) precipitation (MAP), and annual heat:moisture indices (AHM) for each ranch. The geographical location of each ranch was able to be input into the ClimateAB v3.21 program to calculate the AHM values. AHM values indicate the aridity of each location, with wetter conditions having lower AHM values and drier conditions greater values. These were calculated by the software program using the formula: AHM = [(MAT + 10)/(MAP/1000)]. As climatic variables are highly correlated ($|r| > 0.81$), we proceeded by using the AHM index for all further analysis, as AHM accounts for both simultaneous changes in precipitation and temperature at each site, and therefore represents unique moisture limitations for production among our study ranches. Values of AHM ranged from 15 to 49.9 across all sites and varied greatly across natural subregions (Table 2.1).

2.2.3 Participation

To facilitate voluntary ranch participation, we sourced a base of initial ranching contacts by attending six producer events throughout central and southern Alberta. At each event, the researcher was given permission to address the attendees, explain the proposed project and invite ranchers to participate. Participation was completely voluntary, ranchers would approach the researcher during networking sessions and self-identify as being interested in the study. Basic contact information was collected for each interested party, including name, phone number, town, and e-mail. On a few occasions, contact was made with ranchers through a third-party, or a contact known by the researcher. An introductory e-mail was provided that explained the project and provided the contact information of the researcher.

Each interested rancher was contacted via e-mail and provided an information sheet explaining the project in detail, and a consent form to sign (Appendix B). This was followed by a phone-interview within 7 days, which collected basic farm and ranch information, including but not limited to, the legal land description (LLD) of the ranch, acreage of land involved, number of animals, type of animals, length of time the participant had been managing the ranch at that location, changes in grazing system, and basic grazing management practices on the ranch. This information allowed the researcher to identify ranches for inclusion in the next phase of the study (as per the selection process reviewed below – See 2.2.4). All interviews were conducted in accordance with the University of Alberta's code of conduct in human ethics regarding producer participation and handling of interview materials under the Ethics Application Approval ID: Pro00073612_AME1. This research utilized a purposive sampling strategy because we were not able to give all members of the ranching community equal opportunity to participate (Etikan et al., 2016). This means that the sample of participants in the study was not intended as a representation of the ranching population.

2.2.4 Ranch Selection

Based on the phone interview data, several key factors were used to determine an individual rancher's ability to participate in the in-depth interview and range health assessments:

- Physical location – Was considered for each ranch to restrict the travel distance to the study locations, with ranches outside of Alberta excluded from the investigation. Additionally, to facilitate timely and efficient field assessments, ranches where the location of grazing lands were more than 100 km from the home quarter were excluded, resulting in a total of two excluded ranches.
- Livestock – Beef cattle ranching was the desired focus of the study, as cattle are the dominant livestock produced in Alberta on pasture. Thus, ranches grazing other livestock such as sheep, elk, pigs, chickens or co-grazing (cattle and other species) were not considered for further participation, resulting in a total of three excluded ranches.
- Time on-ranch – The pre-existing duration of time each rancher had been managing the ranch was an important consideration to ensure that current range health metrics were indicative of known grazing management activities, including grazing system, as collected from the producer survey. For consistency, a minimum of five years of relatively stable management prior to the study was necessary for a ranch to participate, resulting in a total of eight excluded ranches. Ranches where a new generation of manager was taking over or transitioning to full management could participate as long as no marked changes in grazing management had been undertaken within the past five years.
- Extraneous factors – In some cases, ranches which met the inclusion criteria were not included into the final dataset. These occurred due to producers not having the time to participate, not responding to phone and e-mail requests to set up an interview, or being otherwise unavailable, for a total of three excluded ranches.

Additionally, information provided by the ranchers had to be sufficient to allow the researcher to classify each ranch into a category of grazing system. For this research, the following grazing systems were identified, and ranches were grouped within them according to their stated grazing practices in a simple natural breaks classification:

- Continuous – Ranches in which herds of cattle were placed out on any given pasture for a period of 60 or more consecutive days per year during the grazing season (mean: 111 days, standard deviation: ±24).
- Slow Rotation – Ranches in which herds were rotated through pastures between eight and 59 consecutive days during the grazing season (mean: 26 days, standard deviation: ±9).
- Fast Rotation – Ranches in which herds were rotated through pastures for a period of between one and seven consecutive days during the grazing season (mean: 3.33 days, standard deviation: ±1.02).
- Holistic Management – Ranches in which the rancher self-identified as a Holistic Manager (mean: 2.08 days, standard deviation: ±0.98).

To create the largest number of data points possible, it was decided that each ranch that otherwise met the inclusion criteria would be included for the ranch visits. From an initial pool of 45 interested ranches, a final study site list of 29 ranches was compiled. The location of the final 29 ranches participating in the study was random, as all eligible ranches participated. One ranch withdrew from the study over the course of the investigation resulting in a final data set of 28 ranches.

2.2.5 Range Health Assessments

Visits to each ranch included the completion of an in-depth (2 – 3 hours long) interview and range health assessments within a subset of pastures. These visits were completed between September 4 and October 31, 2017. Every effort was made to complete four range health assessments per ranch, however, on three of the ranches, three assessments were done due to inclement weather. Lotic (flowing water) and lentic (standing water) riparian assessments on some ranches were included in the four assessments, however, these data (n = 12) are not presented in this study due to a lack of comparability between riparian sites, which would have resulted in questionable conclusions drawn from the analysis.

Pasture assessment sites were discussed with each rancher prior to being conducted. These discussions were directed by the researcher as to site selection, and more pastures than were needed for the assessment were discussed, to eliminate rancher bias in selection. Pastures were ultimately chosen for assessment by the researcher after departing from the meeting with the rancher. Discussions were based around access to pastures and grazing history, including that taking place in the current year. Number of animals, specific livestock entry and exit dates, size of pasture (if known), LLD and personal perception of current health, were discussed.

Due to landscape differences across the natural regions of Alberta, it was not always possible to conduct an assessment within each habitat type (forest, tame pasture, native grassland) on every ranch. For example, forested sites were only assessed in the Boreal and Parkland regions due to the lack of forested areas in the Grassland natural region and at the single Rocky Mountain natural region ranch. Also, relatively more tame pastures were assessed in the Boreal and Parkland regions due to the increased land area historically cultivated in those areas, and therefore the greater likelihood of grazing lands being comprised of seeded forages.

The ideal mix of assessments on each ranch was one of each tame pasture, native grassland and forest, with one additional assessment done in the habitat type predominant on the ranch. In most cases, forested sites were not available, so a proportional approach to assessment was taken, wherein the researcher selected additional sites that were representative of the ranch system; for example, if a ranch was a 50/50 mix of tame pasture and native grassland, then two tame pastures and two native grassland habitats were assessed. This also meant that in some cases, all assessments were conducted on tame pasture, or all assessments were native grassland, depending on the ranch. Therefore, each ranch had unique combinations of native grassland, forest and/or tame pasture assessments completed, depending on the habitats available. A breakdown of ranch numbers and habitat type assessments is provided in Table 2.2.

The researcher doing the range health assessments had advanced training in this methodology. The researcher was a Professional Agrologist with the Alberta Institute of Agrologists with the practice area of Rangeland and Pasture Management and attended the provincial range inventory refresher program in June of 2017. The researcher had also been working in the field of range management in different capacities during the previous six years and has gained considerable experience in rangeland assessment and inventory.

To complete the health assessments in the field, the researcher walked through each pasture unit, observing the vegetation (i.e., plant species) composition, abundance (% cover) of each species, litter and LFH abundance, evidence of erosion or bare soil, any weeds and shrubbery, as well as water sources and other indicators of range health. In cases where the pasture was larger than a quarter-section (65 ha or 160 ac), one quarter-section was chosen as the sample area for the assessment to focus the observations of the researcher. Based on what was observed while walking through the pasture, the researcher recorded (at a minimum) the four dominant plant species and their percent cover, within each of the following main categories: grass and grass-like, forbs, shrubs and trees. In most pastures, many more plant species were seen and recorded to facilitate the assignment of a plant community and as supplemental information to aid in answering the scoring questions in the datasheets. Landscape and ground-view photos were taken. Other information collected for each field included the date, ranch, assessment number, field unit (if known), universal transverse mercator (UTM) coordinates, elevation (m), LLD, and information collected from the rancher regarding the use of the pasture for the current year (2017).

For forested and native grassland assessments, a reference plant community and/or current plant community were assigned. These communities were chosen based on the observed species assemblage of the pasture unit, and from the range plant community guides available documenting existing plant community types for various ecosites present in different natural subregions of Alberta (Government of Alberta, 2018b). In some situations, the observed plant community was the same as the reference plant community for a given ecosite, in which case the existing community was compared only to the reference plant community. In other cases, the observed plant community was a successional or modified plant community known to occur on a given ecosite, and in accordance with the range health assessment protocols outlined in the *Rangeland Health Assessment for Grassland, Forest and Tame Pasture Field Workbook* (Adams et al., 2009), these plant communities were compared back to the expected reference range plant community for that ecosite. Tame pasture units were not assigned reference plant communities, as these pastures are typically seeded to introduced forage species and are therefore not represented in the natural subregion plant community guides.

Range health information, as required for the appropriate habitat type, was collected and range health scores were assigned for each of the component criteria (Appendix C) The latter were also totalled for a combined overall range health score, providing a snap-shot in time of current range health, though not an indicator of trend (i.e., changes in health). Comments were noted for future reference on the scoring of each component. The components making up the overall range health score and how they were evaluated are described here:

1. Plant community – In forested and native grassland pastures, this score was assigned based on the extent to which the observed plant community approximated the reference

plant community for the existing ecosite. To assess this, the researcher compared the species assemblage of the current community with the reference plant community, and adjusted the score based on observed differences. This comparison was based on the entire species assemblage and was not discounted by current forage utilization; therefore, forage utilization was not a confounding factor in evaluating the plant community. For tame pastures, this component examined the dominance of desirable seeded forage species (see Appendix D for an adapted Table D-1 from Adams et al. (2009) used in tame pastures to assess component criteria 1 and 2) within each pasture. By calculating the relative percent cover of seeded forage species, the researcher was able to determine the appropriate score for the pasture.

2. Structural layers – In forested and native grassland pastures, this component was scored based on the absence or reduction of any functional layers normally expected to be present for the reference plant community. This included trees, tall and medium shrubs, tall and low herbaceous (grass and forb) cover in forested sites, and tall, medium and low grasses and forbs in native grasslands. Current year forage utilization of a pasture (if applicable) was not a factor when scoring the structural layers. In tame pastures this component criteria examined the desired species present, as well as the amount of weedy or disturbance-adapted plant species in the pasture. This component is additive, with two parts for tame pastures. For the first part, the researcher again used the species table (Appendix D) to calculate the relative cover of tame and desirable native species to assign a score. The second part was scored by calculating the absolute cover of weedy and disturbance species in the pasture, and the appropriate score was assigned.
3. Litter or LFH – In native grassland and tame pastures, this score examined the cover and distribution of litter on the pasture, which acts as a key indicator of soil moisture conservation, nutrient cycling and grazing intensity. Litter was assessed during the walk throughout the pasture, and notes were taken on litter uniformity and cover. A representative 0.25 m^2 plot was hand-raked to evaluate litter mass, and these metrics were used to assign the litter score given expectations for the associated reference community. In forested pastures, litter/fibric/humic (LFH) layer thickness or mineral soil compaction (where there was no LFH layer) was used to estimate the nutrient and water cycling capacity of the site. This was assessed by comparing grazed and protected areas in the forested community and evaluating the ease with which a pencil could be pushed into the LFH or mineral layer in both areas to determine relative levels of compaction or

compression of the layer within grazed areas (i.e., as per the ‘poke test’, Adams et al., 2009).

4. Soil erosion – In all habitat types, this component was scored based on observed evidence of micro- and macro-erosional forces, as evidenced by rills, gullies, soil movement, pedestalling/hummocking, hoof shear and trailing. Bare soil above a normal level for the plant community was considered human-caused and was also accounted for. These indicators were both visually assessed by the researcher during the walk throughout the pasture. Evidence of erosion and human-caused bare soil were additive, and the two scoring components were combined to reach the final score.
5. Noxious and prohibited noxious weeds – For all habitat types, the percent cover and density distribution of any listed noxious and prohibited noxious weeds were observed and considered in the scoring of this component. Percent cover of any weed species was assessed during the walk through the pasture, and a density distribution class was assigned based on Figure E-1 (Appendix E) of the field workbook (Adams et al., 2009). Percent cover and density distribution were additive, and the two scoring components were combined to reach the final score.
6. Woody re-growth – This component applied only to tame pasture assessments, as shrubs and trees are naturally occurring elements of native grassland and forested communities but are considered detrimental in tame pastures where the area would have been initially seeded to tame forage species to the exclusion of woody plants. The percent cover and density distribution of any shrub or tree species observed were considered in the scoring of this component. Percent cover was assessed during the walk through the pasture, and a density distribution class assigned based on Figure E-1 (Appendix E) of the field workbook (Adams et al., 2009). Percent cover and density distribution of woody regrowth are again additive, and the two scoring components were combined to reach the final score.

As a final step, estimations of long-term grazing intensity (non-grazed to heavily grazed) and current year forage utilization (as a percent) were recorded but were not factors influencing the component scores.

2.2.6 Stocking Rate

Collection of stocking rate (SR) data is a critical aspect of interpreting grazing management impacts on vegetation and soil, as past research studies have widely affirmed the overriding importance of SR in regulating rangeland sustainability (Heitschmidt et al., 1987; Brummer and Moore, 2000; Derner et al., 2008; Nuthall, 2012). Stocking rate is defined as, 'The relationship between the number of animals and the grazing management unit utilized over a specified time period' (Holecheck et al., 2004, p.598). During the data collection associated with this study, producers were not asked for specific stocking rates at the pasture or ranch level, in part because typical rancher knowledge in Alberta generally does not include the use of or interpretation of stocking rate data. By and large, most beef producers in Alberta use alternative methods of tracking livestock use (e.g., eyeball) and asking them about this would only serve to point out the lack of specific SR data for the operation. Instead, stocking rates for individual ranches at the ranch level were calculated using the initial phone survey responses, where ranchers were asked about the number of grazing acres, how many animals they maintained, and the length of their grazing season. These coarse-level estimates of stocking rate at the ranch scale (SRR) were calculated as AUM/ha, because when asking producers how long their grazing period was each year they would generally respond in months. These values are understood to be quite accurate, as most producers have a strong working knowledge of the size of their grazing land base, herd size and grazing period.

Stocking rates at the pasture scale (SRP) for each pasture assessed for range health were back-calculated with a similar process. Information on the number of animals grazing, number of grazing days and the size of pasture in acres was collected for most pastures. In some cases, this information was not collected during the survey/consultation process, and in those instances, the researcher contacted the producer after the field season was over to fill in any missing details. These *post-hoc* calculations of SRP are considered less accurate in many cases, as the number of grazing days on pasture and total number of animals on pasture was information that was not always easily communicated by producers. Often, producers would respond with answers such as, 'they were out on that pasture for about two or three weeks', instead of a definitive 14 or 21 days, which leads to the potential for interpretation error in the data. In these cases, the median value (e.g., 18 days) was used as the number of days on pasture. SRP values were calculated as AUD/ha because grazing information regarding specific pasture units was generally responded to with the number of days on pasture. Pasture sizes in acres for both ranch and pasture level SR were converted to hectares for analysis *post-hoc*. For subsequent statistical testing involving different GSs, stocking rates at the pasture level (SRP) were used, as these data were thought to more closely approximate grazing impacts on range health at the scale in which the health was assessed.

2.2.7 Data Analysis

Response data in this study included the range health data for all component scores, the total range health scores for each of the pastures assessed, and the level of current percent forage utilization at the time of field sampling. The primary treatment variable was the grazing system employed, while AHM and stocking rates were important covariates included in the statistical models. All response data were initially tested for normality prior to analysis. The distribution of range health scores (RHS) was found to be normal based on a univariate test, inspection of histograms and associated Kolmogorov-Smirnov tests ($P > 0.150$) and therefore did not require transformation.

Initially, the three habitat types (forests, tame pasture and native grassland) were pooled for analysis to test for differences in total range health and percent forage use relative to habitat type. A mixed-model analysis of variance (ANOVA) was done using SAS software (SAS Institute Inc., Cary, NC, USA) with habitat type as a fixed factor, and individual ranches as the random blocking units. AHM was initially included in the ANOVA as a fixed effect covariate in this analysis to account for variation in agroclimatic conditions across the large geographic study area. However, this model indicated that including AHM markedly reduced the power of the test, likely because AHM values were unique for each ranch location (the random factor), and the distribution of habitat type occurrences varied with AHM (i.e., wetter areas were more likely to contain forests and tame pasture than native grassland). To avoid this confounding effect, the ANOVA was re-run with AHM removed. Observed total RHSs were also regressed against levels of forage use and stocking rates measured at the pasture scale, separately by habitat type.

Next, to test the effect of grazing system on range health and forage utilization, each response variable (total RH, forage use) was evaluated in relation to each grazing system (as a fixed effect). However, this analysis was done separately by habitat type because of the unique range health scoring criteria for each habitat, including the fact that components were weighted with different values (Appendix C). To analyze the effect of GS on RHS, independent treatment levels within the GS fixed factor were coded with dummy variables for use in the mixed-model ANOVA, ranked by increasing complexity (CG = 1, SRG = 2, FRG = 3, HM = 4). Forested pastures were greatly limited by the low sample size ($n = 8$) and were therefore only tested for the effects of GS on RHS using a 1-way ANOVA, with AHM included as a simple covariate to account for variation in growing conditions. SRP was not included in the model due to the high amount of variability within that dataset as discussed above. In contrast, tame pasture and native grassland habitats, which had higher sample sizes (n = 60 and n = 29, respectively), allowed for testing of broader and more inclusive models, a 3-way ANOVA was performed, with GS, AHM and SRP all run as fixed effects, with individual ranches and pastures nested within ranches included as random factors. Where significant effects included AHM and/or SRP, regressions were run to parse out the effect of these continuous factors on RHS and/or forage use, including in relation to different grazing systems, with goodness-of-fit (R^2) and p-values for the models used to detect significance ($P < 0.05$).

In the aforementioned analysis, ranches grazed with the FRG and HM systems were relatively uncommon within the forested (n = 1 and 2, respectively) and native grassland (n = 3 and 2, respectively) habitats, and instead was more common in tame pastures, representing 3 and 6 observations each, respectively (Table 2.2). As a result, the grazing systems of FRG and HM were combined into one category for analysis within the forest and native grassland habitats, thereby increasing the sample size of those systems employing relatively ‘rapid’ movements of livestock. To assess whether the same should be done for the tame pasture, we initially tested for differences in RHS between the FRG and HM systems, and found no difference (FRG = 75.2 ± 4.4% vs HM = 79.0 ± 2.8%; $F_{1,6.69} = 0.55$, $P = 0.485$), which was consistent with the relatively similar way in which livestock were grazed within these management systems. As a result, the FRG and HM data were also combined into one category for the analysis of tame pastures, which had the added advantage of maintaining comparability to the results found in the analyses of the other habitats.

2.3 Results

2.3.1 Habitat Effects

Preliminary data exploration compared means and standard deviations of RHS within each natural region (Table 2.3). Due to the marked variation in biophysical conditions present among regions, no forested sites were assessed in either the Grassland or Rocky Mountain natural regions, with only one forest assessed in the Parkland. Similarly, in the Rocky Mountain natural region, only one native grassland assessment was completed. Overall, the Boreal and Parkland natural regions had relatively similar RHS for tame pastures and forests, while mean RHS from tame pastures were similar between the Grassland and Rocky Mountain natural regions. The Grassland, Parkland and Rocky Mountain natural regions had similar native grassland mean RHS, whereas the Boreal natural region appeared to have a slightly lower mean RHS for native grassland sites (Table 2.3). No statistical analysis was performed at the natural regions scale of the dataset.

Further data analysis was undertaken to compare the mean RHS of the three habitat types. These were summarized first by habitat type, then compared by total scores and again separately for each of the range health components (Table 2.4). The ANOVA results ($F_{2,94} = 4.10$; $P = 0.02$) indicated that forested habitats (83.8 ± 3.8% SE) had greater mean RHS ($P < 0.05$) than those found in both native grassland (71.5 ± 2.0% SE) and tame pasture (73.7 ± 1.4% SE). Utilization data were similarly compared among habitat types. ANOVA results ($F_{2,94} = 5.15$; $P = 0.008$) showed the opposite response to RHS, with the proportional utilization of forage differing among habitat types, being greater in tame pastures (52.5 ± 2.9% SE) than either the native grassland (42.1 ± 4.2% SE) or forest (28.7 ± 7.9% SE) habitat types. Although forested areas appeared to have lower use than native grasslands, high variation in use estimates within forested habitats resulted in statistically similar levels of utilization between these areas and native grasslands ($P = 0.14$).

Trend line data of the RHS assessments revealed a distinct pattern in the relationships between measured total RHS and estimates of forage utilization during 2017 (Fig. 2.1). These relationships were negative for all three habitat types, indicating RHS declined as utilization increased. Forested habitats showed the strongest negative relationship (forested %RHS = 99.1 – 0.53x, Adj. $R^2 = 0.39$, $P = 0.057$, where 'x' is the percent forage utilization), followed by tame pastures (%RHS = 82.6 – 0.17x, Adj. $R^2 = 0.13$, $P = 0.003$), and then native grassland (%RHS = 78.4 – 0.16x, Adj. $R^2 = 0.07$, $P = 0.08$).

Stocking rates at the ranch and pasture level were investigated as explanatory variables of total RHS for the different habitat types. Both ranch and pasture level SRs were considered, as these were often different values, as discussed in the methods (Table 2.5), with ranch level stocking rates consistently greater than those documented at the pasture scale on an AUD/ha basis. Interestingly, RHS for both the pasture and ranch scale remained similar within habitat type. Only native grasslands grazed with FRG, and forested habitats grazed with SRG, showed any notable differences between the ranch and pasture levels (Table 2.6). In some instances, ranches that had been categorized as HM (for example), may have had a pasture assessed on the ranch that was grazed in another manner (e.g., continuously). This resulted in some pastures having a different classification of grazing system management than the ranch overall. Notably, observed RHS did not vary in relation to SRs calculated at either the pasture scale ($P \geq 0.40$) or ranch scale ($P \geq 0.13$).

Due to the stronger relationship between AHM and SRR ($r = -0.253$; $P = 0.01$) than AHM and SRP ($r = -0.054$; $P = 0.60$), we proceeded using SRP values, reinforcing the expectation that overall ranch level stocking rates were being regulated by growing conditions (i.e., moisture availability), and that these variables expressed strong collinearity. In contrast, SRP values appeared to be independent of growing conditions, and therefore the SRP measures were considered to provide a superior independent metric to evaluate individual RHS responses.

2.3.2 Grazing System Effects

2.3.2.1 Forested Habitats

No effects of AHM or GS were observed on total RHS (AHM: $F_{1,4} = 0.22$; $P = 0.66$, GS: $F_{2,4} = 0.12$; $P = 0.89$). RHS across forested areas ranged from 89.4% (± 12.8) in CG pastures, to 81.1% (± 8.9) in SRG pastures and 77.3% (± 18.2) in FRG pastures. There were no HM pastures in forested habitats.

2.3.2.2 Native Grassland Habitats

Correlations within the native grassland sites (n = 29) between SRP, AHM and GS showed one correlation, GS x AHM ($r = -0.556$, $P = 0.002$), which showed a tendency for continuously grazed pastures to occupy more arid regions than those grazed with either a slow or fast rotation (Fig. 2.2). SRP was not found to be correlated to GS in native grassland habitats ($r = 0.272$, $P = 0.15$). Given the close association of GS with AHM, the final model was run as a 2-way ANOVA using GS and SRP as fixed effects to assess RHS responses, with no effects detected for any of the fixed effects (GS: $F_{2,23} = 0.77$, $P = 0.48$; SRP: $F_{1,23} = 0.00$, $P = 0.99$; GS*SRP: $F_{2,23} = 0.35$, $P = 0.71$). No significant interactions of SRP and AHM were observed within the mixed model ANOVAs including all independent variables in subsequent testing of GS impacts on RHS, conducted on native grasslands (SRP: $F_{1,18} = 1.49$; $P = 0.24$, AHM: $F_{1,18} = 0.36$; $P = 0.56$, SRP*AHM: $F_{1,18} = 1.42$; $P = 0.25$) (Fig. 2.3). Within native grassland habitats, the CG, SRG and FRG/HM treatments were associated with RHS of 68.1% (± 7.5), 72.3% (± 9.3), and 74.3% (± 8.6), respectively.

Forage use during 2017 was also tested in a 2-way ANOVA for the effects of GS and SR at the pasture level. None of these factors, alone or in combination, altered observed use during 2017 ($P \geq 0.61$). However, high variation in utilization among pastures appeared to inhibit the appearance of differences in use, particularly in the CG (31.8 ± 11.8%) and FRG/HM (48.0

± 14.7%) systems, which differed by nearly 16%; SRG systems were intermediate in forage use (35.5 ± 9.0%).

2.3.2.3 Tame Pasture Habitats

The same process was repeated with tame pastures (n = 60). Correlations between SRP, AHM and GS were not significant (SRP*AHM: r = 0.072; P = 0.58, SRP*GS: r = 0.199; P = 0.13, AHM*GS: r = 0.028; P = 0.83).

The 3-way full factorial ANOVA results evaluating total RHS responses in tame pastures indicated that the lone effect was an AHM x GS response (AHM*GS: $F_{2,48}$ = 3.17; P = 0.05). In addition, the results indicated a marginally significant effect of GS alone (GS: $F_{2,48}$ = 3.02; P = 0.058). Overall, pastures grazed with an FRG/HM system (76.7 ± 2.6%) tended to have greater health scores (P = 0.08) than those exposed to SRG (70.8 ± 2.1%), while CG areas were in between (72.6 ± 3.3%). Closer inspection of the RHS responses to AHM in relation to GS indicated that while overall RHS declined with AHM (All GS: %RHS = 97.7 – 0.90x, Adj. R^2 = 0.12, P = 0.004), important differences existed in the pattern and extent of decline among GSs (Fig. 2.4). More specifically, only the CG system led to a significant decline in RHS with increasing aridity (CG %RHS = 113.3 -1.53x, Adj. R^2 = 0.29, P = 0.049, where x is AHM), while the SRG (SRG %RHS = 85.8 – 0.57x, Adj. R^2 = 0.05, P = 0.13) and FRG/HM (FRG/HM %RHS = 90.3 – 0.47x, Adj. R^2 = 0.03, P = 0.60) systems showed less decline. No significant interactions of SRP and AHM were observed within the mixed model ANOVAs including all independent variables in subsequent testing of GS impacts on RHS, conducted on tame pastures (SRP: $F_{1,44}$ = 0.18; P = 0.671, AHM: $F_{1,44}$ = 0.46; P = 0.502, SRP*AHM: $F_{1,44}$ = 0.17 P = 0.68) (Fig. 2.5).

Forage use in tame pastures was similarly assessed with a 3-way ANOVA. Unlike RHS, no differences in forage use were found in relation to any of the fixed effects, alone or in relation to one another (P ≥ 0.37). Forage use ranged from 50.4% (± 5.1) in SRG systems, to 56.1% (± 6.1) in FRG/HM systems, and to 58.8% (± 7.7) in CG areas.

2.4 Discussion

2.4.1 Range Health Scores

Range health scores are a relatively new measure of range health adopted by the government of Alberta in an attempt to make range management at the provincial scale more repeatable and consistent across landscapes and habitat types (Government of Alberta, 2018a). To our knowledge, no scientific research has been done into the efficacy of these assessments at consistently drawing complete and accurate conclusions of range health from these scores. There are five or six key questions asked of the assessor to evaluate each habitat type, and they are weighted differently into the final overall scores for the site depending on habitat. How much influence these differing weights have on the overall outcomes on these sites has not been quantified or researched at this time. With the variation of weight assigned to the scoring system, there is the possibility of bias inherent in the evaluation. We used these assessments as the basis of this aspect of the research with the understanding that these assessments have not yet been proven accurate by scientific study. Certainly, this could be an area of future research for next generation range scientists in Alberta, to investigate how the weighted structure of these assessments impacts the outcomes of the range health scores, and whether or not those accurately reflect the actual range health of an area.

The natural regions where the pasture sites were located generally showed no overriding effect on total RHS, with only the Boreal natural region exhibiting a non-significant trend towards an overall lower RHS. This indicates that the larger geographical area where the pastures were located was not a contributing factor to the RHS of the study pastures. In contrast, habitat type did show relationships to RHS. Overall, forested sites had a higher average RHS than native grassland or tame pasture and may indicate a more conservative use strategy by ranchers on forested lands compared to their other habitat types. This notion is consistent with the forage utilization data, which indicated lower utilization rates on forested habitats compared to either of the two herbaceous habitat types. Why this may be a management strategy used by ranchers is not known, as forested sites can be productive areas beneficial to grazing management, though they require specialized management to conserve, such as deferred grazing until mid-summer and the use of low stocking rates (Roath and Krueger, 1982; DelCurto et al., 2005).

Range health scores were highly consistent between stocking rates at the pasture and ranch level. Moreover, SRs documented at either the pasture or ranch level showed that SR was generally not a factor influencing RHS. This is a surprising outcome, as SR is commonly recognized in grazing management as a key factor influencing range health (Heitschmidt et al., 1987; Briske et al., 2008; Zhang et al., 2018). While it is possible that the *post-hoc* calculations of SR at the pasture and ranch level decreased the analytical accuracy of the results, had there been a relevant interaction occurring, we are confident the analysis would have picked up some indicator of significance. As this was not the case, some possibilities we can draw from this study are that either SRP or SRR were non-significant drivers of RHS, or that the quantitative information provided by producers on their livestock use was not reliable. It is also worth noting the large discrepancy between SRs reported at the pasture and ranch level (Table 2.5). The latter were typically much greater, often by an order of magnitude (2 – 3x). While the exact reason for this is not known, it may reflect a tendency by ranchers to overstate their herd sizes across their land base, or alternatively, under-report on the use of specific pastures, whether intentional or not.

Based on the lack of experimental evidence found from our list of influencing factors on range health scores, we must conclude that these factors are not enough on their own to understand and predict range health scores, and we cannot imply that any particular grazing system out-performed the others based on grazing system alone. The implications of these learnings are two-fold. First, the metrics we collected to complete these analyses were not sufficient to understand what factors significantly drive range health. The low R^2 values achieved with the data inputs indicate that there is more at play in range health than we were able to assess. This in an important learning and should be followed up with in future research on this topic. Second, although there were some variations of range health among and between ranches using differing grazing systems, there were none that were significantly different from the rest to indicate a preferential model of grazing for the province. In fact, the overall consistency between range health scores regardless of grazing system would indicate that there is not a single, better system to be recommended for adoption across the province.

2.4.2 Forage Utilization

Forage utilization data showed some of the clearest correlations with RHS within the study. There was clear evidence that as current proportional utilization rates increased, RHS consistently decreased. This effect was most pronounced within the forested habitat types. The latter finding suggests an overall greater negative effect of increasing utilization rates on forested sites, which is consistent with these habitats being particularly sensitive to defoliation (due to dominance of broadleaf vegetation rather than graminoids), though we are unable to rule out the possibility that this response was due to the low sample size of pastures sampled (n = 8). These results follow in line with much of what research on range health and condition have revealed in previous studies regarding both over and under-utilization of vegetation on rangelands (Cook and Stoddart, 1953; Laycock, 1991; Isselstein et al., 2007; Zhang et al., 2018), and serve to validate the results of this aspect of the study. Further to this point, Laca (2009) notes that while grazing itself is one tool available to producers, other characteristics that have significant impacts on both pasture production and foraging behaviour of livestock include pasture size and shape, plant spatial patterns, learned aversions and preferences, and duration and timing of defoliations, intimating that there may be several other factors at play when examining forage utilization as a determinant of RHS.

2.4.3 Grazing System

The influence of GS on total RHS was more varied and less clear. Continuously grazed pastures were consistently located in higher AHM areas. This could be the result of ranchers in arid areas having fewer options in grazing management than their more mesic counterparts. Pastures in those areas tended to be larger and have fewer watering points, which effectively limit the amount of rotational grazing possible. This idea is supported by the meta-analysis of HM and CG literature done by Hawkins (2017), wherein they found that higher precipitation levels may be required to support HM grazing.

Overall, native grassland pastures that were CG had lower total RHS than those under SRG or FRG/HM, though the difference in scores was not significant. The correlation between AHM and GS indicated that ranchers grazing native grassland in more arid environments (i.e., lands with higher AHM values) tended to predominantly use simpler grazing systems, as represented by CG. Interestingly, within native grassland pastures total RHSs consistently decreased under increasing AHM values with SRG and FRG/HM, but not in the case of CG, wherein the RHS increased as aridity increased. This implies that ranchers may be employing more conservative grazing of native grassland pastures under more arid conditions, in effect, counteracting the effect of the arid conditions on the native grassland by using a more extensive grazing model to maintain productivity, and therefore pasture RHS.

Tame pasture RHSs showed similar results to that of the native grassland in response to AHM. RHS consistently declined in response to increasing AHM. The overall trend in tame pasture was negative in response to increasing AHM values for all GS, with CG having a significantly negative effect, while SRG and FRG/HM were non-significant. This could be interpreted as meaning that CG of tame pastures in arid environments predisposes those pastures to more degradation, or that SRG and FRG/HM of tame pastures in arid environments reduces the risk of degradation of those pastures. Given our current set of data analysis, we cannot conclude which interpretation is correct, further study is needed to investigate this outcome. Observed RHSs in tame pastures also showed no interactions between SRP, AHM and GS.

The subtle conclusions reached here, and as found in the low goodness-of-fit (R^2) values presented throughout the results, indicate that for all the various metrics collected for the study, we are left without a clear indicator of what factors are influencing RHS across GS, independent of SR, habitat type or percent forage utilization. This indicates that there is at least one other, and potentially several other contributing factors, that have a more direct influence on RHS than those investigated in this study. For example, the effect of weather conditions (wet vs. dry years) on RHS was not considered. This leaves the question unanswered as to which factors influence RHS, though any future studies would be well served to use these highly interesting, yet mostly inconclusive results, as a basis for continuing the search for a better understanding of the relationship between RHS and GS.

2.5 Conclusion

In this research, we set out with the goal of learning if independent factors including grazing system, current forage use, stocking rate, climatic conditions and habitat type, could be used as means to understand the influence these factors have on range health scores. Of particular interest was the question of the grazing system employed, as this has been the topic of many grazing research studies in the past.

The key findings of this research as related to RHS were that RHS were consistently higher in forested habitats than herbaceous habitats (native grasslands and tame pasture), and that RHS declined with increasing aridity (higher AHM values). Interestingly, we found that RHS appear to be more associated with the current year's percent forage use than SR. A surprising outcome of this research was that grazing system influences on RHS were not indicated. This is contrary to many published studies which find in favour of extensive or intensive grazing models. Our research used range health assessments to assess pastures throughout Alberta under four groupings of grazing management (three for the purpose of this chapter), yet we were not able to determine any clear differences in range health scores based on grazing system alone, or in combination with the other factors also assessed. One interpretation of this data would be that given the apparent lack of significant differences in RHS across the province and between GS, meaning, each is equally as defensible as the next; the best approach for grazing management is to find the system that suits the personality of each producer, just as the variation in these systems across the province suggests has been occurring for some time.

The merits of the various grazing systems are dependent on the user. Extensive grazing such as CG and SRG allow producers to have fewer interactions with their animals, require less time and infrastructure, but also reduce the capability of the rancher to control grazing patterns and behaviours. Intensive grazing systems such as FRG and HM require more time and money inputs, greater upfront costs of infrastructure, and added planning, but gain producers much control over the timing, duration and frequency of grazing and grazing behaviour.

The findings provided by this research have done much to identify factors which apparently do not influence range health scores to a great extent in the province of Alberta. There is a great potential here for future research to further identify the other factors that do influence range health of pastures, as well as evaluate the efficacy and accuracy of the range health assessment protocol itself. A few suggestions of areas that could be focused on in future research would be to add weather conditions beyond AHM into the equation; narrow the focus of the study area to a more uniform and higher production area such as the Central Parkland or Northern Fescue, or the lower production areas of the Mixedgrass or Dry Mixedgrass; as well it would be beneficial to focus the assessments on only tame pastures and native grasslands. These suggestions could help take the focus of grazing management research in new directions. This has therefore been a meaningful contribution to the body of research done on range assessments, with the basis formed now for the identification of new research to branch out from this study and continue the exploration of the very interesting art, and science, of range management.

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Tables

Table 2.1 Summary of number of ranches sampled (N), mean annual precipitation (MAP), mean annual temperature (MAT), annual heat:moisture index (AHM), average elevation (m), dominant soil type and size for each subregion within the study area, as described by the Natural Regions Committee, 2006.

Natural Region	Natural Subregion	N	MAP* (mm)	MAT* (°C)	AHM* index	Elevation* (m)	Dominant soil	Total area (ha)
Boreal	Dry Mixedwood	8	380	1.6	24.1	600	Luvisol	8,532,100
	Central Mixedwood	1	397	1.1	20.6	525	Luvisol	1,678,560
Parkland	Central Parkland	8	441	2.3	27.3	750	Chernozem	537,060
	Foothills Parkland	2	839	3.6	16.3	1250	Chernozem	39,210
Grassland	Foothills Fescue	1	506.7	4	27.6	1100	Chernozem	136,230
	Northern Fescue	3	391.1	2.3	31.6	800	Chernozem	149,330
	Mixedgrass	2	361.8	5.6	43.5	975	Chernozem	200,720
	Dry Mixedgrass	2	349.2	2.4	35.6	800	Chernozem	469,370
Rocky Mountain	Montane	1	529.7	2.4	23.3	1400	Brunisol	87,680

* MAP, MAT and AHM data are specific to the areas of the ranches within the natural subregions. Elevation data are general within the natural subregion

Table 2.2 Summary of the sampling effort (N) used to evaluate range health on 97 pastures distributed across 28 ranches in Alberta, further stratified by habitat type and grazing system. Data were collected between September 4 and October 31, 2017. Pasture subsampling effort among ranches ranged from 3 to 4 (mean = 3.5).

		Pastures (N)			
Grazing System	Ranches (N)	Tame Pasture	Native Grassland	Forested	Total
Continuous	5	9	4	3	16
Slow Rotation	14	27	19	2	48
Fast Rotation	3	7	3	1	11
Holistic	6	17	3	2	22
Total	28	60	29	8	97

Table 2.3 Means and standard deviations of observed range health scores by habitat type and natural region. Data were collected between September 4 and October 31, 2017.

	Tame Pasture		Native Grassland		Forested	
Natural Region	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Boreal	76.3	9.7	63.0	14.0	84.0	12.0
Grassland	65.5	10.3	71.5	9.0	-	-
Parkland	76.6	10.7	73.1	7.8	82.0	-
Rocky Mountain	68.3	9.4	72.0	-	-	-

Table 2.4 Means and standard deviations of total rangeland health scores and individual component scores, summarized separately by habitat type. Data were collected between September 4 and October 31, 2017.

	Tame Pasture		Native Grassland		Forested	
	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Q1	9.5 / 12	2.4	23.5 / 40	6.3	18.8 / 25	5.4
Q2	22.3 / 28	4.9	9.4 / 10	1.2	26.8 / 35	6.0
Q3	16.5 / 25	7.6	18.3 / 25	6.8	19.3 / 20	2.0
Q4	13.1 / 15	2.5	14.3 / 15	1.5	9.8 / 10	0.7
Q5	5.1 / 10	3.9	5.9 / 10	3.7	9.3 / 10	2.0
Q6	7.2 / 10	3.2	-	-	-	-
Total	73.7 / 100	11.1	71.5 / 100	9.2	83.8 / 100	11.2

*See Appendix C for full details of the questions

Table 2.5 Means and standard deviations of stocking rates at the pasture and ranch level, summarized separately by habitat type. Data were collected between September 4 and October 31, 2017.

	Tame Pasture		Native Grassland		Forested	
Stocking Rate	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
SR Pasture Level (AUD/ha)	59.2	58.3	42.5	52.1	27.7	23.7
SR Ranch Level (AUM/ha)	2.8	1.9	2.3	1.7	3.0	1.8
SR Ranch Level AUD/ha	83.5	55.9	88.4	74.8	89.9	50.3

*Stocking rates are reported as AUD/ha and AUM/ha as those were the units reported initially to the researcher

Table 2.6 Means and standard deviations of range health scores at the pasture and ranch scale summarized by grazing system and habitat type. Data were collected between September 4 and October 31, 2017.

	Pasture Level					
	Tame Pasture		Native Grassland		Forested	
Grazing System	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Continuous	74.6	13.4	68.1	8.3	85.0	11.2
Slow Rotation	70.1	9.8	72.3	9.8	83.3	12.4
Fast Rotation	75.0	5.3	77.0	-	82.0	-
Holistic	79.0	10.8	73.0	1.0	-	-
	Ranch Level					
	Tame Pasture		Native Grassland		Forested	
Grazing System	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Continuous	74.9	9.1	68.5	10.4	86.7	11.0
Slow Rotation	70.0	11.7	72.5	9.8	92.0	-
Fast Rotation	75.9	5.4	68.3	6.3	82.0	-
Holistic	78.5	10.3	72.3	1.2	72.0	10.0

Figures

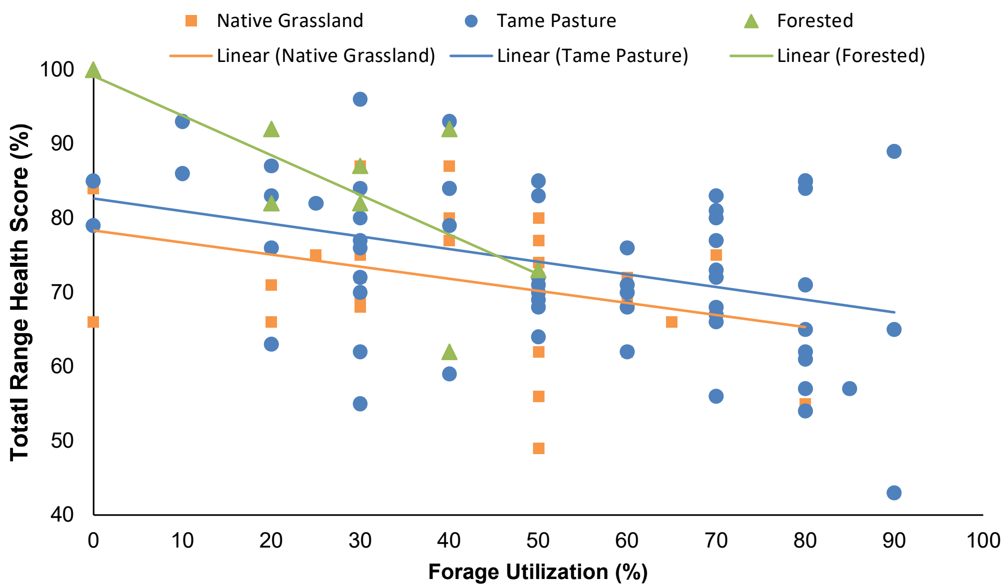

Figure 2.1 Range health scores by utilization for each habitat type represented by points and linear trendlines. Line equations are: forested RHS = 99.1 – 0.53x; native grassland RHS = 78.4 – 0.2x; tame pasture RHS = 82.6 – 0.2x, where 'x' is the percent forage utilization.

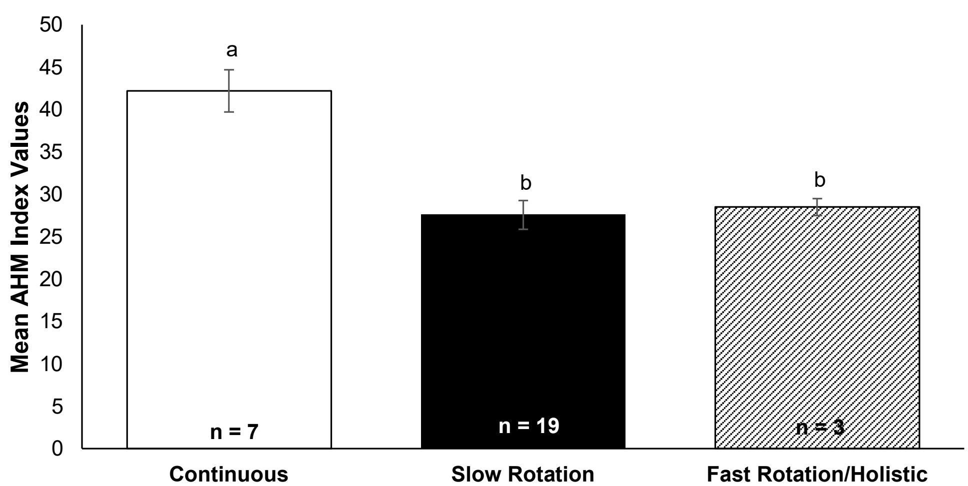

Figure 2.2 Mean AHM index values for native grasslands each grazing system. N refers to the number of sample plots in each grazing system. Standard error bars equal: continuous 2.5; slow rotation 1.7; fast rotation/holistic 1.0. Means with different letters differ, P < 0.05.

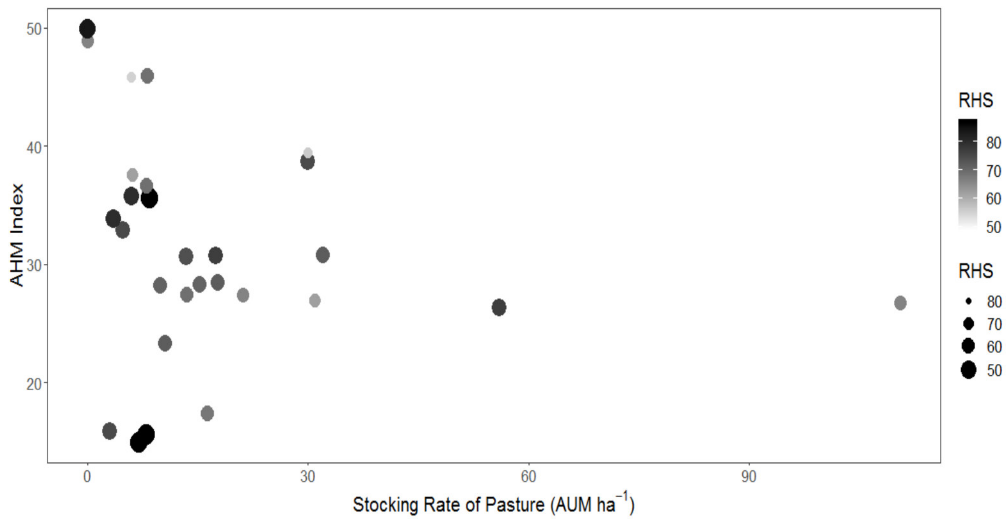

Figure 2.3 Scatterplot showing relationship between AHM index and stocking rate of pastures on range health scores for native grassland habitats.

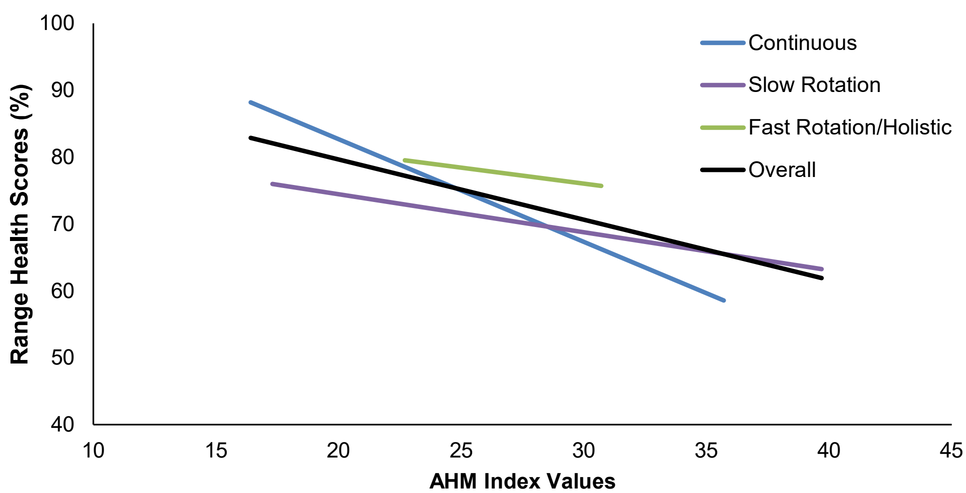

Figure 2.4 Range health scores and AHM index values by grazing system, and overall trendline for tame pastures. Line equations are: continuous RHS = 113 – 1.53x; slow rotation RHS = 85.8 – 0.57x; and fast rotation/holistic RHS = 90.2 – 0.47x, where 'x' is the AHM value. Associated metrics include: continuous n = 11, df = 10, R-Square = 0.3649, Adj. R-Square = 0.2941, F = 5.17, P = 0.0490; slow rotation n = 28, df = 27, R-Square = 0.0870, Adj. R-Square = 0.0519, F = 2.48,

P = 0.1276; fast rotation/holistic n = 21, df = 20, R-Square = 0.0147, Adj. R-Square = -0.0371, F = 0.28, P = 0.6005.

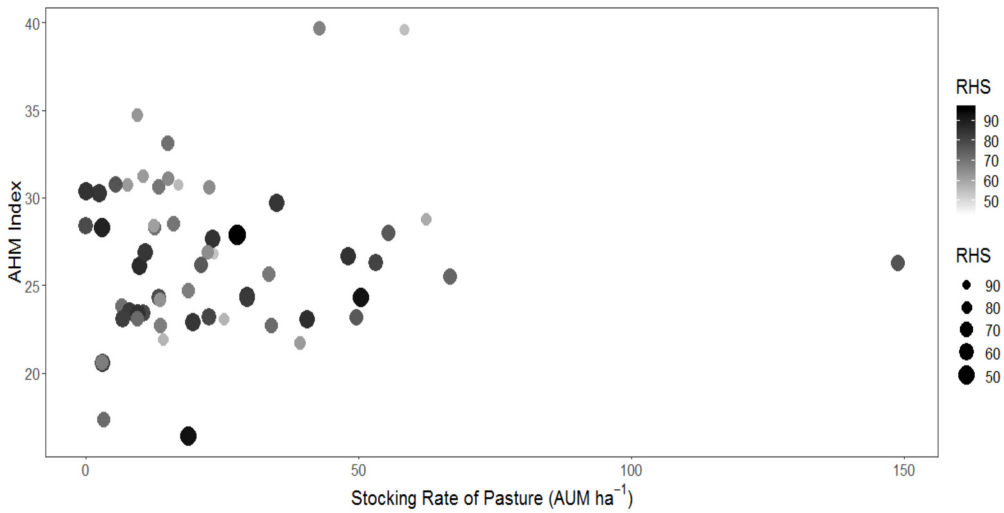

Figure 2.5 Scatterplot showing relationship between AHM index and stocking rate of pastures on range health scores for tame pasture habitats.

Chapter 3. Producer Perspectives of Grazing Management in Alberta

3.1 Introduction

Grazing management as a topic of scientific study and investigation has in the past primarily focused on the highly quantifiable aspects of management: soil properties, plant species diversity and abundance, animal weight gains, etc. Only in the last 20 years or so, from the early 2000's onward, do we begin to see more papers being published and research undertaken into what could be argued to be the biggest influence on grazing management, the personal opinions and preferences of ranch managers themselves (Sherren and Darnhofer, 2017). Why ranch managers make the grazing decisions they do and the motivation behind them is of key importance if social science wishes to gain an understanding of how rangelands are managed (Nuthall, 2012).

Alberta has a long history of ranching, with the first domestic cattle brought into the province in the 1870's (Bailey et al., 2010). Most ranchers in Alberta are independent business owners, responsible for their land and animals, and recognized as stewards of the land (Ellis, 2013). Ranching as most people think about it reflects something along the lines of the Marlborough Man or John Wayne, and ranching stereotypes include notions of people who are strong, quiet, helpful, independent and trustworthy (Steward, 1998). These traits can generally be thought of as industry norms, aspects of ranching that are agreed upon by both those within the community, and those observing it from the outside.

Although a relatively new area of study, research has shown that qualitative evidence in range management is highly beneficial and provides much needed insight in to how producers make decisions (Sayre, 2004). As Lynam and Smith (2004, p.71) state, 'The human processes are as important as the ecological processes'. This statement reflects the real need for a deeper understanding of the human dimension of grazing and livestock management, to better capture this missing component that drives the ecological aspect. Greiner and Gregg (2011) show that even with strong government support and policy in place, including economic incentives, producer adoption of conservation practises is not guaranteed, and that often farmers are motivated by well-being and care-based factors such as stewardship, tradition, and family succession planning rather than purely financial drivers. Because of this, ranchers may make management decisions that are not always financially beneficial, a condition which leads to under-adoption of financial incentives and other government programs (Kim et al., 2005; Greiner and Gregg, 2011).

The argument against a wholly quantitative research program is that these types of studies often miss critical components of decision making. Didier and Brunson (2004) identified nine factors that inhibited, motivated or characterized producers in their decision-making process. For example, an inhibiting factor identified was attachment to tradition, a motivating factor was to improve land stewardship, and a characteristic was a large social network. These findings were possible because the researchers conducted conversational interviews using open ended questions with ranchers, allowing them the opportunity to freely express opinions which may have been missed by other research due to the rigid structure of purely quantitative studies. This methodology can be contrasted with the work done by Cox et al. (2015) which used a survey designed to be analysed quantitatively and was comprised of survey questions on a 1 to 5 (least to most) scale which effectively limits both the type and range of answers that can be given.

Contemporary research addressing grazing and range management is rife with mixed and often contrasting evidence. Examples of research extolling the virtues of holistic management (HM) (Savory and Parsons, 1980; Stinner et al., 1997; Savory, 1999; Savory, 2013a), rotational (both fast and slow) (Hubbard, 1951; Rogler, 1951; Heitschmidt et al., 1987; Gibson and Brown, 1992; Chorney and Josephson, 2000; Teague and Dowhower, 2003; Gerrish, 2004; Briske et al., 2008; Teague et al., 2013), and continuous grazing (Rogler, 1951; Heady, 1961; Hormay, 1970; Holechek et al., 1999; Derner et al., 2008) are easily found, but often these studies confound stocking rate with grazing system, and therefore must be interpreted with caution. Also, these studies generally ignore the human aspect of grazing management, which is critical in understanding what motivates producers to adopt the various systems (Sayre, 2004; Briske et al., 2011; Teague et al., 2013; Mann and Sherren, 2018), resulting in knowledge gaps within the body of literature available on this important topic.

Given these mixed results and a dearth of research on range management decision-making, I address two main objectives in this study which will contribute to the growing body of work in rangeland social science. Using the interview data, the first objective was to understand the social factors including social experiences, industry norms, and the culture of ranching that influence their grazing management decisions. Second, based on these factors, I sought to determine if there were common thematic perspectives among the groups of ranchers using different grazing systems.

Learning what are the significant drivers of grazing managers in Alberta, or if there are strong differences in philosophies or perspectives between different groups of producers, could help future policy creation be more effective by aligning socio-economic and environmental policy changes to have the greatest impact for both the ranching community and the general public.

3.2 Literature Review

3.2.1 Independence

Perceptions of the ranching lifestyle include a variety of themes: rugged men on horseback riding the open range, checking or moving cattle, working with the land, making an honest living, and principally, independence. As stated by Peterson and Horton (1995, p.148), 'Independence is the freedom to make ethical judgements regarding specific ranching activities'. This is a major piece of the identity of many livestock producers in areas where rangelands are usually privately owned (e.g., Canada, the US and Australia), where ranching remains primarily a self-driven and directed enterprise. Ranchers are free to set their own goals and choose their own priorities (Peterson and Horton, 1995), this is one of the main themes within ranching, that being one's own boss and making your own decisions is a very valuable aspect as to why ranchers feel so drawn to the work and lifestyle.

The independent nature of ranching is built upon a strong belief and understanding that each ranch is an individual unit, owned and operated independently from the others around it, and the ranchers who own these lands are the primary decision makers. This is evidenced by the wide variety of grazing decisions highlighted in the work of Chorney and Josephson (2000), who completed a survey of pasture management involving beef producers across Alberta, Saskatchewan and Manitoba, Canada. A key finding of their survey shows that close to two-thirds of respondents were relatively new to rotational grazing, having implemented the system 10 years ago or less. This result is consistent with the independent nature of ranching, as ranchers are free to make decisions and implement progressive changes on their lands as they see fit and are not beholden to others when deciding on grazing practices to use.

Personal experience and observation are critical components of the theme of independence. The rationale for altering the timing, duration and frequency of grazing varies widely and uniquely with each individual, with reasons for moving cattle off pasture including the number of days, targeted forage height, percent of pasture utilized or some other method; about half of respondents also used more than one methodology (Kabii and Horwitz, 2006; Henderson et al., 2014). These grazing management approaches all relate to the theme of independence, that each ranch and situation are unique, and one of the most important aspects of ranching is the ability to make your own decisions based on what you see as optimal on your own land (endogenous factors). Also important in this context, choices that are not dictated by government regulation or other contributing influences (exogenous factors).

Strongly connected with the independence of ranching is the idea of stewardship. Most ranchers describe themselves as stewards of the land, and this term is found across a wide variety of ecological regions throughout North America (Ellis, 2013; Henderson et al., 2014; Larsen et al., 2015). Stewardship of the land carries many meanings, but Ellis (2013, p.435) describes it best, 'Stewardship is about balance… if ranchers overgraze the land, the natural feedback… will ensure that there is less grass in future years, which will mean less cattle have less feed and the profitability of the ranch will be in danger. ...When stewardship is done properly, when it is in balance with the environment, it is seen as good for everyone and everything: the ranchers, the animals, and the environment'. Kabii and Horwitz (2006) echo this sentiment, indicating that stewardship pertains to the duty of care and prevention of harm to the land for next generations, as well as extending beyond just the landholder themselves. The study by Henderson et al. (2014) done in the Milk River region of Alberta, noted that many of the ranchers interviewed credited past generations for their stewardship practices in helping to maintain the native ranges, and the learnings they had received from them. This philosophy of independence, and belief in being stewards of the land for the next generation, are strongly held principles in ranching communities.

3.2.2 Social Norms and Social Capital

Lifestyle aspects of ranching are critically important to the community. Traditional and social aspects of ranch life such as brandings (young animals are permanently marked for identification purposes before being put out on rangelands) and cattle trailing (the movement of herds of animals over land to other pastures, often across a neighbour's property) require cooperation between neighbours and friends and creates a strong social currency among participants (Liffmann et al., 2000). These community bonds are fundamental aspects of ranching. Strauss and Reeser (2013, p.121) comment on the 'Code of the West', which, '…directs ranchers to take care of themselves within a strict but simple normative code of trust and reciprocity'. This social capital among ranchers supports them in maintaining their operations independently, as it is also noted that, '…social capital is strongest in cultures characterized by high levels of trust and reciprocity that also have capable agents who can connect others with [external] resources' (a person who acts as an intermediary or agent between the community and others) (Strauss and Reeser, 2013, p.121). One could argue that social capital and independence regarding the ranching community appear to be contradictory, but this is not necessarily the case. Social capital, as Strauss and Reeser (2013) describe it, is formed of three parts: bonding (family), bridging (friends and acquaintances) and links to external resources. These pillars of rural society are part of the ranching heritage and a fundamental set of accepted social norms that influence many ranchers, yet cooperation and 'Code of the West' norms in ranching are also inherent, and by helping each other through these social and practical functions, ranchers are able to maintain their independence.

The presence of social norms in ranching requires some discussion. Mackie et al. (2015, p.8) describe social norms as, '…to do with beliefs about others, that is, social expectations; within some reference group; maintained by social approval and disapproval and other social influence'. Within the ranching context, this can be thought of as one rancher's thought about how their own actions will be approved or disapproved of by their reference group, most likely, their nearby ranching neighbours or family. The pervasive tradition in ranching has been one of a more extensive management style, those managing grazing and livestock with minimal interference. Extensive graziers tend to be those using continuous grazing (>60 consecutive days on a single pasture unit) or a slow rotational (between eight and 59 consecutive days on a single pasture unit) system (as defined for the purpose of this thesis) on their lands. This style of grazing management is what ranching was built on in Alberta since the time of settlement and is still widely practiced today (Bailey et al., 2010).

There are two main components of social norms as put forth by Farrow et al. (2017) and supported by findings of Chenard and Parkins (2010). The first is injunctive norms, which refer to what most people approve of doing, while the other is descriptive norms, which are described as what most people do. Nolan et al. (2008) and Farrow et al. (2017) also mention that what others think and do makes a great deal of difference to individuals, and strongly impacts social outcomes and behaviours, although most individuals state that social norms don't influence their own behaviours. Durlauf and Blume (2007) note that social norms shape an individual's sense of obligation to their communities and families, and that norms are sustained through the threat of social isolation or disproval. In the ranching context, one could think of social norms as the continuation of traditional ranching behaviours (e.g., extensive grazing management) and the slow adoption rates of ranching innovations within the ranching community.

This theory relates closely to another proposed by Abson et al. (2019), which comments on the resilience of social-ecological systems, wherein those systems having close internal links while being more disconnected from the whole, are more likely to withstand external shocks and remain active. We can understand this in the ranching industry as the process by which extensive grazing has remained the social norm throughout Alberta. Only recently, and slowly, is the cow/calf industry beginning to shift to more intensive forms of grazing management, with approximately 33% of farms using rotational grazing as of 2016 (Government of Alberta, 2018). Continuous grazing is more common on large ranches with large tracts of land. Most of these will have ranches with similar amounts of land and numbers of cattle as neighbours. In these situations, most ranchers are likely to continue the practice of continuous grazing, as that is seen as the norm in their area. Mackie et al. (2015) further develop the idea of social norms into two sub-categories: descriptive norms and injunctive norms. Descriptive norms are described as doing what others do, while injunctive norms are described as doing what others think you should do. In continuing the practice of extensive grazing management, we can understand this as that neighbours are likely to be doing the same, and also, are likely to approve of what you are doing, thereby meeting both descriptive and injunctive norms as described above.

The presence of these well-established social norms in ranching may pose a significant challenge to those who would be considered innovators or early adopters of alternative (i.e., intensive) grazing management in Alberta. Diederen et al. (2003), found that characteristics such as farm size, age, market position and solvency differed between groups of innovators/early adopters and those who adopt innovations late or not at all. They also found that age was highly significant in the likelihood of being an innovator or early adopter, with older farmers significantly less likely to adopt new innovations. This factor could play a significant role in the adoption of intensive grazing practices in Alberta, as the mean age of the ranching community continues to increase year over year (Government of Alberta, 2018).

Mackie et al. (2015), also describe social regularities as including social norms of coordination and cooperation. This ties back in with the idea discussed previously about the social capital aspect of ranching, working together as a community to ensure everyone’s work gets done, by helping each other, including during critical times like branding and cattle trailing. These interconnected work activities establish what are considered the social norms of the reference group, of which individual ranchers are also a part. These social norms and activities can be considered consistent with the idea of personal ‘ingroup’ or ‘outgroup’ status, according to

Bernstein et al. (2010). Their study highlights findings that an individual's sense of belonging within a social group is of the utmost importance to all people, and that exclusion or rejection by any group leads very quickly to negative moods, feelings and increased pain. Maintaining one's status as a part of the norm, or 'ingroup', and behaving in a way that is perceived as the same or at least similar to the others, is part of maintaining these norms and statuses (Bernstein et al., 2010; Mackie et al., 2015). Social norms can be highly ingrained in the social group, making independent change away from the norm very difficult, as people are social creatures and do not want to be perceived as contrary or different.

Changes in the agricultural sector, with decreased numbers of farm holdings and increasing farm sizes (StatsCan, 2016a), has put pressure on remaining farmers and ranchers to find new ways to remain profitable and sustainable. One of these includes the encouragement of including value-added enterprises and diversification of farms and ranches (Barbieri et al., 2008), which can mean keeping young animals longer, finishing them on pasture and direct marketing to consumers, known as the grass-fed industry (Capper, 2012; StatsCan, 2016b). This is a step-away from the conventional cattle marketing process involving the use of feedlots to finish calves to market size but does speak to the increased pressure faced by ranchers to diversify their operations and offer a different product to consumers. The latter typically occurs at an increased price-point, which they are often able to set independently based on what the customer market is willing to pay for the added perceived benefits of grass-finished beef, such as increased nutrition of meat, better living conditions of animals, and fewer chemical inputs (Daley et al., 2010; Capper, 2012).

The acceptance of this new marketing strategy may indicate that the ranching community is beginning to move away from the strictly held social norms of agricultural production, and that producers are becoming more willing to accept shifts in their social community in return for increased profitability. Often, keeping calves on the farm longer requires a more intensive grazing management strategy, and/or a longer feeding period, and many therefore also move more towards intensive grazing systems, either fast rotation or adopting the HM system. While the national average age of farm operators in Canada is 55.3 years (StatsCan, 2016c), young operators (<35 years) are becoming more common, especially across the Prairies (StatsCan, 2016d). This younger demographic may be more willing to take on new challenges in ranching and try new ways of doing things, as they may have less of a historical background with the social norms in their area (Pradhananga et al., 2017). These trends of new and younger producers, paired with the increased pressures of managing the ranching capacity on small land holdings to remain profitable, could explain why there is indication of a decrease in the power of the long-held social norms of ranching, and a greater acceptance of changing social communities.

3.2.3 Social Stigma

Following closely in line with the idea of social norms regarding grazing practices, is the idea of social stigma. Social stigmatization, according to Miller and Sinclair (2012, p.484) refers to the 'actual or feared negative psychological experience'. The idea of stigma or labelling in grazing management, and how it may affect new and established ranchers has to our knowledge, not been applied to the question of HM or other intensive grazing systems adoption behaviour. Movement away from long-held traditional grazing methods (i.e., continuous) into more intensive and less commonly used practices has been slow to come in the grazing community. At the community scale, the reluctance to adopt intensive grazing practices are shown by the low rates of adoption, as presented by Diederen et al. (2003), social barriers to adoption in the theory of 'ingroup' and 'outgroup' status (Bernstein et al., 2010) and maintenance of social norms (Mackie et al., 2015). At the individual scale, reluctance in adoption of intensive forms of grazing management are exhibited in the potential for isolation from the local grazing community, which can be viewed as social stigmatization (Gregory and Satterfield, 2002).

Stigma is defined as, 'a mark of disgrace associated with a particular circumstance, quality, or person' (Oxford English Dictionary, 2017). Other communities, such as those impacted by forestry, mining and technological fields such as nuclear power, have dealt with social stigma issues (Gregory and Satterfield, 2002; Goldenberg et al., 2010; Parkins and Angell, 2011; Miller and Sinclair, 2012; Filteau, 2015; Genareo and Filteau, 2016). In those contexts, stigma is usually placed on incoming and transient workers, as sources of disease, social unrest, drug use and trafficking, violence, and many other forms of social disturbance (Goldenberg et al., 2010; Parkins and Angell, 2011; Filteau, 2015). These issues exist within agricultural settings as well. The organic farming community faced stigmatization early on and was a cause of social challenges for organic farmers (Lahdesmaki and Siltaoja, 2017). Likewise, producers of genetically modified (GM) foods continue to face scrutiny and deeply held social stigmas, though their use has been sustained now for many years and evidence has shown no adverse effects (Mather et al., 2012).

It is possible that there could be an aspect of stigma or label discrimination happening within grazing communities. The mere mention of the term Holistic Management can elicit a strong reaction (Sherren et al., 2012; Briske et al., 2013, Savory, 2013a; Briske et al., 2014). Many academics seem to prefer a more neutral label (i.e. not linked to Savory), such as Adaptive Multi-Paddock (AMP), High Intensity – Low Frequency (HILF), Management Intensive Grazing (MIG), Planned Grazing, etc., to describe a grazing system that is a version of HM grazing, but without the label (Donkor et al., 2001; De Bruijn and Bork, 2006; Teague et al., 2013). AMP grazing appears to be the naming convention most producers in the industry would apply to their style of grazing management, which is very similar to HM (Teague and Barnes, 2017), but does not require full commitment to all aspects of the HM model. This desire to rename HM may be because of the fear of a stigma associated with the term HM itself, or because the grazing systems being used are truly uniquely different from the HM model. Aversion to the use of HM terminology within the industry and in academic research, especially in North America, could be related to the somewhat abrasive approach and strongly worded comments and claims of Savory when promoting the idea of HM to the North American continent in the 1980's (Chiaviello, 2000; Hadley, 2000). His approach, along with variable results from producers who adopted the model, have resulted in long-term dichotomous associations with the label of HM (Sherren and Kent, 2017).

In relation to the earlier discussion on social norms, it becomes clearer to see why new approaches to grazing management may have been slow to be adopted (Diederen et al., 2003), and why they may be perceived as the fringe of the grazing community. It requires a great deal of courage to go against a widely held social norm and face stigmatization in the form of interpersonal and emotional disconnection from your community (Gregory and Satterfield, 2002) no matter what the perceived benefits may be. Nolan et al. (2008) learned that even general information regarding what others in your neighbourhood are doing can strongly influence what an individual will choose to do, so strong is our inherent desire to be perceived as 'normal'. To adopt an entirely new methodology for managing one's animals and land, completely different from what is socially accepted as normal in your area is quite rare, yet again, this ties in directly with the topic of independence, and the ability to make one's own decisions based on personal values and beliefs.

Through the empirical insights provided in the following section, I explore the issues of independence, social norms and stigma in the context of the ranching community in Alberta. I aim to identify how these factors directly or indirectly influence grazing management decisions and perspectives held by the group of producers in the project, with the intent of understanding how these factors affect the greater ranching community overall.

3.3 Research Methodology

While developing the research plan for this study, the initial considerations focused on how to gather information from a diverse group of beef producers across Alberta following an ethnographic form of research design (Mayan, 2009). The goal of the research was to gain an understanding of the ranching culture, and the divisions that exist within it, by interviewing producers from across the province in their own homes, where they could speak candidly and in confidence about their thoughts and experiences.

Ethnographic research is generally characterized within an anthropological context (Creswell, 2013), that is, research done with a specific group, over an extended period of time, usually a year or more (Knoblauch, 2005). This means that much data is collected from a large group of individuals, covering different events experienced by the group, and is then reported on. The body of work on ethnographic data collection done by Knoblauch (2005), Mayan (2009), and Creswell (2013), discuss in detail how ethnographic data collection is not one hard and fast methodological rule. Rather, there is much overlap between ethnographic data and the many various forms of qualitative research, and indeed, within ethnography itself, in particular, focused ethnography. Focused ethnography as described by Knoblauch (2005) deals with short-term, unique events, either one-on-one or in a group. In order to achieve the research objectives set out by this study, I decided that my approach was best suited to a hybrid of conventional and focused ethnography. As an overview, the categories of conventional ethnography I pulled from for this research include: solitary data collection and analysis, insider knowledge and subjective understanding; while the categories that come from focused ethnography include: short-term field visits, data and time intensity, recording, focused conversations, communicative activities, field-observer role, notes and transcripts and coding and sequential analysis (Knoblauch, 2005). To clarify, the intent of the research was not in seeking a truth from the observations, rather, to be cognisant of the different experiences of each rancher, and then seek to interpret those experiences within the context of this study.

3.3.1 Data Collection

To recruit participants to this study, I attended producer meetings and events around the province where I was able to address the crowd and give a small introductory speech about who I was and what I was hoping to achieve. I also contacted some participants through referral by friends and connections of my own within the farming and ranching industry in Alberta. All interested participants were provided with an information sheet describing the project and the specific activities of their potential involvement. A total of 45 ranches indicated interest in participating in the study, and each were followed up with a phone call to assess their suitability to participate. This research utilized a purposive sampling strategy because we were not able to give all members of the ranching community equal opportunity to participate (Etikan et al., 2016). This means that the sample of participants in the study was not intended to be a representative group of the entire ranching population in the province of Alberta.

There were three main selection criteria used to determine the final selection of ranches in the study, in part to suit the parallel field-based scientific research. Each ranch had to be located within Alberta and have their grazing lands within 100 km of their home location; each had to be grazing cattle and no other livestock; and, each ranch had to be under stable management for at least the previous five years. Of the initial 45 interested ranches, 29 met the research criteria and were selected for in-depth personal interviews. Twenty-nine individual operations were represented, and interviews were conducted with a total of 42 producers, as quite often, a spouse or other family members were present and added input to the discussion. All the interviews took place at the producers' homes and ranged in length from one to three hours. All the producers had cow/calf operations, while some also had feedlot, purebred, organic (certified and non-certified), direct-market, grass-finished and mixed operations (cultivation and cattle) on their ranch. Of note, three of the producers I met with were not the owners of the ranch, they were hired managers, and often did not have the final say on what the operation of the ranch would be. The number of animals ranged from 17 to over 1,300 pairs plus yearlings, and size of land-base ranged from one quarter section (160 ac) to over two townships in size (>46,000 ac). Interviewees whose views are expressed in this paper will be referred to in general, descriptive terms.

Over the course of the research period, one rancher chose to withdraw from the project, leaving a total of 28 participants. Depending on the age and family status of the producer, not all questions were appropriate or applicable (i.e., successional planning for managers who are not owners of the ranch), and in such cases were not asked, at the discretion of the researcher. Any additional information required was collected via phone or e-mail prior to the expiration date of the project ethics approval (July 31, 2018). All interviews were conducted in accordance with the University of Alberta's code of conduct in human ethics regarding producer participation and handling of interview materials under the Ethics Application Approval ID: Pro00073612_AME1.

The primary form of data collection for this research was through in-depth, personal interviews with ranchers throughout Alberta, which is consistent with the premise of focused ethnography (Knoblauch, 2005). As part of the research plan, I decided early on that a critical aspect of my success in this study was dependent on my being able to meet with producers either at their own home or at a location of their choosing. I felt it was important to show them through my actions (coming to their home) that their time and energy spent with me were very important, and I understood the significant adjustment to their day and planning I was having. I also wanted them to feel completely comfortable, to encourage an open conversation not modified by any external factors. To encourage them to speak in terms that they were familiar with, I was completely open about my own background in and knowledge of the beef sector in Alberta, so that they understood I was aware of the issues, topics and terms they were using, and felt no need to explain themselves. This approach was consistent with the insider knowledge component of conventional ethnography (Knoblauch, 2005).

Interviews followed a structured format, in that I did have a set of semi-structured interview questions. However, at no time did I interrupt or change the direction of the conversation, unless there was a natural break in the conversation which allowed me to do so without being obvious. The interviews were slightly different for conventional versus intensive graziers (see Appendix F for full interview guides), but both were organized around five main themes: grazing system, social perspectives, education and politics, environmental concerns, and family and lifestyle. The section on grazing systems was included to ensure that the previous information I had collected from the producer over the phone was consistent and correct, and to ensure my understanding of how they were managing their animals and land. Social perspectives discussed what producers thought about what they and others are doing, personal traits and financial concerns. Education and politics were discussed to determine the extent of post-secondary education influence on producers, as well as political beliefs. The environmental section asked producers what they thought and knew about the ecological capacity of their lands and how they valued them. And finally, the family and lifestyle section discussed topics such as successional plans for the ranch and work/life balance. The goal behind including this variety of topics was to ensure that all aspects that may be involved with the unique decision-making process for each producer were discussed.

3.3.2 Themes and Interpretation

The identification of thematic material and interpretation was done following the theories of ethnographic research and focused ethnography (Knoblauch, 2005; Creswell, 2013). Ethnographic interpretation is appropriate in this context because I have identified the ranching community of Alberta as a cultural group, with shared history, attitudes and patterns of behaviour (Creswell, 2013), and I present the data gathered through a presentation of the themes found within the group. Focused ethnography was also appropriate due to the short-term nature of the data collection, meeting with each participant only once, while generating a large amount of data during that time (Knoblauch, 2005). As discussed previously, ethnographic research is not one set of defined research characteristics, there is much overlap between types of ethnographies (Knoblauch, 2005; Mayan, 2009; Creswell, 2013).

Interview data were collected by note-taking during the interview but was primarily collected with a small recording device. Interviews were later transcribed by hand into word documents for each producer and were descriptively coded. Because of the diverse nature of the content of the interviews and the diversity amongst the group, the number of themes identified for coding was high, at 28. Some themes were very common among responses, such as family, money, time and communication. Others were only mentioned once or twice, like faith and gender. For the coding exercise, I reviewed the interview responses for each producer and each grazing cohort. While doing so, I was able to locate quotes which I felt represented and articulated most clearly the thoughts of each cohort, and these were what I used to develop the themes that follow. The intent of the following section is to illustrate both the similarities and the differences of producers in the ranching industry in Alberta, using their own words to help highlight these numerous points of view.

As discussed in the previous chapter, the participants were categorized into four distinct cohorts of producers: continuous grazers (CG), slow rotation grazers (SRG), fast rotation grazers (FRG), and holistic managers (HM). The interpretation presented was chosen to highlight what I believed to be the most contentious areas of grazing management, namely between conventional graziers (CG and SRG) and intensive graziers (FRG and HM), and are hoped to convey the most insight into the differences or similarities in perceptions from these cohorts. FRG are kept separate from HM. This was done to respect the individuality of the producers and respecting the specific terms they apply to themselves (Sherren and Kent, 2017). Only those graziers who identified themselves during the interview as HM were included in the HM group. Although one could argue that many of the FRG follow the same methodology as HM (Mann and Sherren, 2018), since they did not identify as such (in some cases, very clearly), it was decided that the best approach was to keep these two groups separate, based on the personal preference of the producer.

3.4 Findings

Through the process of speaking with 28 producers across the diverse landscapes they work in across the province, three themes common across the cohorts continued to come to my mind, while a fourth theme was less obvious. The first was that the independent nature and lifestyle provided by ranching in Alberta is critical to how producers see themselves and what they do. The ability to make their own decisions about grazing management based on their own experiences and knowledge was key to their feeling of independence. The second theme that recurred was that everyone truly believed in what they were doing, and that they were making the best choices they could. Of course, most did agree that there was more they could do and that if they could change things they would, but overall, a strong sense of pride in the operation and what they were achieving, and it was clear they believed that they were doing a good job. Community, and the social norms and capital, and even social stigma associated with community are also discussed as a sub-theme. The third theme was the common barriers to having the dream operation they desire experienced by most producers. Practically everyone I spoke to acknowledged they could do more on the ranch and expressed a desire to do better. The primary reasons stated by producers was the lack of time to employ new ideas, or the money to fund them, or even more likely, both. The amount of time and money it takes to run a ranch of any size cannot be overstated. For most, ranching truly is a lifestyle first and a money-making enterprise second.

These highly consistent themes among participants led me to believe that although there may be considerable differences in the style of grazing management producers adhere to, the ranching community overall, at an individual level, is very similar in many ways. Although I expected more overt divisiveness between groups of ranchers, these divisions were not observed in the data. This outcome provides hope that there may be more common ground between groups and systems of producers than one might initially imagine.

A fourth theme that I have included here involves the HM grazing community. The topic did not present as uniformly as the others during the interviews, and there was less consensus. Nevertheless, I felt that this topic was worth investigating more fully, to develop some of the unique viewpoints and aspects of social norms and stigma that indicate where some differences in ranching remain.

3.4.1 Theme one: Ranching is a lifestyle, but it helps that it pays the bills

Most ranchers would readily admit that there would have been easier ways to make a living. Ranching is a non-stop job, requiring full-time attention and effort. Their days are spent out on the land, mending or moving fence, checking cows and water, checking grass and feed, planning and preparing for winter and the other challenges that come with raising livestock. Across the board, the producers talked about the same things they loved about ranching, working for yourself, spending time outside, working with family, the independent nature of ranching. A slow rotation ranch manager (non-owner) said,

> "It's been perfect. I've never worked a 9 – 5 job. I enjoy being my own boss. Don't see any costs except I'm not getting rich. Far outweighs those costs".

Another slow rotation ranching woman from central Alberta had this to say,

> "We are out all day, 7 am to dinner at 10 or 11 at night. That's the life we want. I don't want to be in here canning, I'm not a farm wife, I'll do it once in 5 years and make a ton and begrudge the time I spent doing it. I hate to admit it, I have a housekeeper. I don't want to sweep up dog hair with my time. I'm outside all day long, check cows, check fence, have a big garden that I love. We are both happy".

These sentiments were echoed throughout my conversations with the various ranchers across the province. The strong ties felt to the land and animals was apparent, and the desire to stay on the ranch and continue was clear. The perspective of ranchers across the province seemed to consistently point to the idea that after the years of experience and observation, there was none other who knew better than they did about what was best for the land and animals, which ties in directly with the themes of independence and stewardship.

For many of the ranchers, there were other opportunities along the way that they could have pursued. Several went to college or other post-secondary institutions, but it seems that the draw of the independence of living and working on the ranch outweighed the perceived advantages of other careers. One of the slow rotation producers commented on his decision to stay working full-time on the ranch,

> “I don’t know if I ever really wanted to be an accountant, there are perks to that life too, but I like to be busy and I like what I’m doing”.

A continuous grazing producer had similar thoughts on the topic,

> “I didn’t really ever want to be an architect. It was interesting, but not when I found out I’d have to be away from the ranch for seven years. I like math and engineering, but I got that from SAIT in two years. You wouldn’t be in the coulee fixing fence with the bugs if you didn’t love it”.

On the topic of a career off the ranch, some express a sense of bewilderment,

> “Sometimes I wonder what it would be like to have a job you could leave at the end of the day. It’s yard work and house and cows and water and feeding, all the things needing (to be) done all the time”.

Of course, it does help when doing what you love also pays the bills. Having the farm or ranch reach a sustainable level takes time and effort, and producers don’t always come out ahead. There is a lot of instability in ranching, the markets can fluctuate such that a calf you might have gotten $1.10/lb. for one month can be worth $0.90/lb. the next. Weather and growing conditions are highly variable year to year. But by and large, these are aspects of ranching that producers understand as part of the package, you have to learn from bad years and make changes to survive. Often profitability is far down the list compared to doing what you love with the people you love,

> “Oh yeah. Yeah, we get to be home. There are times we work crazy hours, but our kids are always with us, it’s such a cool way of living. It’s an awesome way to be. It’s very important. It’s the life we choose. I mean, we aren’t rich, we don’t have lots of disposable income, but we get to live here, be our own bosses, have our kids with us, which is also a challenge but it’s the life we want” (central Alberta couple, slow rotation).

One HM producer with young kids echoed her thoughts,

> “We’re not quite there yet, balancing work and family life. We know where we want to be, but we aren’t there yet. It’s the lifestyle you cherish, or you’d be crazy to do this. Nothing in life is easy, always a struggle, but (it’s) what we do have out here. I get to work with nature which is important to me, bigger than myself, my children

can spend the day with me. I really valued my childhood out here, so it's really important for me to have my children have the same".

Passing on the independent nature and lifestyle of ranching to young kids and developing in them the desire to be on the land and share that value system was a common component in the rancher's thoughts on their lives. The financial benefits of working for yourself were secondary to this desire.

3.4.2 Theme two: Making the right choice

One of the initial purposes of the interview process with the ranchers was to glean from them whether or not social norms had a major influence on their decision-making process. For this section, I will not be using the term 'stigma', as I found quickly through questioning that it was too strong of a term, and not one that producers would agree with. Instead, I asked them if they had ever not done something on the ranch because they were concerned what others in their community might think about it, and/or if they felt like an outsider in their community for the way they manage their grazing.

The strong commonality among producers from all cohorts of grazing management was the assertion that it didn't matter to them what other people thought about what they are doing. The producers I met with were strongly convicted about their independence and belief in what they were doing, and that outside pressures didn't matter to them. A fast rotation producer from central Alberta spoke at length about this topic when asked about it,

"Not that I can think of. No, I mean, it's funny, we have coffee and stuff, people think they know what we do. Nowadays, I have contacts all over, western Canada and beyond, likeminded people, kindred spirits. I'm connected to the neighbours, know them all, good people, related to most. There's a good community here that are likeminded. You surround yourself with those. Keep your mouth shut at conventional events. Doesn't influence you though, what the neighbours do. Happy to show the farm to others who are interested too. But it's a big decision, takes time, there's family things to work through always before you can adopt a new system. The other thing is, it's a small town too. I think it would be different if we were out telling everyone what we were doing and how great it is, but I'm not in the business of telling everybody we're right and they're wrong. You've got to be pretty careful not to be 'Our way or the highway'. What works here is different than what works for most of our neighbours. We are the only people in 20 miles that aren't a mixed farm, grain and cattle".

It's very interesting to see how this producer identifies with both his local community of "likeminded" people, as well as a broader community outside of the local area which he also identifies as "likeminded", essentially creating for himself and his family two different sets of ingroups to belong to and be accepted by (Bernstein et al., 2010), and meeting the characteristics of *fit* and *accessibility* as described by Voci (2006). The *fit* in this case would be that the ideals this producer adheres to are matched by those in his cohorts of 'likeminded' people, and *accessibility* is determined by the current motives, values, goals and needs of the perceiver, in this case, the producer (Voci, 2006). This mentality and openness to developing social ties outside of the immediate area could be significant in aiding this producer to down-play the impact that reduced ties with the local community could have.

An interesting distinction, however, was within the HM grazing cohort. All were quick to acknowledge their staunch belief in what they were doing, as well as many also acknowledged being seen by their neighbours as odd or unusual, some were even proud of this distinction. A few examples:

> "Oh no, I'm the nieghbourhood lunatic anyway, so no" (HM producer).
>
> "No, the neighbours think we are weirdos, only ones with electric fence, HM especially. Could care less what they think when it comes to grazing or planning" (HM couple).
>
> "They think we're crazy, oh yeah. But there's reasons we do it, and it outweighs the time. Doesn't bother us" (HM producer).

Although these producers don't know each other, and certainly did not know who was participating in the study, we can see how they have in a way created their own social identity as the outsiders, much like in the work done by Miller and Sinclair (2012). One HM producer spoke in detail about his thoughts on the changes in farming and ranching, and doing something different,

> "Nope I do everything by the fence, so they can see what I'm doing is unusual. I thank a lot of the early guys for stepping out from the norm. Dad really felt it, me not so much, being a kid. People actually respect it, but it's hard for people to change. But change comes slow. I think as individuals, and society, we have to change fast".

One question I specifically asked to both fast rotation and HM producers was if they thought of themselves as outsiders in their community. An interesting theme that came out of this was that for some, it didn't matter what they were doing, the biggest reason they were outsiders was because they weren't from their community,

> "Maybe I shouldn't say this, when you live in (name of town removed by author), if you didn't grow up here, you're an outsider. Doesn't matter how long you've been here. It doesn't matter. If I was farming just like they are, it wouldn't matter, I didn't go to school with them. Everyone we are friends with in the community is also not from here, even now" (HM producer).
>
> "I'm not from here, not worried about old friends or social stigma. People ask questions, but it hasn't stopped us from doing anything. We are aware of the perceptions, but more time and money, that is the indicator. It's good to be tight with some of the locals too, some of our cropping neighbours have gone more (towards) land health thinking too, so there's support here too" (HM producer).

This sentiment was echoed by other grazing cohorts as well. One slow rotation producer, who is not the owner of the ranch, but the long-term manager, spoke about her experience as a non-local,

> "I'm active and accepted in the community, always an outsider, since I wasn't born here. But I try and be involved and be a good member of the community. I've learned to shut up, since you don't know who's related or married (laughs). Felt depressed a lot in the beginning, it was hard being a woman and alone, new in the area. But now I have friends here. So I do have support from locals and the owners (of the ranch)".

One of the HM producing families I spoke with had gone so far as to write a poem about their experience practicing an alternative style of grazing management,

> "Breed your cows right, you'll sleep through the night. Graze through the snow, and you'll roll in the dough. Your neighbours will laugh and not understand, but you'll know you're right when you own their land".

All these examples convey the real conviction producers feel about how and what they are doing with their grazing, regardless of the acknowledged social stigma they face. Perhaps this is an indicator of a change in the established norms of ranching, which can occasionally occur, according to Durlauf and Blume (2007), or it could indicate an increased comfort in being different because of doing what they believe in, regardless of the social norm.

My final point on the theme of belief in what they are doing comes from pasture health. It was extremely interesting to hear producers from every cohort tell me about the health of their pastures. The majority felt that they had healthier pastures than their neighbours, based on personal observation (i.e., over the fence). This was consistent for producers across the study area and speaks to the personal belief they have in their operations, regardless of whether or not they are following the accepted social norms of ranching, namely, conventional grazing systems. An interpretation of this commonality could be that, in this case, the grass is not greener on the other side, as far as these producers are concerned, it is greener on their side. Of course, within each group there were those whose opinions were less certain, but overall the finding was consistent. The following are examples from each grazing cohort, answering whether they think of the health of their pastures was better than their neighbours:

> Continuous: "Yep, probably. Above average. It's the stocking rates and the way we are managing" (meaning by maintaining conservative stocking rates on CG pastures).
>
> Slow rotation: "Yeah I do, not that I've done range assessments or anything, but from the road and seeing how they graze their cows, yeah I think we do. I think we are mostly in a healthy state".
>
> Fast rotation: "Yes, 100%. Night and day. Carrying capacity, the whole thing, 100% sure".
>
> HM: "Absolutely. See our pastures, we get 3, 4 or 5 times the growth. It makes sense, more grass catches more rain and more sun, we get more growth".

What is important to note here at the end of this segment, is the high level of agreement between each of the grazing cohorts. Those who are conventional in nature and those who are intensive, all believe whole-heartedly in the health and productivity of their ranches. The point here being the incredible similarity between these otherwise obviously different factions, and again, ties in with the importance of independence in decision-making that they all adhere to.

3.4.3 Theme three: Time and money – The universal challenge

During the discussions with producers, we talked in detail about the challenges they faced in ranching. The overwhelming commonality among them was time and money. Time to complete the chores that needed to be done daily, as well as the ongoing improvements and changes they want to implement on the ranch, and money, the financial ability to pursue these improvements and changes (Didier and Brunson, 2004).

There are many services and programs available to the agricultural community to assist in funding new projects and developments on farm. Two main sources are the Canadian Agricultural Partnership (CAP, 2018) (formerly GrowingForward2), and working with other non-governmental organizations such as Ducks Unlimited Canada. Although these services and programs are available, their use on ranch is limited. The time and detail required by some applications can be daunting for producers who prioritize work outside over work on the computer. Almost all the producers I spoke with articulated the need to improve aspects of the ranch, and even knowledge of programs aimed to help them do so. The common barrier to acting on these ideas was always the same, time to do the work, or the money to implement. This is consistent with the work done by Greiner and Gregg (2011) in Northern Australia, who also found that across the regions of their study, capital and labour were the top two impediments to adoption of conservation practices.

Ranches are, at a basic level, a business. They generate income through the production of beef as live animals, which are sold mostly seasonally, with some variation. Almost all the producers agree with this statement, and also that the ranch had to make money to be sustainable for them, and for the next generation. The priority is to make the ranch as profitable, and sustainable as possible. One continuous grazier in southern Alberta had this to say,

> "Goal is to make money. I don't really have goals, want to be able to continue in the future, keep it healthy, work with the conservation groups, but not increasing herd size or anything".

We can contrast this statement with one from an HM producer, to highlight the differences between the groups, despite a similar ethic,

> "Yep, goal setting is something we need to visit more often, but we do. Production is daily, long term we talk about once a month. We talk together about these goals often. Try to defer pastures if we can, have one we try to defer because it's not easy to get to. Like to defer grazing when possible".

This contrast is not made to suggest that only fast rotation or HM producers talk about and set goals. That is certainly not the case. Most ranchers, regardless of grazing system did present at least some form of goal setting and recognized the value in talking about and making goals. The point is to highlight the variation that can exist between these groups in how they structure their thinking.

An interesting sub-theme that arose out of these conversations was the indicator that although profitability was the primary goal, money wasn't always the only consideration when producers were making decisions on the ranch,

> "What is success? Not only profit. Based on three things, land, money, people. Can't always make decisions on money alone, applies to life too. Ranching is just financially based. It's been so hard to make a living, it's a cultural issue about food prices. Absolutely money is important, and making money is important, but direct market is where we profit. Also we cut out a bunch of middle men, but it's a lot more work, delivery, marketing, emails, it's not for everyone, but as farmers we got to stop being victims and stand up for ourselves, create your own thing. Profitability is important, so is educating the client" (HM producer).

Although profitability is a driving factor, most producers choose a practical approach to ranch management, balancing what they want to do with what they need to do. The pervasiveness of economics in ranching is notable. A very typical response to the question of why producers don't make more use of economic programs put out by the government or the other programs available to producers to participate in was given by one slow rotation rancher in central Alberta. She said,

> "We don't. We keep kicking ourselves that we don't. There's just not enough time in the day to do it. I hate to say it. No EFP (environmental farm plan), no verified beef, nothing. We could have got in with McDonald's (verified beef program), but we just don't. I don't know if it's the age thing, but there just isn't enough time in the day. We'd like to save money where we can, but for me to justify, and (name removed by author), sitting in here on the computer doing that stuff, I can't justify that time. Computers don't give me grief, but I'm just not prepared to give up everything else I do in order to do that. I'd much rather go to meetings or courses than spend that time in the office. Time is extremely valuable. Maybe we don't need these things that bad. Just because it's there doesn't mean you need it".

I followed up this thought with her by asking if financial constraints ever kept them from doing the things they wanted to on the ranch. Her response,

> "No, if we need something, or want to make something better on the ranch, we do it. We have what we want. We would spend money to save time, like on the drone. (Name removed by author) likes to take the most oldest things and keep them running. It's a challenge to him. To get new equipment, no way. A lot of fixing happens here, but we have the time and are always breaking things and building things".

We can see how even though they are aware of the financial or production programs in place that could help with some of the costs associated with running the ranch and making improvements, their choice was reliably to not do so. This theme was consistent among ranchers from each cohort. Time and money are what drive their decision-making process, but they don't necessarily prioritize the time needed to help with the money aspect. One middle-aged continuous grazier from the northern edge of the study area had this to say about economics on the ranch. From my perspective, this simple statement sums up this theme, and draws an interesting parallel between the 'grass farmer' discourse known in HM and intensive grazing systems, and those practicing continuous grazing, as having very similar values,

> "I came from nothing, had to fight and claw, things have to add up. I will sit down and do plan A, B, and C. Usually end up on plan B or C. More practical stuff. Everything has to work. So much comes back to the financial, but that all comes back to the grass. Was a long time to learn that, to manage grass. That's the basis of everything I do".

3.4.4 Theme four: Holistic management as a grazing system

When first going out to meet with the producers, I was anticipating hearing negative comments about HM grazing based on some of the literature available (Chiaviello, 2000; Hadley, 2000; Sherren et al., 2012; Briske et al., 2013, Savory, 2013a; Briske et al., 2014). I was surprised to find this was not the case. While most producers had heard of HM as a grazing method, they generally expressed little interest in learning more about it or had heard stories of those who'd tried the system and had it not work out well. A continuous grazier made these comments about the system and costs involved,

> "I don't know much about it. I've seen it attempted here, I've never seen it work well in the area. Not sure it would work well on the sand. No I've never tried it. I

> tried moving the cows more often but didn't see the benefit. Maybe my eye wasn't good enough then. Might look at it different now, my perception of the grass is better now than it used to be. Infrastructure, huge water, fence. I would like to be able to get more (production), but it's intensive, you might as well milk cows. For me, I don't have the manpower for that kind of an operation".

The pattern among responses regarding why they wouldn't be interested in adopting an intensive or HM system on their ranch was commonly along the line of resources. While some expressed interest in adopting a more intensive grazing system, as previously discussed in theme three, time and money are at the forefront of many management decisions and implementing an intensive grazing system requires a lot of up-front costs both in labour and funding. A slow rotation producer who was interested in HM had this to say about the barriers to adopting the system,

> "I think it works good, looks good. Yes I would be interested in it, want to work towards it. (The) limiting factor is labour, we have a lot of land. We hired a new guy this spring, that's helped, he does a lot of fencing and such for us. I'm totally for doing some of those things, its just getting it practical. I don't see us ever getting to the move every day point, but moving once a week would be good. Time and resources are the biggest factors. Terrain is a challenge too, we have lots of hills. Water is an issue too. We are pretty spread out. Ideally, I'd like to run 600 pairs in a bunch, but getting there is the challenge. We're running multiple herds all over right now".

While some producers were interested in adopting more intensive grazing systems, two of the producers I met with had formerly been managing their ranches holistically, and had moved away from the practice, for different reasons. The first was because after several years of using the standard wagon-wheel pasture system, they were in fear of losing the ranch, had caused significant damage to the grass and watering areas, and had no grass left to feed their cows even with intensive rotation at high stocking rates. I asked them specifically about the choice to return to a more extensive grazing system,

> "20 years ago, maybe 30, we had a Savory grazing system set up, but it wasn't put up properly, it didn't take any of the natural contours in mind. So we did that for about six years then had to rip it all out. Because of the contour of the ridge here. They (the Savory grazing method team) just put a centre down in the middle of each section, and then did the pinwheel, the trails coming down to the water were

deep, eroded. Took that all out, because that wasn't working, opened it up. It was causing a lot of damage. (Savory would say) if it doesn't work, you're doing it wrong. What we were doing wrong was, nobody took into account the slope and the terrain at all. Were moving faster at a higher stocking rate, still causing damage. We just about went broke. Pulled it out early 90's and moved back to a slow rotation system".

The second ranch which moved away from the HM model did so because he didn't feel that he was doing enough 'holistically' on the ranch to call himself such (e.g. crop agriculture). Here he explains why he felt they were not a 'holistic' farm,

> "You know, with all the 'rules', we sorta followed the rules, but not all. I wouldn't say we totally adopted the system. Our biggest thing back then was doing the grain, and we had machinery, and that worked for us, so that's why we kept on with it".

This statement echoes one found in the research presented by Mann and Sherren (2018, p.1860), 'Others set a more stringent threshold for adoption because holism is such a central concept to adaptive grazing; in other words, being 'partially holistic' is not an option'.

Having a strict definition of what is holistic management and what is not has had a major impact on the acceptance of HM as a grazing system in Alberta and may be a factor in why some fast rotation producers don't identify with the HM model. The guidelines and stocking rate recommendations put out by Savory (1999) have no doubt influenced this perspective among graziers. An HM couple had this to say about the impact of Allan Savory in Alberta,

> "Some claims about how you can increase stocking rate, carrying capacity, when others are destocking. I filter that stuff a bit. I'm still skeptical of some claims. There's claims made about HM, or grazing management that are hard for me to believe. How you can increase carrying capacity when others are forced to destock. I don't think I could do that. I'd like to see somebody do that under the conditions we've had here. When Savory brought it here, he was very aggressive and very offensive with people. He pissed people off. He tried to change people. He was a speaker at a Red Deer, (Alberta) talk about stock density, and (how you) don't see any improvement from animals until (you hit) 80,000 lb/ac. Savory didn't like to be challenged. I think there's been a lot of HM people, educators, that have

> spent a lot of effort in damage control of Savory. HM has evolved to be something quite different than what Savory talked about in his first book. The biggest impediment to people's operations are people issues, and Savory doesn't talk about that".

The points this producer make lead me to believe that there could be some stigma associated with the term HM, which may be directly related to past actions of Savory, similar to the comments of Chiaviello (2000), and Hadley (2000). The producer comments about damage control and people issues are very relevant to how the system is perceived in the grazing community, possibly as an 'outgroup' of grazing (Bernstein et al., 2010) and it is interesting to hear from an HM producer skepticism of what the method is capable of achieving.

Contrast those thoughts with the sentiments of an HM producer who notes the need for community ties and cooperation while using an HM system (Liffman et al., 2000), which is not common in his area, but talks about the future with hope and a realistic attitude of what is achievable. His could be some of the best statements about HM, the positive aspects of the system, and the possibility of creating and maintaining new social norms even in a diverse landscape,

> "(The) reality is we need each other (our neighbours) and to be able to work together. As a smaller farmer, community and working together is needed to be successful. (We) have a good community here. Kind of developing a group of like-minded producers, holistic farmers. Takes time to get it built, we are still developing it. It does take time, it does take money, but its not something you have to do overnight".

3.5 Discussion

3.5.1 Commonalities in ranching

From the themes presented in the previous sections, there came out a few other topics of similarities among ranchers that are in need of further discussion. The first to address is the topic of ranch economics, and the impact that has on the ranch managers and their decision making. In the context of this research, I described how ranch economics, although not the final deciding factor for most producers, was certainly a focal point among all the ranchers, and ranch viability was a common focus. Much work has been done on the economic impact, family considerations (e.g. off-farm employment) and choices in livestock production on ranching decision-making, not just in Canada, but around the world (Liffmann et al., 2000; Rowe et al., 2001; Didier and Brunson, 2004; Kim et al., 2005; Kabii and Horwitz, 2006; Greiner and Gregg, 2011; Henderson et al., 2014). Decisions to change, modify or adopt new systems on the ranch are in many cases, dependent on the perceived economic benefit to the operation (Josephson, 1993; Didier and Brunson, 2004), as well as being dependent on the characteristics of the ranch at the time (Diederen et al., 2003; Didier and Brunson, 2004). An ambivalent attitude towards various incentive programs aimed towards helping ranchers with the financial burdens of improvements was common among the grazing cohorts, but was not unanimous, some producers made significant efforts into applying for and working with these programs, though they were among the minority.

In the theme discussing the belief in the current system of management, a very interesting pattern was the agreement among ranchers that their pastures were, by and large, healthier than those of their neighbours, because of the way they managed their grazing. This was such an interesting concept, and unfortunately, because this was not a paired design, I did not have any data to prove whether or not they are correct in their assumptions, but what was interesting was finding that the perceptions were so similar. Not all the responses were clear cut, and in fact, the language used to describe their pastures is something to consider as well. Responses ranged from what I would describe as a firm yes, my pastures are healthier, to a moderate, yes I believe they are, to even more moderate, those who claimed not to know, perhaps out of politeness, or respect for their neighbours. These differences in response are difficult to interpret without language training, but certainly they indicate that within the range of positive answers, and ambivalent ones, there are permutations that exist which may indicate varying levels of confidence in their responses.

3.5.2 An evolving social norm?

While the traditional aspects of ranching still hold true and are a fundamental aspect of the practice of ranching in Alberta, the discussions that I had with these producers lead me to believe that the social norms of ranching are in fact shifting, or at least being molded into new norms that recognize a more diverse ranching community. The effect of cooperation and coordination norms among ranchers remains strong (Mackie et al., 2015), and aspects of social norms are part of the shared rules of conduct within the ranching community (Farrow et al., 2017).

Based on the wide variety of grazing systems used by ranchers across the province, I had expected to observe that those in the conventional grazing cohort would be more strongly tied to the norms of independence (in the ability to make one’s own decisions) and interdependence (in needing to cooperate as a community) than their intensive grazier counterparts. I found this not to be so. Intensive and even holistic managers participate in many of the same social norms (independent decision making and cooperation) as conventional graziers. These findings may indicate an evolution in the social norms of ranching, which is consistent with findings presented by Durlauf and Blume (2007). The possibility of a shift of the social norms of ranching away from the conventional and long-held systems of grazing management and towards a new set of norms is a positive one. If ranchers from different cohorts are able to work together in the spirit of cooperation and coordination or work independently without fear of stigmatization or social isolation then that can be seen as a progressive shift away from long-held social norms. The findings presented above indicate that this shift may indeed be happening in Alberta, potentially leading to a more diverse and less divisive ranching community (Durlauf and Blume, 2007; Chenard and Parkins, 2010).

The discussions I had with producers on the idea of the influence of social norms on their management showed a strong response in the negative, that is, that producers from all grazing cohorts indicated that they did not make management decisions based on what they thought their neighbours may think about it. This can be a difficult question to ask of a person and expect an honest answer, as the previously stated independent nature of ranching would indicate that most ranchers would not admit to social influence on their decision making. Therefore, I do have to consider how much social influence was under-reported, as is commonly known to occur based on the work by Farrow et al. (2017), which shows that people underestimate the impact social norms have on their own behaviour. Unfortunately, this study was not set up to specifically address this issue, so I can only use the evidence I collected, and cannot speculate on the rest. Overwhelmingly, the response from all sides was in agreement that concerns for their neighbours' thoughts did not impact their decision making, and as I felt that our conversations were candid and honest, I must present the evidence in that tone. This was an interesting counter-point to a recent paper by Mann and Sherren (2018), which describes the findings of interviews with intensive grazing trainers. Their research indicated that the top reason trainers associated with non-adoption of intensive grazing practices were social/community pressure above all other possibilities. The trainers they worked with for the project were from throughout North America, and so we can expect to see some differences, yet it does bring to the forefront the real possibility that within Alberta, some of these social norms could be evolving. It would be interesting to know what trainers local to Alberta would say about this topic, and thereby assess if this trend was equally strong here.

3.6 Conclusion

At the outset of beginning this research study, I thought that I would find some striking differences between the producers using the various systems of grazing management. It was my expectation that I would discover reproducible differences between them that were more significant than the similarities. After discussing and reviewing the data, it was surprising to find my results point to the opposite, that in fact, the feelings and motivations behind individual grazing production systems are by far more similar than is suggested in the current literature.

These findings are very important to the understanding of the ranching industry in Alberta and should be capitalized on in future policy development and implementation. However, it bears repeating that the sample of producers in the study was not developed as a representative sample of the ranching community of Alberta, and therefore should not be interpreted as such. If we can lean on these findings, that producers believe in what they are doing, are working towards similar goals of improvement, profitability and time management, and basically all feel the same constraints of having enough time and financial stability to do what is needed as well as what they want to do, there is great potential here to develop new programs that speak more directly to ranchers and acknowledges the challenges they face. These findings could be used by many different groups. For example, within the government context, the learning that many producers feel that online applications are too complex and take too much time away from the daily activities of ranching life, could respond by modifying and simplifying financial application processes to be less time-consuming and cumbersome. Non-government organizations could, with this increased understanding of the strong traditional and social ties many feel to their land, animals, and stewardship, develop more interconnected approaches to conservation plans working with the larger community to acknowledge these ties, rather than targeting individual producers. The food industry at both the slaughter and consumer stage, using these findings could do more to recognize the differences in the animals brought to them for sale. If they have been grass-finished, organically, or holistically raised, provide a premium for those animals and meat products, to acknowledge the additional time and resources that went in to raising those animals.

While the interviews I had with producers were thorough, in an effort to respect their time, we were not always able to go into as much detail on some topics as would be desired, including education and politics, and the environmental aspects of their management. Another interesting pattern I observed from producers that would be worth investigating further is the differences (real or perceived) between owner/managers and non-owner/managers. During my conversations with producers, this distinction came up repeatedly among owner/mangers, although my discussions with non-owner/managers did not indicate any such significant differences. Building on the interview data available, a future research opportunity would be to investigate the language differences between grazing cohorts. As discussed above, there were telling differences in the style of answers given, to many questions, and there is a great deal of further learning that could be made from looking into these differences more deeply. These are just some suggestions for topics that could be further developed and investigated by future researchers, to try and understand better how these issues relate to the management practices of Alberta ranchers.

Ranching is really a dichotomy, a highly independent venture, full of self-determination and independent decision-making, while at the same time, the interdependent traditions and lifestyle are important socially to producers. We must recognize these two important factors at play in determining how ranching activities are done in Alberta, if we are to address the ranching community as a whole and recognize the individuality of producers in their thoughts and actions, as well as the inherent commonality among them. The research I have presented on the topic of grazing management systems and the unique decision-making processes behind them, clearly indicates that there is no one common factor determining why different systems of grazing management are adopted or maintained. Producer characteristics including (but not limited to) age and size of ranch play a part in these decisions. In some cases, what has worked before continues to work today. In other cases, new approaches and innovations are adopted out of necessity, a desire to do something different, or a fresh start allows for new ideas. What remains consistent among them all, is the importance of the independence they have to make those decisions, regardless of what they are.

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Chapter 4. Synthesis

At the outset of this research project, we identified two key objectives that we hoped to achieve through our work. The first was to gain an understanding if there was a difference between grazing systems and range health scores, and identify influencing factors of these health scores. The second was to identify and understand the social factors of ranching that influence grazing management choices and investigate if there were differences in perspectives between producers using different grazing systems. We believe that we have made some very important discoveries about these topics which are relevant to the body of work on these subject areas.

In Chapter 2, we set the objective of understanding if grazing system has an impact on the range health scores of a ranch. We have learned that in general, there are no significant difference between ranches across Alberta, based on their grazing system alone. This is a key revelation, as much research has gone in to proving and disproving the impacts to landscape health of one system over another. However, as the sample of producers used for this study is not considered representative of the population of the ranching community, we cannot extrapolate to policy recommendations with the data gathered. Within the context of our research, we were able to determine that range health scores were influenced more by aridity levels (AHM) and the current years percent forage utilization than either stocking rate or grazing system. These are new contributions to the scientific realm we are able to contribute to the body of knowledge on range health, based on our findings.

Some limitations to the conclusions we can draw based on the research conducted are whether this same methodology would yield the same results in other landscapes. Our research was done in the northern ranges of the Norther Great Plains. We cannot say for certain if others would find the same results if they were to conduct this same research in more mesic areas, especially since we noticed the trend that mesic sites (forested habitats) had higher range health scores than more arid sites (tame pastures and native grasslands). Perhaps an observable difference between grazing systems would become apparent under different climatic conditions. This would be an area of study that could be pursued based on these findings.

Additional limitations of the range health scores component of our research was the small sample size of both fast rotation graziers, holistic managers and continuous graziers. The low numbers of participants in these categories limited the statistical analysis we were capable of completing with our data. This is further complicated by the fact that many producers used more than one system of grazing management on their ranch, on different pastures, which resulted in comparatively few holistic and fast rotation pastures that were assessed, and we therefore had to combine those data points into one category for analysis. Ideally, one would be able to select an even number of participants from each grazing category so that there could be a more balanced experimental design. This would also apply to the grazing systems used on the pastures for assessment within each ranch, attaining equal numbers from each system would lead to a more robust dataset and therefore a better understanding of grazing system impacts on range health scores.

In Chapter 3, we set the objective of identifying the social factors involved in the use of different grazing systems and investigating any differences between groups of producers and their perceptions of grazing management. It was expected that there would be significant differences between the perspectives and mindsets of the producers from the four identified grazing cohorts. What we found instead, was that there were far more perspectives and mindsets in common between the producers from these grazing systems than differences. As stated above, the purposive sampling method used to acquire the ranching participants was not developed to be representative of the ranching population. For this reason, we cannot conclude that the data collected is appropriate for policy development, but instead lays a foundation of results on which to build more comprehensive studies exploring this area of enquiry.

Four themes arose from the conversations with producers. The first theme that was congruent among them all was that while lifestyle was a primary reason for pursuing the business of ranching, it was also imperative that the ranch was sustainable from an economic point of view. The second common theme was that all the producers were doing what they truly thought was the best for their ranch, land and animals. The third theme identified was that at the end of the day, everyone was motivated primarily by two main drivers, time and money. The fourth theme addressed the topic of holistic grazing and discussed what producers from the different cohorts thought about the system. The similarities identified between the four cohorts were a surprising outcome, revealing that although there was a wide variety of grazing systems at use between them, their basic concerns were highly comparable. These new understandings of rancher mindsets add a great deal of information to the body of knowledge available on ranching sociology.

One of the limitations we identified to this study was that although the interviews were very detailed and long, in some cases over two-hours, we would have been better served by having a more focused set of interview questions. As the questionnaires were being developed, we felt that the topics discussed would add much breadth to the interviews, and therefore increase our understanding of the producer's perspectives. What this broad aspect of questions accomplished though in actuality was less focus on the issues that we would come to want to focus on for the purpose of the study. Of course, it is inherently difficult to know at the beginning of a research project which topics will become the important ones. In the future, it could be recommended that for interview-based research, introducing a shorter, and more focused set of interview questions, while allowing for more free-speech interactions with participants would likely reduce the amount of extraneous interview data.

While 28 interviews are in many cases of qualitative research considered a robust dataset, given that the ranching community in Alberta numbers in the thousands, we must still assume that more participants would have resulted in a higher level of accuracy and confidence in the data collected. Future researchers would be well served to involve a greater number of participants for this reason.

These two studies come together in an interesting way. Because of the mixed-methods used for the two main chapters, one quantitative and one qualitative in nature, it would seem that there is little overlap. However, after reviewing the data, we find that both of these studies indicate the same overarching result. We asked if range health scores would be different between ranch lands exposed to different grazing systems, and we found this not to be the case. We also asked if producers using different grazing systems would have different perspectives and values, and we once again found this to not be the case. This is a striking parallel and indicates that the grazing system used on a ranch predicts neither the range health of the land, nor the perspectives and values of the producer.

Overall, what we have learned from this research has added much to the existing knowledge available on grazing management, in both the range health and social aspects of grazing management. The range health aspect of grazing management has been well established over the years as was discussed above, while the social side of grazing is only now beginning to grow and develop. We have developed two significant contributions to the body of literature and will be publishing both results in various journals, to share these findings with others. There are many opportunities to further develop these new understandings and continue to grow both the range health and social aspects of grazing management in the future.

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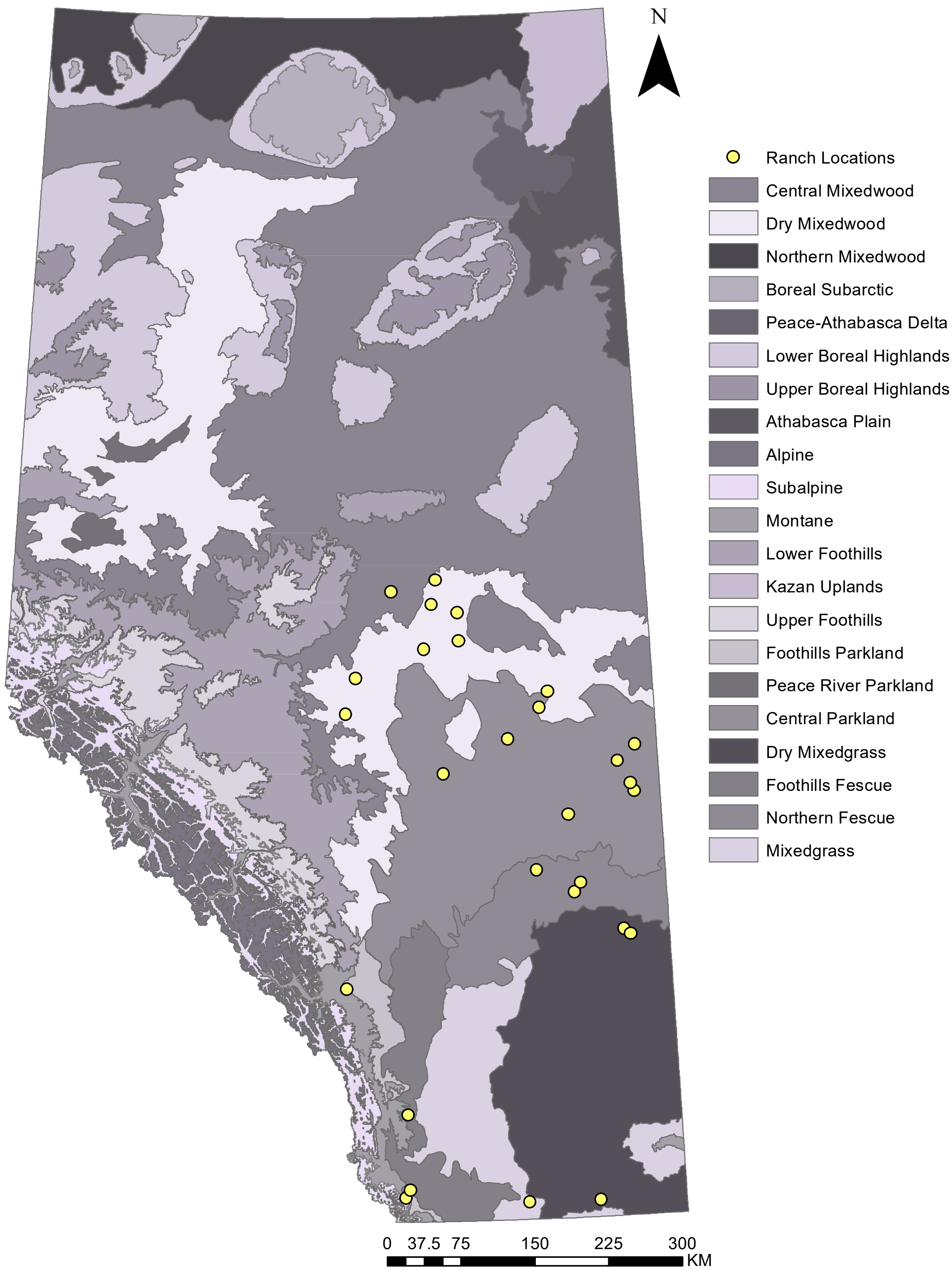
APPENDIX A. Map of Natural Subregions of Alberta and Ranch Locations



Source: Government of Alberta, 2005

APPENDIX B – Information Sheet and Consent Form

Identifying different perspectives on beef producer grazing management systems

Background
We are seeking to understand the differences in practices and perspectives of grazing management systems in the Alberta prairies. Specifically, we are interested in what are the different perspectives, motivations and outcomes between Holistic Management (HM) grazers and other rotational grazers. You have been invited to participate in a graduate studies research project because of your knowledge and experience on the subject.

Purpose
This study can contribute to an understanding of how and why livestock producers have adopted or not the HM grazing system. It will also look into if the differences in lifestyle, economics, personal motivation and biophysical benefits are accurately represented by the HM grazing community. Both HM producers and non-HM producers will be included in the study for a complete view of the grazing community. The research will clarify these differences, and could be used to influence provincial or federal recommendations for agricultural Best Management Practices (BMPs) in grazing management.

Benefits and Risks
Participants can potentially benefit from sharing personal views, perceptions, and experiences regarding the grazing management system they practice. It is an opportunity to participate in research that can contribute to understanding how and why grazing management decisions are made and the outcomes of those decisions. We do not foresee any risks associated with participating in this study.

Study Procedures
You are invited to participate in a short telephone interview about your perspective, experiences, and practice of grazing management. If you decide to participate, the interview will take place over the phone, at a time that is convenient for you, and will last approximately 15 to 20 minutes. With your permission, the interview will be audio recorded to ensure accuracy and to type up a transcript for analyzing the data. The recording and transcription will be stored on a secured server at the university and the transcribed interviews with have your name and any other identifying information removed. For this phase of the project, we will be looking at high level ranch organization, grazing practices, personal motivations and perceived outcomes from each system of grazing management. This short phone interview may be followed up with an in-depth, in person interview if the participant is agreeable.

Confidentiality
Data collected will be safely stored in the university secured network to protect confidentiality. Only the researchers listed below will see the transcripts in full. All the interview transcripts will have your name, along with any other identifying information removed. Direct anonymous quotes and information will be used in a graduate student thesis, academic publications, and presentations. If you would like to view any of these, you may do so upon request.

Freedom to Withdraw
Your participation is voluntary, and you are not obliged to answer any questions that you are not comfortable with answering. You may withdraw your participation during the interview anytime. You may also withdraw the content of the interview within three months of the interview date. If you choose to withdraw from the research project, any information you have contributed will be destroyed at your request.

Additional Contacts

If at any moment you have any questions or concerns regarding the project, the interviews, or the interview questions, please feel free to contact any of the researchers listed below. The plan for this study has been reviewed for its adherence to ethical guidelines by a Research Ethics Board at the University of Alberta. For questions regarding participant rights and ethical conduct of research, contact the Research Ethics Office at (780) 492-2615.

John Parkins
Professor
Department of Resource Economics and Environmental Sociology
University of Alberta
Phone number: (780) 492-3610
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Edward Bork
Professor – Mattheis Chair
Department of Agriculture, Food and Nutritional Science
University of Alberta
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Kristine Dahl
Graduate Student
Department of Agriculture, Food and Nutritional Science
University of Alberta
Phone number: (780) 288-8087
Email: kmdahl@ualberta.ca

Consent:
By signing this form you indicate that you understand the information on this consent form and it demonstrates that you consent to this study and agree to participate voluntarily. A copy of this consent form will be given to you to keep.

____________________________ ___________________________ ___________________
Signature of Participant Name (please print) Date

Please initial below for any items to which you agree:

I have received and reviewed a copy of the project information sheet__________

I have had the opportunity to ask questions about the research__________

I agree to participate in an interview for this project__________

I authorize the use of an audio recording device during the interview__________

I, as the researcher, agree to abide by the terms and conditions described in the information sheet referenced above.

____________________________ ___________________________ ___________________
Signature of Researcher Name (please print) Date

APPENDIX C – Tame Pasture, Native Grassland and Forested Range Health Datasheets

Tame Pasture Health Assessment – Score Sheet

Date:		Observer:	Disposition/Project:			Plot:
Field Unit:			Polygon:			Decile:
Latitude:			Longitude:			Elevation:
LSD:	QS:	SEC:	TWP:	RGE:	M:	Photo #:

Special Observations (e.g., climate, weed or brush control, grazing management)	

Dominant Species

Grass and grass - like	Cover %	Forbs	Cover %	Shrubs	Cover %	Trees	Cover %

Subregion/Plant Community (PC) or Conditional PC Name (code)	

Scoring: check the appropriate value(s) and add to the score box

1. Do introduced forage plants dominate the site? Answer 1A (tame) OR 1B (modified tame)

1A Tame Pasture	12 ☐ 9 ☐ 5 ☐	Comments	Score (1A or 1B)
1B Modified Tame Pasture	9 ☐ 5 ☐ 0 ☐		

2. What kind of plants are on this site? Shift in stand composition. Answer both 2.1 and 2.2.

2.1 Tame & desirable native	14 ☐ 7 ☐ 0 ☐	Comments	Score (2.1 + 2.2)
2.2 Weedy & disturbance	14 ☐ 7 ☐ 0 ☐		

3. Are there changes to the surface organic layer (LFH thickness and compaction)?

Cover & distribution	25 ☐ 16 ☐ 8 ☐ 0 ☐	Comments	Score

4. Is there accelerated soil erosion? Answer both 4.1 and 4.2.

4.1 Erosion Evidence 10 ☐ 7 ☐ 4 ☐ 0 ☐	Comments	Score (4.1+4.2)
4.2 Bare Soil 5 ☐ 3 ☐ 1 ☐ 0 ☐	Site is normally ☐ stable / ☐ unstable (check) Human-caused bare soil (%)____	

5. Are prohibited noxious and/or noxious weeds present? Answer both 5.1 and 5.2.

	Species	%	DD	Infestation Size	Unit	Treated	Score (5.1+5.2)
5.1 Cover (%) 5 ☐ 3 ☐ 1 ☐ 0 ☐					ha ☐ ac ☐ m² ☐	UNK ☐ no ☐ yes ☐	
					ha ☐ ac ☐ m² ☐	UNK ☐ no ☐ yes ☐	
5.2 Density Distribution (DD) 5 ☐ 3 ☐ 1 ☐ 0 ☐					ha ☐ ac ☐ m² ☐	UNK ☐ no ☐ yes ☐	
	Comments						

6. Does this site have woody re-growth? Answer both 6.1 and 6.2.

	Dominant Species	Cover %	Density Dist.	Score (6.1+6.2)
6.1 Cover (%) 6 ☐ 3 ☐ 0 ☐ N/A ☐				
6.2 Density Distribution 4 ☐ 2 ☐ 0 ☐ N/A ☐				
	Comments			

Grazing Intensity (estimated long term; check) ☐ U ☐ U-L ☐ L-M ☐ M ☐ M-H ☐ H	**Total**
Observed Utilization ____%	of
Trend (apparent; check): ☐ Upward ☐ Downward ☐ Stable ☐ Unknown	= %

0%------------------------------50%------------------75%------------------100%

<50% Unhealthy — 50% - 74% Healthy with Problems — 75% - 100% Healthy

Grassland Range Health Assessment – SCORE SHEET

Site ______________________ **Observer** ______________________ **Date** ________

LSD ______ **Quarter** ______ **Section** _____ **Township** ______ **Range** ______ **Meridian** ________

Photo # ______________ **GPS Coord (NAD 83) Lat.** ______________ **Long.** ______________

Estimated useable forage production ______________________________

Special Observations (Climate, changes in management) ______________________________

Scoring (Circle appropriate values and add their sum to the score box)

Dominant Species

Grass & grass likes	Cover%	Forbs	Cover%	Shrubs	Cover%	Trees	Cover%

Plant Community Name (code) ______________________________

1. What kinds of plants are on the site? What is the plant community?

						Comments	Score
1A	40	27	20	15	0		
1B				15	8	0	

2. Are the expected plant layers present?

					Score
10	7	3	0	Comments	

3. Does the site retain moisture? Is the expected amount of plant litter present?

				Score
25	13	0	Comments	

4. Is there accelerated soil erosion? Site normally stable / unstable (circle)

					Comments	Score
4.1 Erosion Evidence	10	7	3	0		
4.2 Bare Soil	5	3	1	0	Human caused bare soil (%)__________ Moss & lichen cover (%)__________	

5. Are noxious weeds present?

					Dominant species	Cover%	Density Dist.	Infestation Size	Score
5.1 Cover	5	3	1	0					
5.2 Density Distribution								ac or ha	
	5	3	1	0	Comments				

Grazing Intensity (Estimated long term) .... Circle U U-L L-M M M-H H
Observed Utilization _______%

Trend *(apparent - Circle):* **Upward** **Downward** **Stable** **Unkown**

Site Score (Total Score)	Score

0% --**50%** ------------------**75%** ---------------- **100%**

< 50% Unhealthy 50% - 74% Healthy with Problems 75 - 100% Healthy

Forest Range Health Assessment – Score Sheet

Date:	Observer:	Disposition/Project:	Plot:
Field Unit:		Polygon:	Decile:
Latitude:		Longitude:	Elevation:

LSD:	QS:	SEC:	TWP:	RGE:	M:	Photo #:

Special Observations (e.g., climate, management)	

Dominant Species **Cutblock site (check):** ☐ yes or ☐ no; **if yes,** was a level 1 assessment completed? ☐ **yes** or ☐ no

Grass and grass - like	Cover%	Forbs	Cover%	Shrubs	Cover%	Trees	Cover%

Subregion/Plant Community (PC) or Conditional PC Name (code)	

Scoring: check the appropriate value(s) and add to the score box

1. Does the PC resemble the reference PC?

25 ☐ 20 ☐ 15 ☐ 10 ☐ 5 ☐ 0 ☐	Comments	**Score**

2. Are there any changes in forest plant community structure?

35 ☐ 27 ☐ 18 ☐ 9 ☐ 0 ☐	Comments	**Score**

3. Are there changes to the surface organic layer (LFH thickness and compaction)?

20 ☐ 14 ☐ 8 ☐ 0 ☐	Comments	**Score**

4. Is there accelerated soil erosion? Answer both 4.1 and 4.2.

4.1 Erosion Evidence 5 ☐ 3 ☐ 1 ☐ 0 ☐	Comments	**Score (4.1+4.2)**
4.2 Bare Soil 5 ☐ 3 ☐ 1 ☐ 0 ☐	Site is normally ☐ stable / ☐ unstable (check) Human-caused bare soil (%)____ Moss and lichen cover (%) ____	

5. Are prohibited noxious and/or noxious weeds present? Answer both 5.1 and 5.2.

	Species	%	DD	Infestation			**Score (5.1+5.2)**
5.1 Cover (%) 5 ☐ 3 ☐ 1 ☐ 0 ☐				Size	Unit	Treated	
					ha ☐ ac ☐ m² ☐	UNK ☐ no ☐ yes ☐	
					ha ☐ ac ☐ m² ☐	UNK ☐ no ☐ yes ☐	
5.2 Density Distribution (DD)					ha ☐ ac ☐ m² ☐	UNK ☐ no ☐ yes ☐	
5 ☐ 3 ☐ 1 ☐ 0 ☐	Comments						

Grazing Intensity (estimated long term; check) ☐ U ☐ U-L ☐ L-M ☐ M ☐ M-H ☐ H	**Total**
Observed Utilization ____%	
Trend (apparent; check): ☐ Upward ☐ Downward ☐ Stable ☐ Unknown	

0%------------------------------**50%**------------------**75%**------------------**100%**

<50% Unhealthy 50% - 74% Healthy with Problems 75% - 100% Healthy

APPENDIX D – Table D-1. Commonly Occurring Plants in Tame Pastures Categorized to Assist in Answering Questions 1 and 2

	1A	1B	2.1	2.1	2.2
	Introduced forages	Included forages	Tall productive forages	Grazing induced forages	Weedy / disturbance induced non-forages
Cover estimation method	Relative	Relative	Relative	Relative	Absolute
Introduced					
Kentucky bluegrass	Y	Y	-	Y	-
Smooth and meadow brome	Y	Y	Y	-	-
Timothy	Y	Y	Y	-	-
Crested wheat grass	Y	Y	Y	-	-
Quack grass	Y	Y	-	Y	-
Creeping red fescue	Y	Y	-	Y	-
Orchard grass	Y	Y	Y	-	-
Alfalfa	Y	Y	Y	-	-
Low-growing legumes (clovers)	Y	Y	-	Y	-
Dandelion	N	N	-	-	Y
Sweetclovers	Y	Y	Y	-	-
Native					
Marsh reed grass	N	Y	Y	-	-
Rough fescue	N	Y	Y	-	-
Hairy wild rye	N	Y	Y	-	-
Wheat grasses	N	Y	Y	-	-
June grass	N	Y	-	Y	-
Needle and thread	N	Y	Y	-	-
Canada bluegrass	N	Y	-	Y	-
Foxtail barley	N	N	-	Y	-
Peavine, vetch	N	Y	Y	-	-
Pussy-toes	N	N	-	-	Y
Strawberry	N	N	-	-	Y
Yarrow	N	N	-	-	Y
Prickly pear cactus	N	N	-	-	Y
Wormwood	N	N	-	-	Y
Pasture and prairie sage	N	N	-	-	Y
Buckbrush	N	N	-	-	-
Sedges	N	N	Y	-	-

*Adapted from Adams et al. (2009) and modified by Dahl, K. (2017)

APPENDIX E – Figure E-1. Density distribution guide for rating weed infestation and woody regrowth

Density Distribution

Class	Description of abundance in polygon	Distribution	Weeds Score	Regrowth Score
0	None		5	4
1	Rare		3	
2	A few sporadically occurring individual plants			
3	A single patch			
4	A single patch plus a few sporadically occurring plants		1	2
5	Several sporadically occurring plants			
6	A single patch plus several sporadically occurring plants			
7	A few patches			
8	A few patches plus several sporadically occurring plants		0	0
9	Several well spaced patches			
10	Continuous uniform occurrences of well spaced plants			
11	Continuous occurrence of plants with a few gaps in the distribution			
12	Continuous dense occurrence of plants			
13	Continuous occurrence of plants with a distinct linear edge in the polygon			

*Adapted from Adams et al. (2009)

APPENDIX F – In-depth Interview Questionnaires – Conventional and Intensive Producers

In-Depth Interview Questionnaire – Conventional Producers

Grazing System

1. How long have you been managing the grazing on this farm?
    - Follow-up: Have you changed the grazing system in the last 5 years?
2. On the farm, you are grazing approximately how many cow/calf pairs?
3. What is the estimated acreage that you use for grazing these animals each year?
4. With your grazing management, do you try to achieve a certain stocking rate?
    - Follow-up: What would it be?
    - Follow-up: What criterion do you use to set the SR?
    - Follow-up: What is the goal for you in maintaining a stocking rate?
5. Do you use farm inputs? (fertilizer, pesticide, seeding, cultivation)
    - Follow-up: Why or why not?
6. Do you graze your native and tame pastures differently?
7. Do you have goals set for your farm and grazing outcomes?
    - Follow-up: How do you develop these goals? Is your family involved?
    - Follow-up: How often do you revise your goals?
    - Follow-up: What does a successful year look like?
    - Follow-up: What does a poor year look like?
8. Do you have a set of criteria you use when making decisions about your grazing? (forage health/production/quality, time of year, animal weight gain/health, pasture condition, litter cover).
9. How important is adaptability to you in your grazing management?
    - Follow-up: How are you adaptable?
10. What kinds of changes (positive or negative) have you noticed on the farm while using your grazing system?
11. Has your grazing management changed since you started grazing?
    - Follow-up: In what ways?
    - Follow-up: Why?

Social Perspectives

1. Would you say that the grazing system you use is ‘normal’?
    - Follow-up: What would an abnormal system be?
    - Or: Follow-up: What would a normal system be?
2. Do you think most graziers in your local community graze the same way?
3. Does it matter to you, to be part of the majority or not?
4. Have you ever not done something on the farm because you were concerned others in your community might think it’s unusual?
5. Has there ever been a time you wanted to try something new on the farm, but didn’t?

- Follow-up: Do you have an example?
- Follow-up: What was the main barrier?

6. When was the last time you tried something new?
7. I assume you have heard of Holistic Management, or other forms of intensive rotational grazing. Why don't you use this system on your farm?
8. Would you try more new ideas on the farm if there was financial support for it?
9. Is the bottom line for you purely economic? Have you ever made decisions that don't necessarily make financial sense, because you felt they were important?
    - Follow-up: What would an example be?
10. Where do you go for advice?
11. Are you a member of any grazing organizations, online or otherwise?

Education and Politics

1. Does the political situation in Alberta impact your farm management?
2. If the government endorsed a novel method of grazing, different from your own as a best management practice, and made funding available to help farmers change, would you take advantage of that opportunity?
    - Follow-up: Why or why not?
3. Do you consider yourself a risk-taker?
4. How would you describe your risk-assessment of whether or not to try something?
5. Do you have any formal educational background in agriculture or grazing?
6. Have you read any scientific articles (journals, publications) that have facilitated a change in grazing management? Including with respect to your grazing system or other systems?
7. Have you read any non-scientific articles (blog, producer magazine) to assist with your grazing management that were specifically referring to your grazing system?
8. What do you think about these articles?
    - Follow-up: Do they influence your decision making process?

Environmental Concerns

1. Do you believe grazing systems have an impact on the health of the land?
    - Follow-up: Do you believe your grazing system impacts the health of your land?
    - Follow-up: In what ways?
2. Do you think you have healthier pastures than others in your region that graze differently?
    - Follow-up: How much better? On a percent scale of 0 – 100%.
    - Follow-up: What gives you this impression?
3. How much of a role does influence of the environment (climate, soils, vegetation, topography, moisture) have on your grazing operations?
4. Rangelands are known for their production of environmental goods and services (EG&S). Can you rank on a scale of one to ten each of the following EG&S according to its importance to you and your grazing management:
    - Water filtration and storage:

- Biodiversity retention:
- Wildlife habitat:
- Carbon and GHG storage:
- Forage production:
- Aesthetic value:
- Open space preservation:

5. Has your landscape/soil/vegetation/fauna species changed over the last 20 years?
    - Follow-up: IF YES: Do you think these changes could be related to climate change?
    - Follow-up: How are you adapting to these changes?
    - Follow-up: IF NO: Why not?
6. Is there any place on the farm that you are especially proud of?
    - Follow-up: Why?
7. Is there any place you would like to improve?
    - Follow-up: Why?
8. Rangelands in Alberta are scored out of 100, with 0 – 49 considered Unhealthy, 50 – 74 Healthy with Problems, and 75 – 100 Healthy. This year, how would you score your native pastures?
    - Follow-up: The tame pastures?
    - Follow-up: Riparian areas?
    - Follow-up: Forested communities if you have them?
    - Follow-up: What is your reasoning for those scores?
9. How would your favorite place score compared to your 'needs improvement' place?
10. Would you say you have an emotional connection to your livestock or land?

Family and Lifestyle

1. If someone works off farm, is this to supplement farm income (flexibility), essential income (sustain the farm) or for personal/professional interest?
2. How much of an impact does farm income make on your decision making?
3. How important is your farm legacy to you?
4. Do you have a successional plan?
5. Do you want your children to take over your farm? ONLY if they have children and it's a family farm
6. How important is your family's support for your grazing management to you?
7. Would you consider a change in management style if your family/partner wanted it?
8. Would you support your successor if they wanted to implement a different management strategy after you retire?
9. How important is lifestyle to you in your day to day?
10. Does managing the farm as you do now give you the lifestyle you want?
11. Do you feel that the benefits outweigh the costs?
12. Have you sacrificed anything important to you to make life on the farm work?
    - Follow-up: What was it?
13. If you could change one thing about your farm, what would it be? Why?

14. Has your perspective on grazing changed over the years?
- Follow-up: In what ways?

15. Is farming your dream job?
- Follow-up: Have you ever wanted to do anything else?

<u>In-Depth Interview Questionnaire – HM or Intensive Producers</u>

Grazing System

1. How long have you been managing the grazing on this farm?
   - Follow-up: Have you changed the grazing system in the last 5 years?
2. On your farm, you have approximately how many cow/calf pairs?
3. What is the estimated acreage that you use for grazing these animals each year?
4. With your grazing management, do you try to achieve a certain stocking rate?
   - Follow-up: What would it be?
   - Follow-up: What criterion do you use to set the SR?
   - Follow-up: What is the goal for you in maintaining a stocking rate?
5. Do you use farm inputs? (fertilizer, pesticide, seeding, cultivation)
   - Follow-up: Why or why not?
6. Do you graze your native and tame pastures differently?
7. Do you have goals set for your farm and grazing outcomes?
   - Follow-up: How do you develop these goals? Is your family involved?
   - Follow-up: How often do you revise your goals?
   - Follow-up: What does a successful year look like?
   - Follow-up: What does a poor year look like?
8. Do you have a set of criteria you use when making decisions about your grazing? (forage health/production/quality, time of year, animal weight gain/health, pasture condition, litter cover).
9. How important is adaptability to you in your grazing management?
   - Follow-up: How are you adaptable?
10. What kinds of changes (positive or negative) have you noticed on the farm while using your grazing system?
11. Has your grazing management changed since you started grazing?
    - Follow-up: In what ways?
    - Follow-up: Why?

Social Perspectives

1. While you were developing your system of grazing management, did you ever encounter any interest from others in your community?
2. What about hostility or disapproval?
   - Follow-up: How did you deal with this?
3. Has it impacted you in your decision making, what other people think?

4. Have you ever not done something on the farm because you thought others in your community might think it is unusual?
5. Have you ever felt like an outsider in your community for the way you manage your grazing?
6. Has there ever been a time you wanted to try something new on the farm, but didn't?

- Follow-up: Do you have an example?
- Follow-up: What was the main barrier?

7. Would you try more new ideas on the farm if there was financial support for it?
8. Is the bottom line for you purely economic? Have you ever made decisions that don't necessarily make financial sense, because you felt they were important?

- Follow-up: What would an example be?

9. Where do you go for advice?
10. Are you a member of any grazing organizations, online or otherwise?

Education and Politics

1. Does the political situation in Alberta impact your farm management?
2. If the government endorsed a novel method of grazing, different from your own as a best management practice, and made funding available to help farmers change, would you take advantage of that opportunity?

- Follow-up: Why or why not?

3. Do you consider yourself a risk-taker?
4. How would you describe your risk-assessment of whether or not to try something?
5. Do you have any formal educational background in agriculture or grazing?
6. Have you read any scientific articles (journals, publications) that have facilitated a change in grazing management? Including with respect to your grazing system or other systems?
7. Have you read any non-scientific articles (blog, producer magazine) to assist with your grazing management that were specifically referring to your grazing system?
8. What do you think about these articles?

- Follow-up: Do they influence your decision making process?

Environmental Concerns

1. Do you believe grazing systems have an impact on the health of the land?

- Follow-up: Do you believe your grazing system impacts the health of your land?
- Follow-up: In what ways?

2. Do you think you have healthier pastures than others in your region that graze differently?

- Follow-up: How much better? On a percent scale of 0 – 100%.
- Follow-up: What gives you this impression?

3. How much of a role does influence of the environment (climate, soils, vegetation, topography, moisture) have on your grazing operations?
4. Rangelands are known for their production of environmental goods and services (EG&S). Can you rank on a scale of low to high each of the following EG&S according to its importance to you and your grazing management:

- Water filtration and storage:
- Biodiversity retention:
- Wildlife habitat:
- Carbon and GHG storage:
- Forage production:
- Aesthetic value:
- Open space preservation:

5. Has your landscape/soil/vegetation/fauna species changed over the last 20 years?
    - Follow-up: IF YES: Do you think these changes could be related to climate change?
    - Follow-up: How are you adapting to these changes?
    - Follow-up: IF NO: Why not?
6. Is there any place on the farm that you are especially proud of?
    - Follow-up: Why?
7. Is there any place you would like to improve?
    - Follow-up: Why?
8. Rangelands in Alberta are scored out of 100, with 0 – 49 considered Unhealthy, 50 – 74 Healthy with Problems, and 75 – 100 Healthy. This year, how would you score your native pastures?
    - Follow-up: The tame pastures?
    - Follow-up: Riparian areas?
    - Follow-up: Forested communities if you have them?
    - Follow-up: What is your reasoning for those scores?
9. How would your favorite place score compared to your 'needs improvement' place?
10. Would you say you have an emotional connection to your livestock or land?

Family and Lifestyle

1. If someone works off farm, is this to supplement farm income (flexibility), essential income (sustain the farm) or for personal/professional interest?
2. How much of an impact does farm income make on your decision making?
3. How important is your farm legacy to you?
4. Do you have a successional plan?
5. Do you want your children to take over your farm? ONLY if they have children and it's a family farm
6. How important is your family's support for your grazing management to you?
7. Would you consider a change in management style if your family/partner wanted it?
8. Would you support your successor if they wanted to implement a different management strategy after you retire?
9. How important is lifestyle to you in your day to day?
10. Does managing the farm as you do now give you the lifestyle you want?
11. Do you feel that the benefits outweigh the costs?
12. Have you sacrificed anything important to you to make life on the farm work?
    - Follow-up: What was it?

13. If you could change one thing about your farm, what would it be? Why?
14. Has your perspective on grazing changed over the years?
    - Follow-up: In what ways?
15. Is farming your dream job?
    - Follow-up: Have you ever wanted to do anything else?