Range Management Review
For
Antelope Creek Habitat Development Area

March 31, 2020

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Antelope Creek Ranch
HABITAT DEVELOPMENT AREA

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Contents

Introduction

The Antelope Creek Habitat Development Area (ACHDA) is a 5,500-acre working ranch located twelve miles west of Brooks, Alberta and is managed as a partnership between Alberta Fish and Game Association, Wildlife Habitat Canada, Ducks Unlimited Canada and Alberta Environment and Parks. The partnership was established in 1986 and stands testament as a success story showing that it is possible for ranching, oil and gas operations and wildlife to co-exist on the same property. The ranch has a long history highlighting the ability of native grasslands to recover from the impacts of drought and overgrazing through adaptive range management practices. The property consists of native prairie (Pastures 1-4 and Cassils Field, Figure 1), tame pastures under flood and pivot irrigation, saline lowlands, constructed and natural wetlands, irrigation canals and an extensive industrial footprint from upstream oil and gas.

The project discussed in this report started as a proposal to use the ranch as a demonstration site to ground-truth the Grassland Vegetation Inventory (GVI) for accuracy on a familiar land base. This opportunity expanded in scope to include completion of a detailed range inventory to support future management of the ranch. In 2014, an Invasive Plant Management Plan was completed, inventorying the invasive footprint across the ranch and providing management recommendations for the next ten-year period (Michalsky, 2014). Summer rangeland technicians completed inventory efforts from 2015-2018 which together comprise a complete, detailed range inventory of native pastures.

ACHDA has four long term Range Reference Areas (RRA), established in the 1980s, which provide insight into ecological succession, recovery of disturbed plant communities, impacts of climate change, shifts in plant community composition, forage production values and rangeland site potential. Data from these study areas has been used to create long-term vegetation production reports and provincial plant community guides. ACHDA has been the site of several research projects from surveying plant and wildlife biodiversity (MULTISAR, ABMI), evaluating avian response to habitat fragmentation and several rangeland focused projects. In 2016, a GPS collar analysis was used to determine the influence of plant community types on cattle distribution and to investigate cattle preference for crested wheatgrass (*Agropyron pectinforme)* community types (Antelope Creek Technical Committee, 2018). In 2018, an independent study examined cattle preference of crested wheatgrass over native species and how Crested Wheatgrass-dominated communities change over a period of three years under early-season skim grazing (Rushton, 2018). ACHDA has been used for a number of years as a demonstration site for the Grassland Restoration Forum's Grassland Assessment Training workshop.

This report summarizes detailed inventory findings on the native pastures of ACHDA, provides stocking rates based on vegetation composition and range health, and summarizes rangeland function, health and stewardship. For the purpose of this report, invasive species data is not included as the existing Invasive Plant Management Plan is considered current. In addition to supporting operational ranch management, this dataset has further value as a high-resolution base map for interpretation of wildlife inventory data and livestock behavior studies.

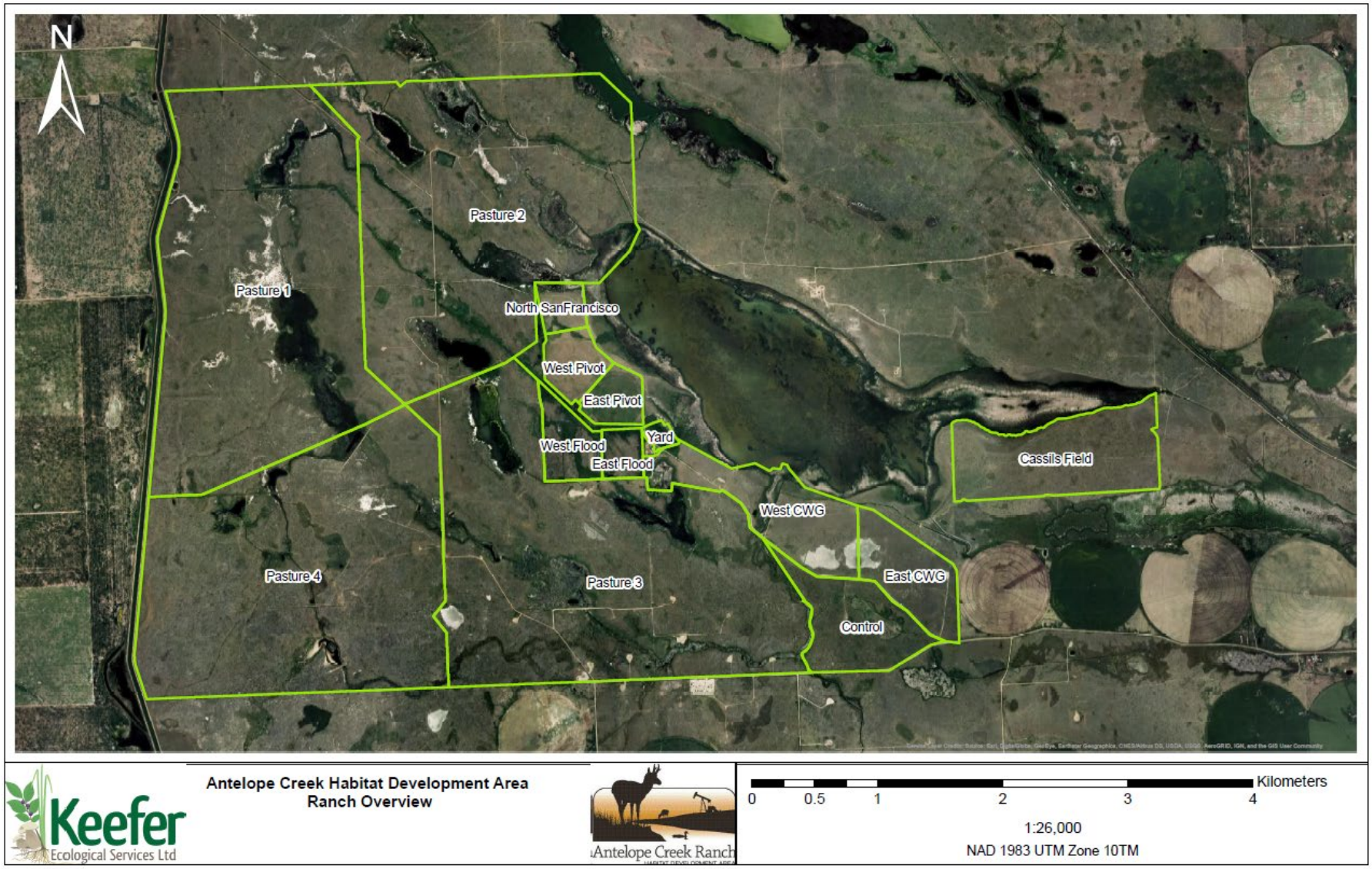


***Figure 1**: Overview map of ACHDA showing field names and fence lines.*

Historical Management

Prior to establishment of ACHDA, historically high stocking rates combined with severe drought in the late 1980s resulted in heavy overgrazing across the ranch. These conditions lead to the range resource being severely degraded with no carryover remaining. Initially the ranch was only able to support 160 cow-calf pairs throughout the grazing season and initially a rest-rotational grazing system was used to promote recovery. Five years after the establishment of ACHDA, carryover and vegetation had recovered to desirable levels and stocking rates were gradually increased.

In 1987, a primary management plan was established which outlined the following key management objectives which are still managed for today (Radford, 2013):

- Protect, enhance and develop key wildlife habitat for upland birds, waterfowl and non-game species
- Manage livestock grazing to benefit both wildlife and livestock, in order to demonstrate the benefits of complementary grazing systems and gain community support for overall management objectives through integrated land use
- Integrate petroleum and natural gas activity with wildlife habitat, recreational and grazing components
- Provide preliminary non-mechanized recreational opportunities
- Provide education and research opportunities
- And to use all the "assets" of the property to highlight best use and to ensure self-sufficiency.

By the early 1990s, native vegetation within the study area had recovered sufficiently and a deferred rotational system was put into place, staggering season of use to avoid grazing pastures in the same period each year (N. Wilson, per comms, March 3rd 2020). In 1994 the first ranch manager, Bob Kaufman, was hired to oversee the day-to-day continuity of all on-ranch operations. By 2004 the ranch could sustain 260 cow/calf pairs under a complementary, deferred rotational system. The 2004 Antelope Creek Ranch annual report showed a positive trajectory in rangeland health of all native pastures on the ranch.

Current Management

In 2005, Neal Wilson and Shannon Burnard became the managers of ACHDA and continue to manage the ranch at present. The same deferred rotational grazing system was used until 2009 when early-season skim grazing was implemented as a management tool to address crested wheatgrass infestation on the property. Crested wheatgrass covers approximately 400 acres from seeded and managed tame pastures and seeding along industrial roadways, well pads and pipelines. This agronomic species can maintain itself within a stand for 50+ years through mature plants and seedling recruitment. This species establishes and spreads through seed spread, expanding readily into native vegetation in the Dry Mixed Grass (DMG) Natural Subregion (Vaness & Wilson 2007). Crested wheatgrass produces early spring growth and is often the first plant to green up in this area. Palatability decreases rapidly, with protein

levels often inadequate for lactating cattle by mid-June (Zlatnik 1999). Spread can be reduced over time with targeted grazing application (Hendersen, 2005).

Currently, the ranch sustains 285 cow/calf pairs managed in a complementary deferred rotational grazing system. Tame pastures under irrigation pivots are used for early season grazing to allow deferral of use on native pastures until later in the growing season. In recent years flood irrigated fields on the ranch have been reserved for wildlife use only. Early season forage availability is limited in the DMG on native grasslands, so crested wheatgrass is opportunistically skim grazed in the spring between May 15 and June 1, providing early season forage and targeted management of spread. Native pastures are typically grazed with an on date of July 1-15 and an off date of October 15-28. Field 3 and Cassils field tend to see heavier grazing in the spring (Figure 1).

The ranch contains many wetlands constructed and watered by Ducks Unlimited, so water is not a limiting factor influencing livestock distribution. Strategic salt and mineral placement have had limited effect on livestock distribution patterns on the ranch (N Wilson, per comms, March 3rd, 2020).

Total livestock use of native pastures was 1766 AUM in 2017, 1603 AUM in 2018 and 1684 AUM in 2019 (Figure 4).

Ecological Overview

ACHDA is located within the western extent of the DMG Natural Subregion. The DMG has the warmest summers, longest growing season, and lowest precipitation of any Natural Subregion in Alberta. This subregion makes up half of the Grassland Natural Region in Alberta, occurring over level to gently undulating glacial till consisting of an unsorted mixture of sand, silt and clay mixed with coarse fragments, or lacustrine plains consisting of clay settled from suspension in ice-marginal glacial lakes with hummocky uplands and sand dunes occurring throughout (Natural Subregions Committee, 2006).

When evaluating grasslands, soils information is an essential component in predicting the reference plant community and is important when evaluating the influence of disturbance on ecological status of the current plant community. The Agricultural Region of Alberta Soil Inventory Database is a digital soils database that allows the user to establish the site and soil characteristics within a reasonable degree of accuracy.

The Dry Mixed Grass Range Plant Community Guide (Adams et. al, 2013) lists tables to help interpret the major soil series and their associated range sites for each ecodistrict in the DMG subregion. ACHDA falls within the Bow City Plain, and is dominated by two major soil series, Hemaruka (HUK) and Ronalaine (ROL). The HUK Soil Series is a Brown Solodized Solonetz with a glacial till parent material and a Blowout (Blo) Range Site (RS). The ROL Soil Series is a Solonetzic Brown Chernozem with a glacial till patent material and a Loamy (Lo) RS. Saline Lowlands and riparian communities are associated with depressional features. Solonetzic soils are the second most common soil order in the DMG, occurring where sodium rich bedrock material occurs at or near the soil surface. They can also occur in areas with former saline and sodic groundwater discharge.

The “mixed grass” name refers to the co-dominance of both short and mid-height grasses, with the most widespread species being blue grama (*Bouteloua gracilis),* needle and thread *(Stipa comata),* western wheatgrass *(Agropyron smithii)* and June grass *(Koeleria macrantha).* Shrub communities occur in depressions, ravines, coulees and on north aspects where moisture is increased and are commonly

comprised of prickly rose *(Rosa arkansana),* silverberry *(Elaeagnus commutata),* buckbrush *(Symphoricarpos occidentalis),* and silver sage brush *(Artemesia cana)*. Trees are uncommon but can be found adjacent to rivers and creeks as tall shrub and forest communities of willows *(Salix spp),* thorny buffaloberry *(Sheperdia argentea)*, and plains cottonwood *(Populus deltoides).* Sedges *(Carex spp)*, spike rushes *(Juncus spp)*, and willows occur with Gleysolic soils in wet, poorly drained areas (Natural Subregions Committee, 2006). The majority of plant communities found on ACHDA are dominated by western wheatgrass or needle grass. Trees and shrubs are limited to the wettest sites on the ranch, and the majority of riparian features are dominated by sedges, rushes, and cattail.

On the ACHDA lands, the majority of plant communities occur on Blowout range sites and are predominantly led by western wheatgrass or needle and thread. The footprint of crested wheat grass is significant, occurring on nearly 10% of native pastures. Depressional areas have a high component of Kentucky bluegrass (*Poa pratensis)* and are commonly invaded by weeds such as sow thistle (*Sonchus arvensis)* and Canada thistle *(Cirsium arvense)*.

Methodology

Successful planning depends on accurate, up to date inventories and range health audits which are performed in a standardized, measurable and repeatable process. The methodology for the inventory work done on ACHDA from 2015-2019 is based on the Rocky Mountain Forest Reserve Allotments and Grazing Leases Range Inventory Contractor Certification Manual (AEP, 2019), and the Range Health Assessment for Grassland, Forest and Tame Pasture tool (AEP, 2016). For repeatability, the specific methodologies used on ACHDA are provided in Appendix A. To capture vegetation composition, a 50 metre transect was sampled in every polygon on ACHDA with 10 microplots sampled at 5 metre intervals. A range health score was calculated on a polygon level for each polygon and a litter estimate was recorded in lbs/acre.

A number of polygons could not be assigned to a published plant community type. The majority of excluded polygons were riparian plant communities that, unlike upland plant communities, do not have published stocking rate recommendations. Given that some level of livestock use is inevitable, it is reasonable to include riparian areas in the overall grazing capacity, so a conservative stocking rate of 0.25AUM/ac (equivalent to 190lb/acre forage consumption) was assigned in lieu of plant-community specific stocking rates (R Adams, per comms, March 5th 2020). Also excluded were non-range features such as gravel roads, sites significantly affected by recent or ongoing industrial disturbance, active disturbance and reclaimed disturbances that are not ecologically stable. These features are significant across the ACHDA and account for approximately 100 acres. While it is likely that they provide some forage for livestock, sustainable stocking rates are expected to be low and exclusion of these sites does not have a significant impact on overall grazing capacity for native pastures.

All range polygons that could be given a plant community code from the DMG guide were assigned one. Range health and litter scores were used to determine if the appropriate ecologically sustainable stocking rate (ESSR) would be average, at the high end, or at the low end of the recommended range. Conditional communities were provided with a composition description and an assigned ESSR to the nearest applicable community.

ACHDA is on the western margin of the DMG and production data from RRAs indicate that ACHDA occupies an area transitional to the Mixedgrass natural subregion. As a result, some plant communities

on ACHDA are more productive than comparable communities in drier parts of the DMG, and it was necessary to adjust recommended ESSRs upwards to accurately reflect local plant community productivity. Long term production from the ACHDA4 RRA (Appendix B) suggest 50% higher average productivity than guidebook values for blowout (Blo), Overflow (Ov), Sub-irrigated (Sb) and saline lowland (SL) range sites. To account for early season skim grazing of Crested Wheatgrass, polygons with crested wheatgrass communities (DMGB1 and DMGB2) were assigned 0.5AUM/ac which is above the suggested ESSR range. Skim grazing during early spring, when crested wheatgrass is green and palatable but most native upland grasses are still dormant, provides more available forage as Crested Wheatgrass can be grazed more heavily without degrading adjacent native plant communities. This adjustment is considered appropriate only under adaptive management where grazing impacts are closely monitored to ensure that livestock are removed prior to the point when native grasses become palatable. Livestock can then be returned to the pasture later in the growing season when native species are better able to tolerate grazing.

Results

Healthy rangelands provide sustainable grazing opportunities to livestock producers while providing a wide range of ecological and social benefits. Healthy rangelands are productive, efficiently utilizing available energy and water resources to sustain biomass production and provide forage for livestock and wildlife, and consumable products for all life forms. It will be stable, protecting soils that have taken centuries to develop, reducing runoff and soil erosion, and provide more stable primary productivity during drought. It will capture, store, and beneficially release of water, reducing flood severity and making moisture available for plants and other organisms. It will provide nutrient cycling and carbon storage, conserving and recycling nutrients available for plant growth while not requiring the input of fertilizer. And, a healthy rangeland will have rich plant species diversity, consisting of grasses, forbs, shrubs and trees which provides high quality wildlife habitat and supports biodiversity while also providing forage for livestock and wildlife (Adams et. al, 2016).

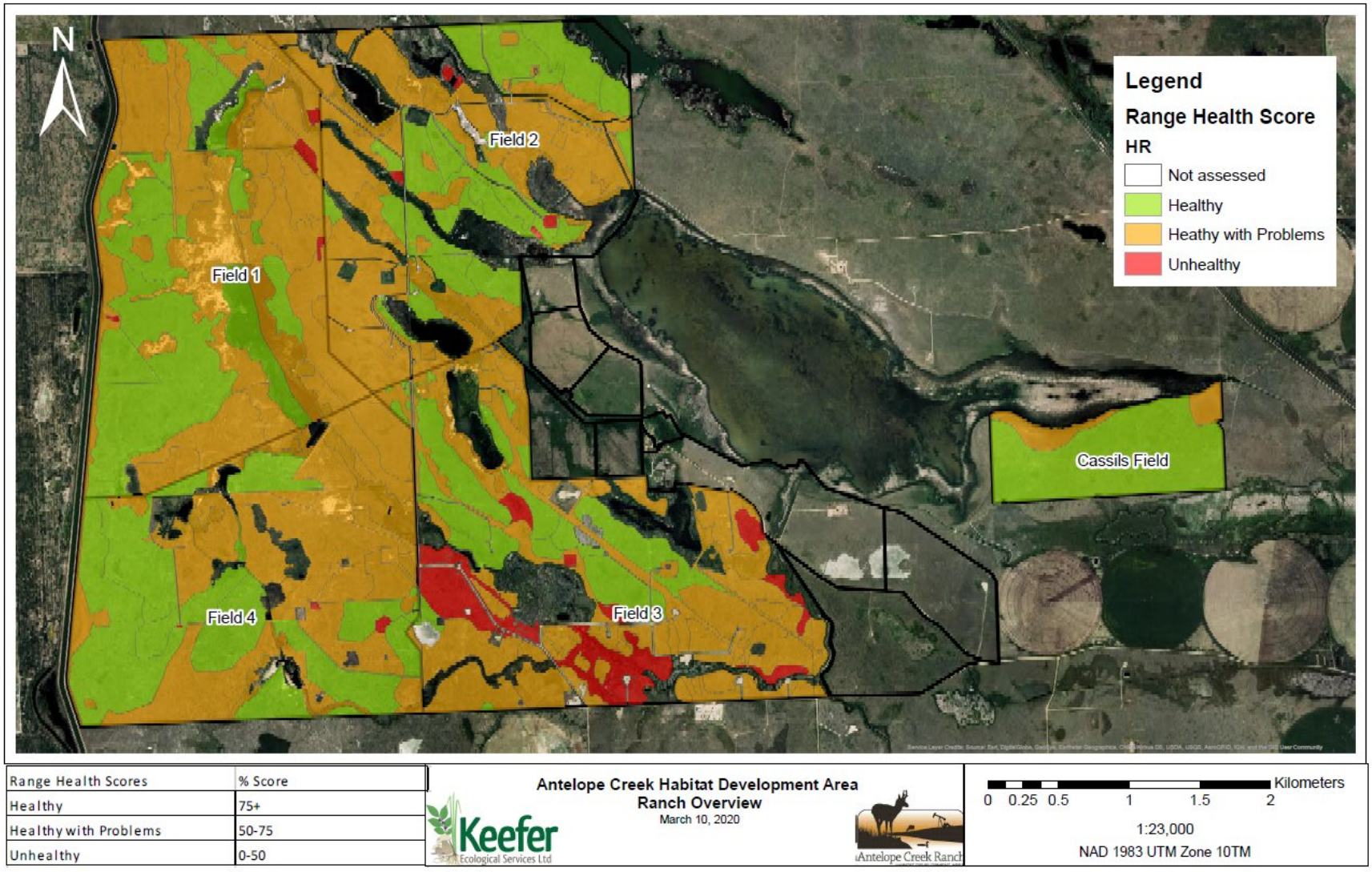


***Figure 2**: Overview Map of Rangeland Health on ACHDA.*

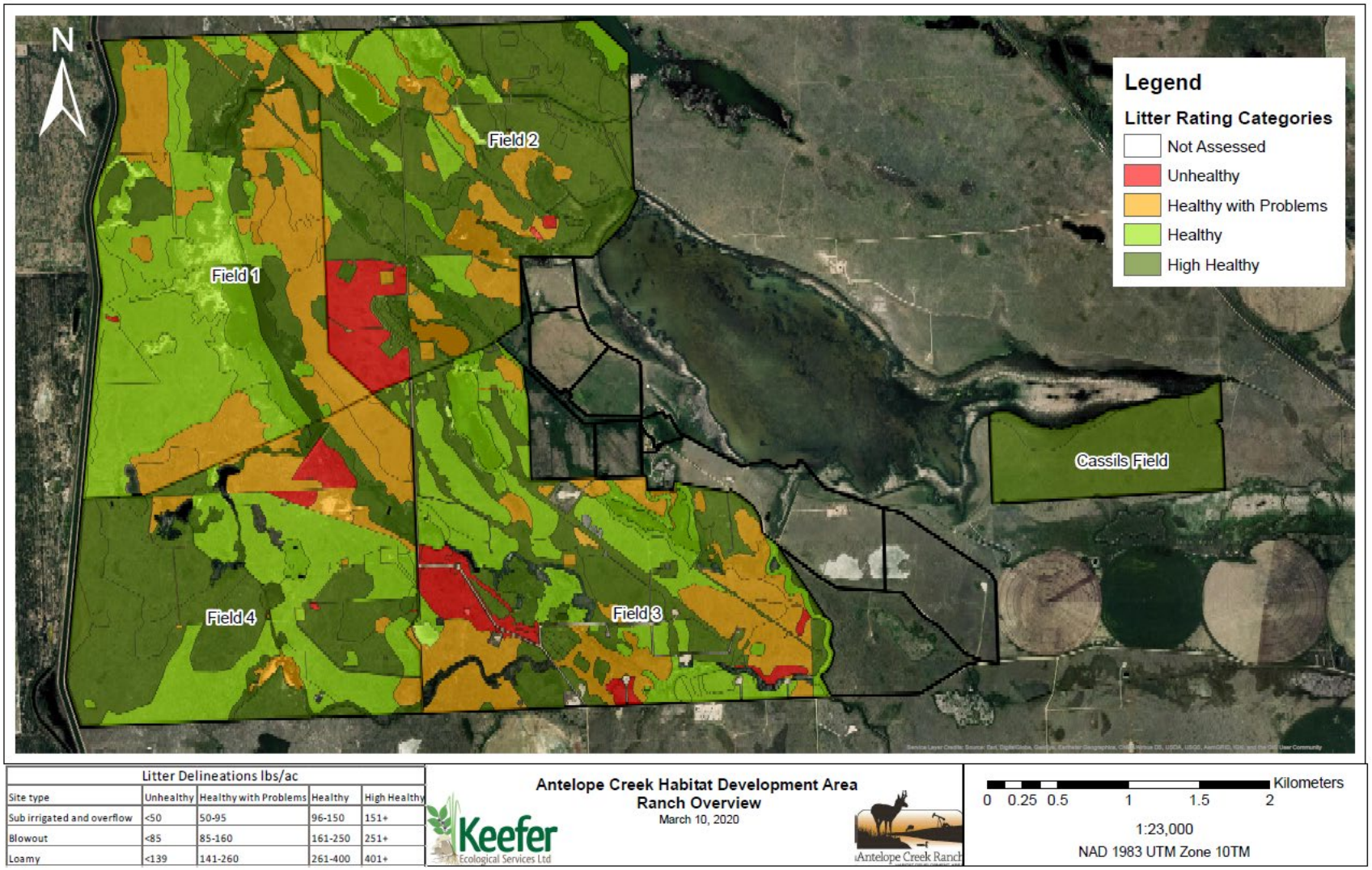


Figure 3: *Overview Map of Litter on ACHDA.*

A rangeland health assessment allows the manager to evaluate if ecological functions are occurring and intact. Five questions are addressed in the range health assessment protocol which are outlined below. Appendix C provides a copy of the Rangeland Health Assessment Field Worksheet for Grasslands.

1. Integrity and Ecological Status

   Plant species composition influences a site's ability to perform functions and provide products and services. Plant species changes due to disturbance are predictable, where perennial species decline with disturbance and less desirable species increase in abundance with disturbance. This question evaluates how the plant community has changed due to disturbance when compared to the Reference Plant Community (RPC).

2. Community Structure

   How the plant community is maintaining net primary production and nutrient cycling and energy flow is evaluated by examining the structure and diversity of the plant community. Ideally, several layers will exist and could include trees or tall shrubs (where moisture is not limiting), medium shrubs, low shrubs, tall grasses, mid grasses, short grasses and ground cover. Varied canopy structure and rooting depths utilize sunlight, water and nutrients most effectively. This question compares the number of structural layers on a site with the number expected to be present in the reference community.

3. Hydrologic Function and Nutrient Cycling

   This question compares the amount and distribution of litter on the site with reference values for the same range site. Moisture retention and nutrient cycling are measured by the abundance and distribution of dead plant material which is called "litter" on a site. Litter is important because it reduces raindrop impact on the soil surface, enhancing infiltration, reducing soil erosion from wind and water, and reducing evaporative losses by shading and cooling soil. Litter removal can reduce forage yields in mixed grass ecosystems by up to 50%.

4. Site stability

   Managers strive to minimize soil erosion due to land management practices by maintaining adequate vegetation cover and minimizing exposed soil. This question measures the extent of human caused bare soil and erosion above the amount that naturally occurs on the site.

5. Prohibited Noxious and Noxious Weeds

   Weeds are rarely a problem where native plant vigor and cover are maintained but they can still occur in healthy stands. Generally, the presence of weeds indicates a degrading plant community because weeds opportunistically invade areas where disturbance has resulted in space and resources becoming available to them. Weeds can become an expensive management concern and diminish the agricultural potential, biological

diversity, function and stability of the range resource. This question measures the foliar cover and spatial distribution of prohibited noxious and noxious weeds on the site.

Range health for ACHDA has been recorded in each upland range polygon (Figure 2). For the purpose of analysis in this report, individual polygon scores are averaged in each field to give an overall picture of where range health scores have been affected as shown in Table 1.

***Table 1**: Range Health summary averaged per field for each range health question.*

RH Question	1. PC Composition	2. Plant Layers	3. Litter	4.1. Erosion Evidence	4.2 Soil Exposure	5.1 Weed Cover (%)	5.2 Density Distribution	Average score
Possible Score	**40**	**10**	**25**	**10**	**5**	**5**	**5**	
Cassils	25.3	7.0	25.0	9.6	5.0	3.3	3.3	78.5
Pasture 1	23.6	8.9	20.9	8.8	4.6	4.1	3.9	74.9
Pasture 2	25.0	8.6	20.4	9.9	5.0	3.6	2.6	75.1
Pasture 3	20.2	7.5	19.4	8.4	4.7	2.3	1.3	63.8
Pasture 4	21.6	7.8	22.7	9.0	4.7	3.9	3.7	73.4

Litter values have been calculated in each polygon and are provided in an overview map in Figure 3. Individual fields displayed in appendices D, F, H, and J for the purpose of this report. Table 2 summarizes the litter health categories that will be described below.

***Table 2:** Threshold values for the litter maps created for ACHDA.*

Litter Delineations (lbs/ac)				
Site type	Unhealthy	Healthy with Problems	Healthy	High Healthy
Sub irrigated and overflow	<50	50-95	96-150	151+
Blowout	<85	85-160	161-250	251+
Loamy	<139	141-260	261-400	401+
Range Health Score	**<50%**	**50-74%**	**75-100%**	

Cassils Pasture:

Cassils pasture is a 247-acre pasture located on the eastern extent of ACHDA with three polygons that have an overall range health rating of healthy (Appendix D). The dominant plant community is a DMGA16_S (Western Wheatgrass-Sedge-Needle and Thread) plant community that occurs on a Blowout 4 ERS. This community is one of the most productive of the blowout range sites. The other polygons in

this field are a DMGB7 (Foxtail Barley-Kentucky Bluegrass-Western Wheatgrass) community. This community is typically located in depressional areas and can tolerate some alkalinity and salinity.

The overall rating for this pasture is healthy, however, some range health marks were lost in question one, scoring an average of 25, meaning that compared to the RPC, plant communities show minor alteration due to grazing or other disturbance under a light to moderate level of disturbance. Marks were also lost on Question 2, meaning that compared to the RPC, one lifeform layer is absent, significantly reduced, or not fully expressed. Litter levels in this field are high healthy (Appendix E).

Pasture 1:

Pasture 1 is a 1187-acre pasture located on the north west portion of ACHDA comprising 70 polygons. The most common plant community is a DMGA16 (Western Wheatgrass-Sedge-Needle and Thread) occurring on a Blowout 4 ERS. Crested wheatgrass communities occur on 86 acres in this pasture in a DMGB2 (Crested Wheat Grass-Needle and Thread/Silver Sagebrush) community. Riparian communities occur on 134 acres in this pasture. The overall health of Pasture 1 is on the high end of Healthy with Problems (Appendix F).

Range health marks were lost on question one, scoring an average of 23, meaning that in some cases, compared to the RPC, plant communities show minor reduction in wheatgrass and needlegrass cover due to light to moderate grazing. Another common cause for loss of marks on question one was the presence of invasive introduced grasses such as Kentucky bluegrass or crested wheatgrass. Marks were also lost on site stability due to occasional areas of human-caused bare ground and signs of micro-erosion, and on the presence of noxious and prohibited noxious weeds. The overall litter rating is healthy (Appendix G). The range health map shows that cattle may concentrate in the central area of this pasture.

Pasture 2:

Pasture 2 is a 1147-acre pasture located on the north east portion of ACHDA comprising 128 polygons. The most common plant communities are a DMGA16 (Western Wheatgrass-Sedge-Needle and Thread) occurring on a Blowout 4 ERS, DMGA3 (Needle and Thread-June Grass-Blue Grama) which occurs on 139 acres of well drained loamy range sites, and DMGA35 (Western Wheatgrass-Sedge-Needle and Thread) which occurs on 137 acres. A conditional Kentucky bluegrass community occurs on 104 acres. Crested wheatgrass communities DMGB2 occur on 98 acres and the DMGB7- Foxtail Barley-Kentucky Bluegrass-Western Wheatgrass community occurs on 70 acres. The overall range health rating is on the low end of healthy (Appendix H).

Range health marks were lost on question one for the same reasons as discussed in Pasture 1, and on the presence and distribution of noxious and prohibited noxious weeds. The overall litter rating is high healthy (Appendix I). The southwest corner of this pasture is most heavily utilized.

Pasture 3:

Pasture 3 is a 1239-acre pasture located on the south east portion of ACHDA comprising 180 polygons. The most common plant communities are a DMGA35 (Western Wheatgrass-Sedge-Needle and Thread) community which occurs on 253 acres, a DMGA16 (Western Wheatgrass-Sedge-Needle and Thread) occurring on 156 acres, a DMGA3 (Needle and Thread-June Grass-Blue Grama Grass) community which occurs on 117 acres, a DMGB1 Crested Wheatgrass community occurring on 93 acres, a DMGB7 (Foxtail

Barley-Kentucky Bluegrass-Western Wheatgrass) community occurring on 87 acres, a DMGB2 (Crested Wheat Grass-Needle and Thread/Silver Sagebrush) community occurring on 85 acres, and a DMGA15 (Western Wheatgrass-Needle and Thread-June Grass) community occurring on 75 acres. 46 acres in this polygon are considered non-rangeland roads or industrial development, 60 acres are a conditional Kentucky bluegrass community, and 62 acres are riparian. The overall range health of this pasture is healthy with problems (Appendix J).

Range health marks were lost on community composition for the same reasons discussed in Pasture 1, reduction in plant community structure and the presence and distribution of noxious and prohibited noxious weeds. The overall litter score is healthy (Appendix K). The polygons which received a healthy score are generally loamy sites.

Pasture 4:

Pasture 4 is an 1129-acre pasture located on the south west portion of ACHDA comprising 87 polygons. The most common plant communities are DMGA16 (Western Wheatgrass-Sedge-Needle and Thread) plant community occurring on 351 acres, a DMGA15 (Western Wheatgrass-Needle and Thread-June Grass) community occurring on 222 acres, and a DMGB7 (Foxtail Barley-Kentucky Bluegrass-Western Wheatgrass) community occurring on 62 acres. 46 acres are riparian areas and 13 acres are industrial non-use. The overall range health rating is high healthy with problems (Appendix L).

Range health marks were lost on community composition for the same reasons as discussed for Pasture 1, reduction in plant community structure, and the presence and distribution of noxious weeds. The overall litter score is high healthy (Appendix M). The north east portion of this pasture sees the highest grazing pressure.

Estimated Grazing Capacity Based on Inventory Results:

The long-term Grazing Capacity (GC) for ACHDA on the native pastures is estimated to be 1104 AUM. GC estimates for each native pasture are summarized in table 3. The native pastures on ACHDA were stocked at 1766 AUM in 2017, 1603 AUM in 2018, and 1684 AUM in 2019 as summarized in Figure 4. Additional AUM's are available on the ranch in crested wheatgrass fields and irrigation fields which are not included in the GC calculations for this report.

Table 3: *Calculated grazing capacities for ACHDA.*

FIELD	AREA ac	GC (AUM)
CASSILS	247.58	54.11
PASTURE 1	1186.87	250.95
PASTURE 2	1122.31	257.8
PASTURE 3	1239.8	328.7
PASTURE 4	1128.52	212.84
Totals	**4925.08**	**1104.4**

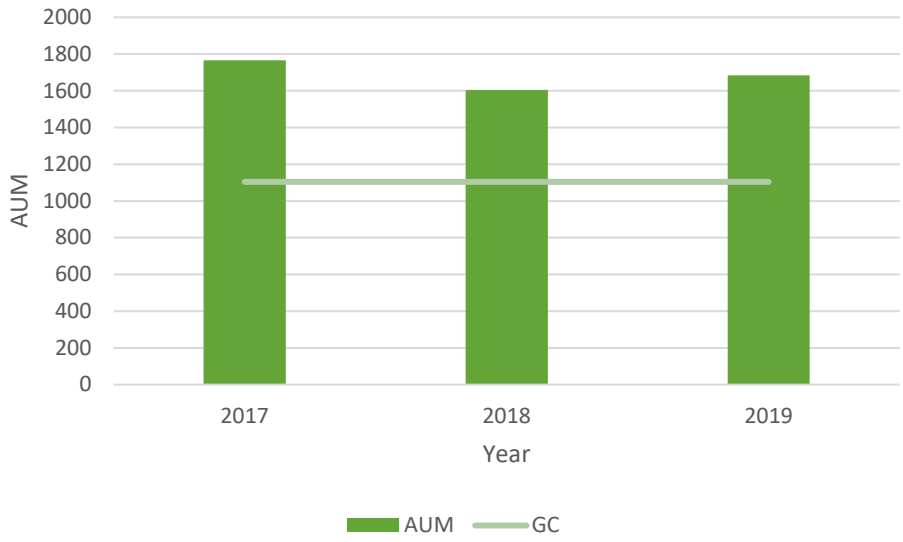


***Figure 4**: Stocking rates over three years for ACHDA native pastures. The bars show the AUMs that were stocked each year, and the line shows the suggested grazing capacity for native pastures.*

Between 2004 and 2015, both annual and growing season precipitation have been at or above average in the ACHDA area (figures 4 and 5), and the influence of this is observed in above-average forage production (see appendix B), litter levels, and range health results. As such, higher stocking rates during periods of favourable moisture are sustainable as long as productivity and litter are closely monitored and the livestock manager proactively plans to reduce stocking rates during periods of drought. Grazing capacity estimates represent a long-term average, taking into account fluctuating moisture availability, and in any given year livestock managers may stock above or below the estimated GC based on current conditions.

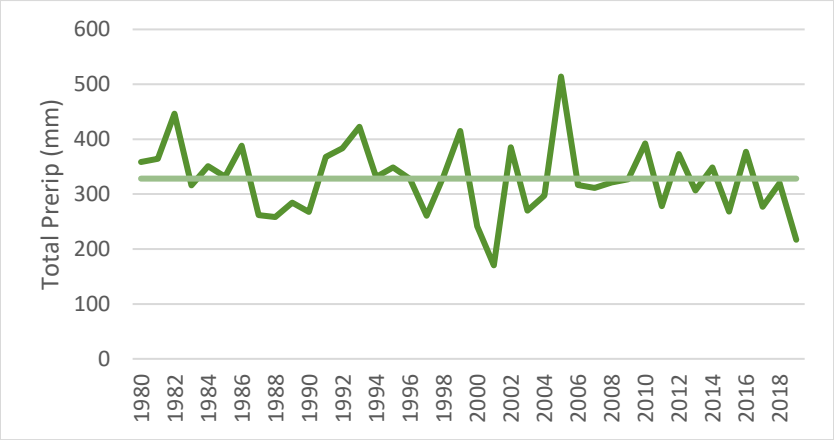


***Figure 5**: Precipitation for the ACHDA area showing total annual precipitation pulled from township 19 range 16*

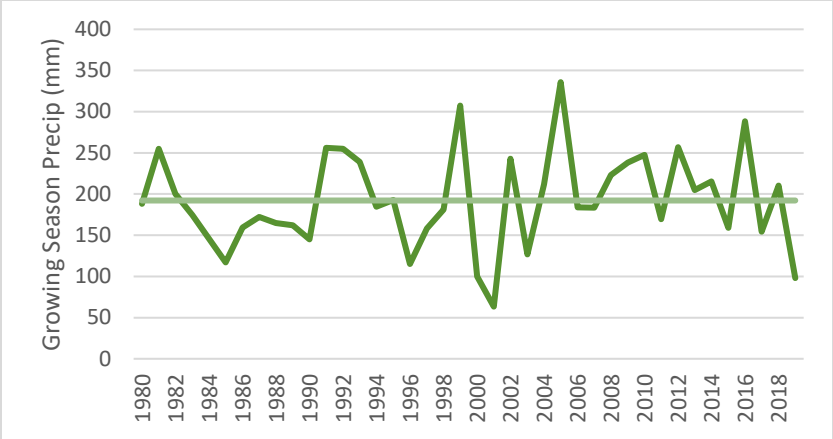


Figure 6: *Precipitation for the ACHDA area showing growing season precipitation (May to September), pulled from township 19 range 16.*

Discussion

In order to get a complete picture of range stewardship on ACHDA, it is helpful to consider the livestock management system alongside the results of the range inventory. This will provide context for any issues identified through the inventory and will inform future management. The following discussion is broken up into two parts; first a discussion of the condition of the rangeland resource based on inventory results, followed by an analysis of livestock management according to the principles of range management.

The first consideration is whether a concern with the state of the resource exists. This measure is not directly analogous with range or riparian health, but rather aims to evaluate whether the current state of the resource indicates a management issue that is degrading range health and function. Rangelands are mosaics, and species which inhabit them have complex and diverse requirements. Bird and mammal species on the prairies evolved and adapted to variations in grazing intensity and timing with most species adapted to moderate grazing or disturbance and some species preferring light grazing or no disturbance, and others preferring heavy grazing or disturbance (Adams et al, 2013). When considering the state of the range resource, it is also important to note that some range health issues are inherited legacy effects from previous overgrazing or other historical disturbances that cause increased presence of agronomic or invasive species. Resource concerns refer to how management is affecting range health, and whether management is meeting ecological goals. Since the inception of ACHDA in 1986, range health, forage production and carryover have continued to improve.

In the DMG Natural Subregion, one of the most important range health indicators is litter accumulation, due to the role litter plays in mitigating moisture limitation in the region. Overall, litter levels on ACHDA are considered to be high healthy or healthy (Figure 6). To get a high score, a distinct litter layer must be present, with uniform distribution across the pasture. Litter standing crop (lb/ac) must be in the range of 65 to 100% of expected levels under a moderate grazing regime. For loamy sites in the DMG, a healthy score yields 400 lbs/ac and a blowout site yields 250 lbs/ac. Litter amounts across the majority of the ranch exceeded these thresholds. Litter is a sensitive measure in range health and is the first indicator of overgrazing. Litter levels suggest that stocking rates and management of livestock distribution have

been appropriate and beneficial to range health over the past 5-20 years. The overall range health rating on ACHDA is high healthy with problems, and all pastures except pasture 3 score on the threshold between healthy-with-problems and healthy (Table 1; Figure 5).

An overall rating of high healthy-with-problems indicates minor impairment of some key functions of healthy rangeland. This can indicate that a management change is required in order to improve the overall health of the range resource. However, it is important to note that some range resource issues such as the presence of invasive grasses, including Crested Wheatgrass and Kentucky Bluegrass, are legacy issues stemming from historical industrial activity or above-average precipitation. These factors are beyond the control of current livestock management, but the presence of introduced grasses has had a significant negative impact on plant community composition across ACHDA, leading to reduced range health scores. For this reason, it is important to consider the livestock management system and overall management objectives in addition to range health results to separate grazing-related impacts from impacts created by other types of disturbance.

The biggest management consideration on the ACHDA land base is management of cumulative effects. Wetlands and water features are widespread across native pastures and provide moisture conditions that are suitable for a number of invasive plant species. Further, ACHDA is a popular destination for bird watchers, wildlife viewers, day hikers, hunters and group tours. Industrial footprint is the most significant human-created feature with over 100 acres of gravel road and non-use (by livestock) industrial facilities, and over 400 acres of industrial disturbance that was revegetated with crested wheatgrass. Industrial features, recreational pressure, and irrigation ditches all provide vectors for invasive species. Adaptive management requires continual monitoring and treatment of noxious and prohibited noxious weeds.

This has been addressed through several methods on ACHDA. To minimize introduction of invasive plants onto the land base, motorized vehicles and ATVs are only permitted on designated public access roads and parking areas. Targeted grazing during the spring and early summer has been used to address crested wheatgrass infestations, and downy brome on industrial features and roadsides has been addressed by hand pulling and herbicide application. As part of overall ranch management, ACHDA has an Invasive Management Plan in place with the specific objectives (Michalsky, 2014):

- Prevent the invasion of new species into ACHDA,
- Early detection of new invasions, especially high-risk areas,
- Rapid response to invasions of high priority species,
- Containment, control and eventual eradication of high priority species, and
- Collaboration with county, industry, livestock patrons and other stakeholders with the ability to influence plant management on ACHDA.

Taking into account the overall range health results (high healthy-with-problems), along with the fact that ranch management has plans in place to monitor and address the factors most strongly contributing to range health problems, there are no concerns with the rangeland resource on ACHDA.

The next component to be considered is overall stewardship on ACHDA, which evaluates the land manager's awareness and understanding of range management principles and their application of these principles to stewardship. The four principles of range management are:

- Balance livestock demand with available forage
- Distribute livestock grazing impact

- Avoid grazing in vulnerable periods
- Provide effective rest after grazing

ACHDA demonstrates that the first principle of range management is addressed as livestock demand and available forage are balanced through adaptive management and flexible stocking rates. Figure 4 shows that growing season precipitation was at or above average between 2004 and 2015, which translated into a significant increase in forage productivity over the same period (Appendix B). This has allowed for above average grazing opportunity, and ranch managers have been able to sustainably graze above the estimated grazing capacity for the last several years while still providing adequate levels of carryover to protect plants and soil, build organic matter, and provide for wildlife use. However, stocking above the suggested grazing capacity in the long term is not sustainable, and it is imperative to pay attention to precipitation and environmental factors and adjust livestock numbers accordingly. The sustainable grazing capacity for ACHDA native pastures is estimated at 1104 AUM. This is an average value, and in some years, there will be an opportunity to utilize more AUM. However, during drought or years with other management challenges, it may require utilizing fewer AUM.

ACHDA demonstrates that the second principle of range management is addressed by the manager's ability to distribute livestock grazing impact. Cattle are inherently lazy and will choose to stay close to salt and water. On ACHDA, water is not a limiting factor and is easily accessible in all pasture units throughout the ranch. Strategic placement of salt and mineral as a livestock distribution tool has had limited effect on animal distribution, and physically moving cattle by herding has worked as the best tool (N Wilson, per comms, March 3rd 2020). The complex network of industrial features, irrigation features and low-lying saline features throughout the ACHDA lands are likely have an impact on distribution across ACHDA (R Adams, per comms, March 25th2020). Reviewing the range health and litter maps highlights areas that could potentially have distribution issues. High health and litter along the western fence line in field 4, and in the north portion of field 2 suggest underutilization which can be expected as these areas are furthest from the yard and may be difficult for livestock to access. However, there are no indications that livestock are overutilizing any area, so overall livestock distribution is not a concern in native pastures.

ACHDA demonstrates that the third principle of range management is addressed by avoiding grazing during vulnerable periods. Native grasslands can be damaged by early spring grazing so common practice in the DMG is to defer grazing until plants have enough leaf area to tolerate defoliation. Riparian areas are also vulnerable to trampling, pugging and hummocking in the spring and early summer when soils are saturated by runoff. Since ACHDA has significant riparian and native pasture, grazing of native grasslands is deferred until July 1 by first grazing tame pastures on other parts of the ranch. However, native pastures are skim grazed for two weeks in May to utilize Crested Wheatgrass when it is most palatable to livestock. This skim graze is monitored carefully, and livestock behaviour studies done at ACHDA show that cattle preferentially select crested wheat grass over native grasses in the spring and early summer (Rushton, 2018).

ACHDA demonstrates that the fourth principle of range management is addressed by providing effective rest after grazing. ACHDA is operated under a deferred rotational management system, meaning that the order in which cattle are rotated through fields on the ranch which is changed annually. This means that field 1 might be grazed first on year one, then grazed third on year two. This staggers the season of use, allows for rest between grazing periods, and provides rest during the growing season between grazing episodes.

Summary

Current management practices on ACHDA maintain rangeland health and function. The long-term trend of range health on this land base is upwards which is a testament to sound management practices over the last several decades. Cumulative effects and legacy issues are the main management concern on ACHDA with an extensive industrial footprint and hundreds of acres of wetlands and riparian features that are at heightened risk of invasion by weeds and introduced grasses. Range health scores are reduced due to shifts in species composition in nearly all plant communities on the ranch. Litter scores are healthy across much of the ranch which illustrates the success of both short term and long-term management practices. Invasive species exist on the ranch but have been inventoried and are being managed under a comprehensive Invasive Species Management Plan. Wildlife surveys which have been completed over several years also form a basis which help to inform management decisions.

It is recommended that a range health audit is completed in 2030 which incorporates a review and update of the Invasive Plant Management Plan. When growing season precipitation levels trend downward, management should be adjusted to a more conservative stocking to utilize fewer AUM and ensure adequate carry over is maintained to protect soils and vegetation, ensuring that the benefits of healthy and functioning rangelands are maintained on ACHDA.

Appendix A: Range Inventory Protocol for Antelope Creek Habitat Development Area

Step 1: Stratification

For ACHDA, an initial stratification is already available in the form of the Grassland Vegetation Inventory (GVI). GVI consists of a polygon map and an attribute table that describes the inferred range site composition of each polygon. GVI polygons may contain up to 4 range site types, each with an attached percentile (ie. 100Lo denotes a polygon that is 100% loamy range site, while 65Lo-25BlO-10Sb denotes a polygon that is 65% loamy, 25% blowout, and 10% subirrigated range site by area). For a detailed description of the characteristics of range site types and their identification, please consult pages 18-22 of the *Dry Mixedgrass Range Plant Community Guide*. The surveyor will be provided with a copy of GVI for ACHDA prior to beginning the inventory.

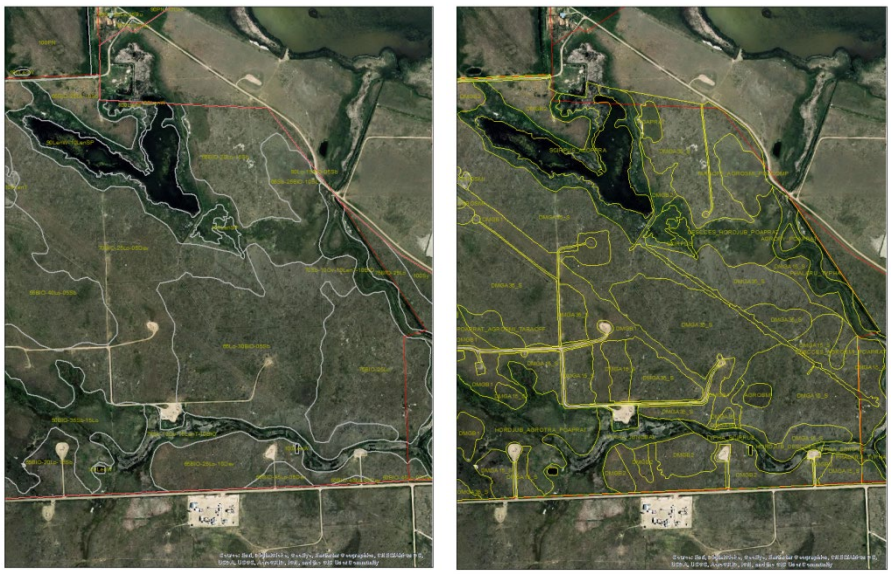


Figure 1. Example of basic plant community polygon line work (GVI/AVI/PLVI polygons) as the basis for inventory, and detailed map of inventoried area delineated by plant community polygons.

Due to the high level of industrial activity on ACHDA, there are many roads, tracks, ditches, pipeline rights-of-way, as well as active and reclaimed wellsites. The larger of these disturbances should be mapped out and assessed separately from surrounding polygons, and where roads, canals, or pipelines bisect a polygon, the polygon should be split along course of the linear feature and each side should be assessed separately. Finally, any polygon bisected by a fence should be split along the fenceline and each side assessed separately to account for differences in management and livestock distribution between pastures. Other disturbances may not be obvious from aerial photography, and cannot be mapped until the surveyor is in the field.

Step 2: Field Survey

Field survey serves 4 purposes:

- Verify of the location of stratified polygon boundaries and identify the boundaries of additional plant community polygons if necessary.

- Verify the range site classification of each polygon.
- Assess the composition of the plant community in each polygon.
- Assess the range health of each polygon.

Many GVI polygons on ACHDA contain 2-3 range site types, each with different ecological conditions and typically expressing different plant communities. Where this occurs, and the transition between plant community types can be easily mapped, large polygons should be subdivided to yield one polygon for each plant community contained in the larger original polygon. Additionally, the surveyor may encounter areas of anthropogenic disturbance so severe that the range site type cannot be determined, or where most or all native species have been replaced by introduced grasses and weeds. These severe disturbances should also be mapped out and assessed separately from surrounding polygons, using the range site of the polygon adjacent to the disturbance to determine reference plant community.

The fundamental unit at which an inventory is conducted is the polygon, delineated by the methods discussed above. For each polygon, and in order:

1. The surveyor should first explore the polygon to verify the boundaries of the plant community. Where boundaries differ from those suggested by pre-field stratification, draw in the corrected polygon boundaries on the map.
2. Name the polygon. The naming system is arbitrary and up to the surveyor, but ensure that each polygon, vegetation inventory transect, and health assessment has the same name to simplify data entry. At the scale of inventory done at ACHDA, each polygon should have its own transect and health assessment, and reconnaissance and visual plots should not be used.
3. Determine the range site type of the polygon using the range site descriptions found on pages 18-22 of the *Dry Mixedgrass Range Plant Community Guide*. The surveyor will receive training in range site interpretation for the Dry Mixedgrass natural subregion before the inventory begins.
4. Find a location within the polygon that is representative of the polygon in both plant community composition and range health.
5. On the representative location, lay out a 50 m transect tape. Record on the vegetation inventory form (MF5) the GPS co-ordinates at 0 and 50 m on the tape, and while standing at 0 m, record the compass bearing along the tape.
6. Place a 20x50 cm (Daubenmire) plot frame at 0 m. Over this plot, superimpose a 1x1 m plot starting at 0 m on the transect tape. The Daubenmire frame is used to assess cover of grasses, forbs, moss and lichen, bare soil, and total vegetation. The 1x1 m plot is used to estimate shrub cover. 10 of these 'nested' plots are done along the 50m transect, starting at 0m and done in 5m intervals.

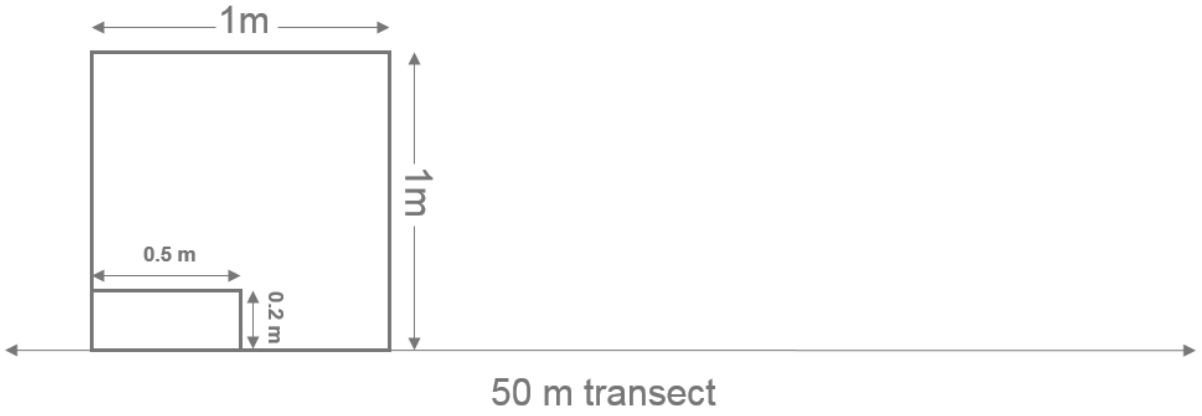
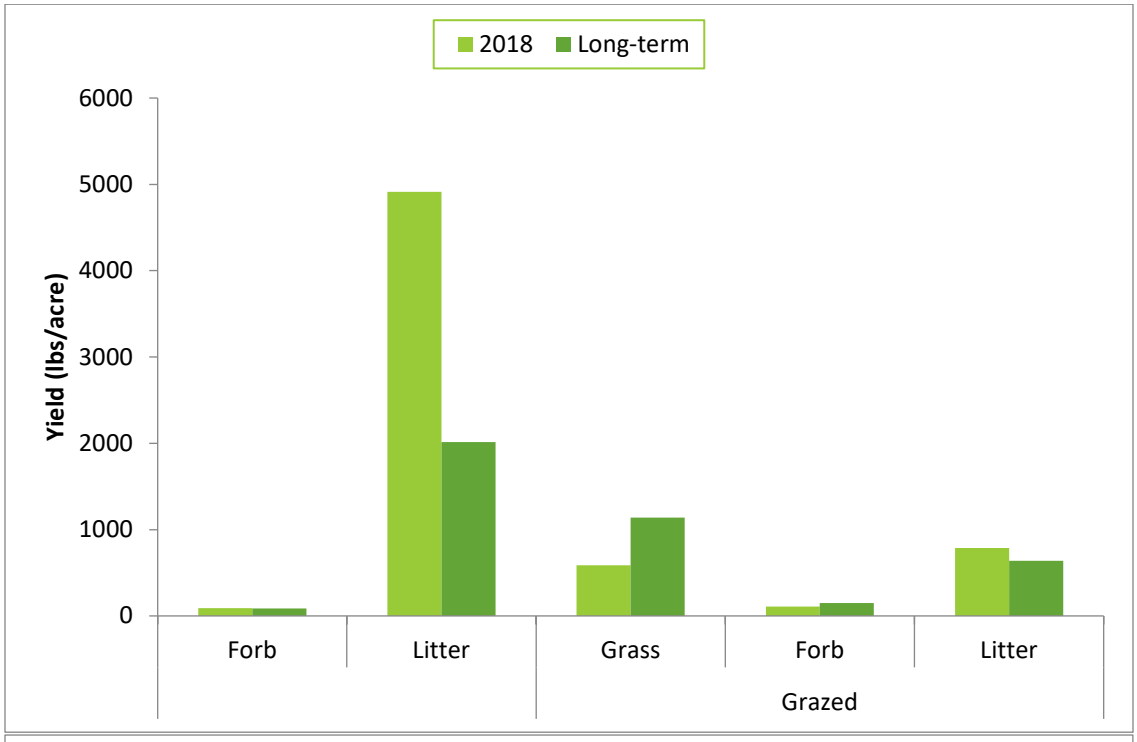


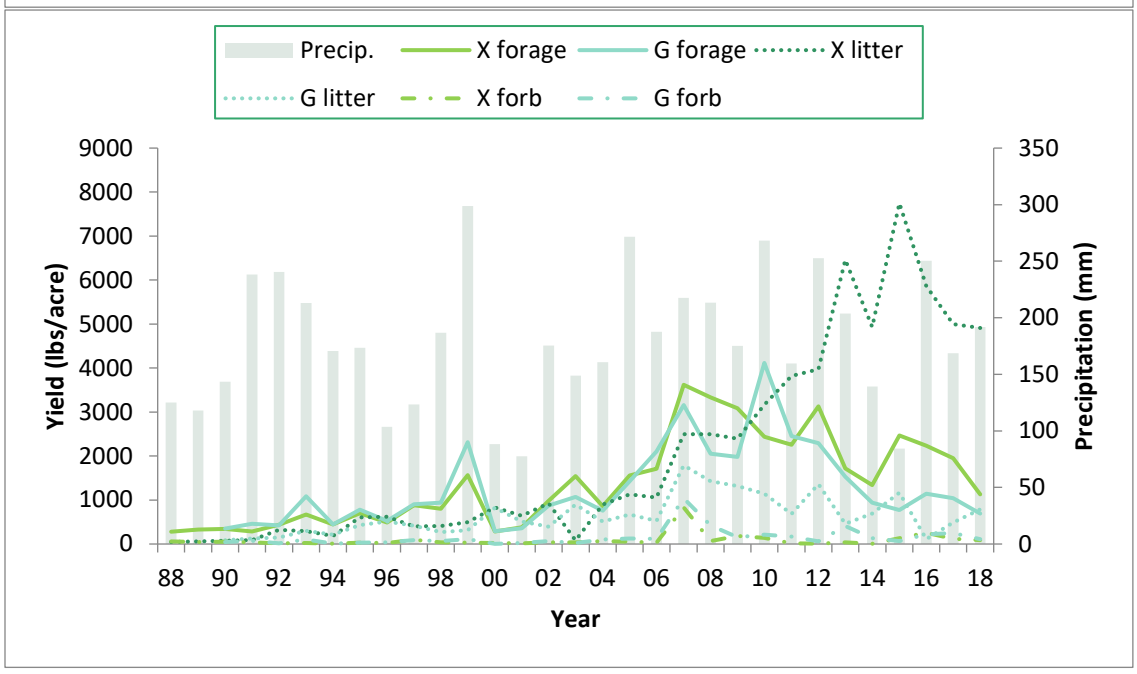
Figure 2. Schematic and dimensions of a transect.

7. Take 3 photos of the first plot at 0 m on the tape; a) a landscape photo looking down the transect tape (for this photo, make sure that no more than 1/3 of the shot is occupied by the sky), b) a photo looking straight down on the Daubenmire frame, and c) a photo looking on the Daubenmire frame at approximately 45° angle with the ground.
8. Assess vegetation cover at 5 m intervals along the transect tape using the Daubenmire and 1x1 m frames (**10 readings per transect**). Record the foliar cover of each grass, forb, and shrub species, as well as the cover of bare soil, moss & lichen, and total vegetation cover on an MF5 vegetation inventory form. Total vegetation is defined as all plant material in the plot, living or dead.
9. Rake all litter within a 50x50 cm plot at 2-3 locations within the polygon, and determine the litter weight by comparing raked litter with the images on page 30 of the range health assessment guide. Take the average for litter levels across the polygon and report it in the comments for Question 3 of the health assessment. The surveyor will receive training in litter weight estimation before the inventory begins.
10. Given a completed vegetation inventory form, confirmation of range site, and average litter amount, complete the native grassland health assessment for the polygon.

for the polygon.

Appendix B: Range Reference Area Antelope Creek 4 Data





Appendix C: Range Health Protocol, abridged format

Range Health Assessment

Field Worksheet for Grasslands

What is rangeland health?

Range health refers to the ability of rangelands to perform key ecological (i.e., natural) functions like:

- produce plant biomass including forage for livestock and wildlife,
- maintain site potential by protecting soil from erosion and degradation,
- capture and beneficially release water,
- cycle nutrients and energy, and
- maintain biological diversity.

Healthy rangelands optimally perform key functions and provide a broad range of values and benefits for society (e.g., carbon storage, clean water, wildlife habitat, recreation), whereas unhealthy rangelands cannot. Healthy rangelands provide stable grazing opportunities along with watershed and soil protection.

Why should I consider range health?

Health assessments provide an indication of sustainability and resiliency. They are a snapshot in time of management impacts on a particular site. Monitoring range health can highlight the impacts of disturbance, indicate management issues, guide management changes and evaluate outcomes. Assessments provide a means of tracking and communicating successes or arising issues.

What can this tool assess? How do I assess my grassland?

This is an abridged version of the grassland rangeland health assessment from the Rangeland Health Assessment for Grassland, Forest and Tame Pasture (Adams et al., 2016). The assessment focuses on evaluating the level of impact that disturbances are having on range health. Although the wording of the tool has an emphasis on grazing disturbances, any disturbance such as wildlife use and human activities (e.g., off road vehicle use, camping, etc.) could be evaluated.

The grassland range health assessment can be used for native (natural) grasslands throughout the province. If the land has been cultivated, the Tame Pasture Health Assessment should be used.

A health assessment involves comparing indicators of key ecological functions and processes on the assessment site to a standard (i.e., Reference Plant Community) representing the potential plant community type for that ecological site or rangeland site type. The Reference Plant Community (RPC) is an expression of plant composition on similar growing conditions with little or no disturbances (e.g., ungrazed or lightly grazed). The Alberta Rangeland section has developed range plant community guides that provide further information about RPCs and the sites you may be evaluating (available on the Government of Alberta website).

An assessment is completed within, and represents one, ecological site. A pasture unit may contain a variety of sites with different plant communities as a result of successional stages or site potential. If required, map the pasture unit subdividing areas of differing site potential or successional stages and assess each separately.

Health categories

The range health score is a cumulative measure of 5 indicators of key characteristics and ecosystem functions and is classified in one of the following health categories:

Healthy:

- A score of 75% or greater
- All of the key functions are being performed
- Grazing (disturbance) is balanced with site capabilities

Healthy with Problems:

- A score of 50 to 74%
- Performance of one or two of the key functions may be impaired
- This score is an early warning that adjustments to management are needed
- Recovery to a healthy category can normally occur within a few years

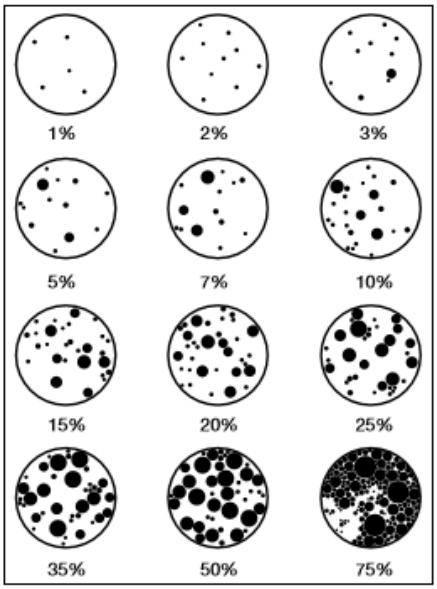
Unhealthy:

- A score of less than 50%
- Few of the functions of healthy range are being performed
- Significant management changes are required to address unsustainable grazing pressure or other types of disturbance
- Recovery to a healthy category may take many years

For more detailed information:

For more discussion on this tool, range health concepts and evaluation techniques, please refer to Adams et al., 2016 "Rangeland Health Assessment for Grassland, Forest and Tame Pasture" available at a Government of Alberta Rangelands office or website.

Percent Cover Examples



Density Distribution

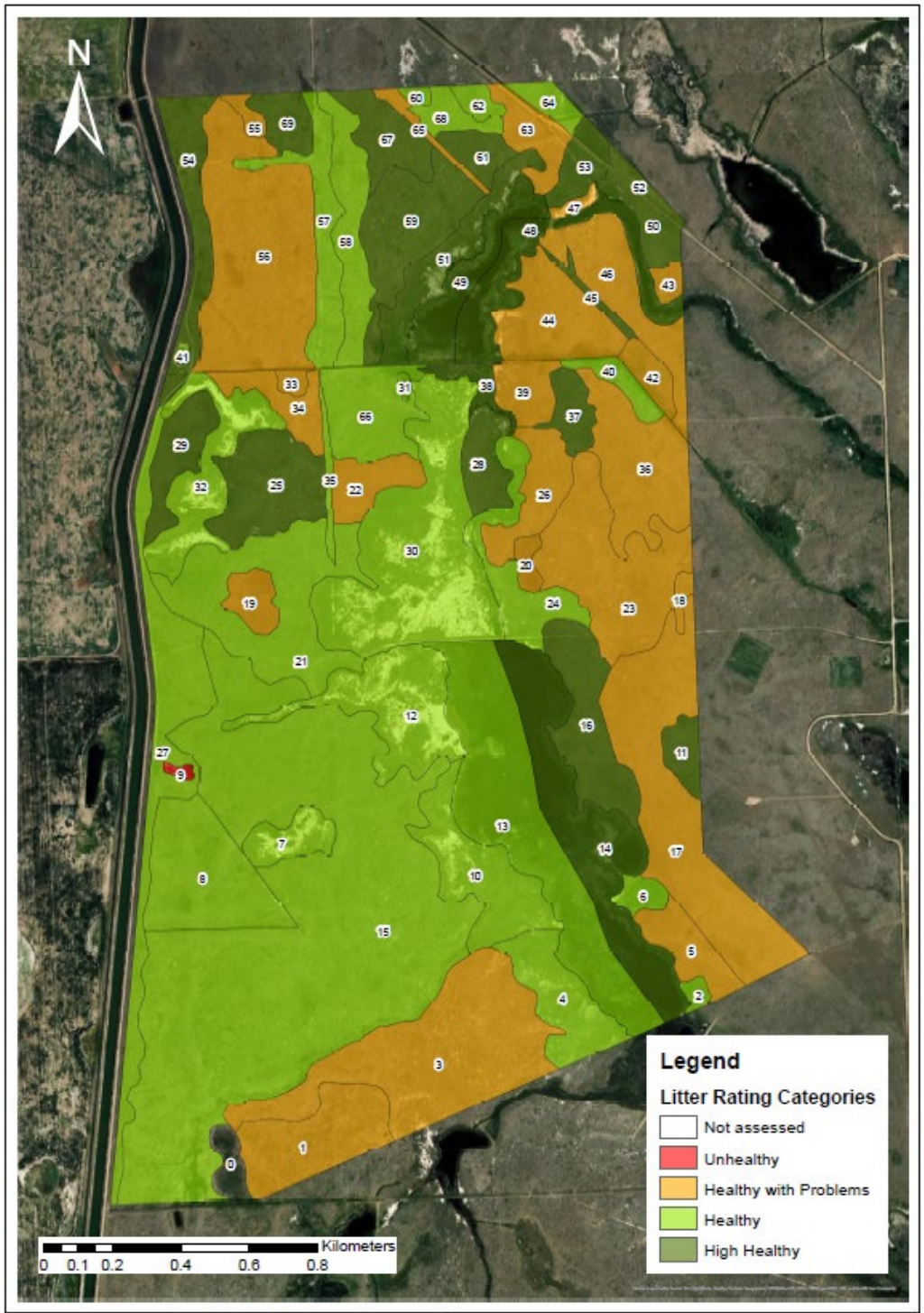
Class	Description of abundance in polygon	Distribution	Weeds Score
0	None		5
1	Rare		3
2	A few sporadically occurring individual plants		
3	A single patch		
4	A single patch plus a few sporadically occurring plants		1
5	Several sporadically occurring plants		
6	A single patch plus several sporadically occurring plants		
7	A few patches		
8	A few patches plus several sporadically occurring plants		0
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		

Rangeland Health Assessment Litter Thresholds (lb/ac)

Natural Subregion (Soil Zone)	Range Sites	Healthy		Healthy with Problems	Unhealthy
		Average	>65%	65% - 35%	<35%
Aspen Parkland (Black)	Loamy	1500	(>975)	975 - 525	<525
	Sandy	1100	(>715)	715 - 385	<385
	Sands	800	(>520)	520 - 280	<280
	Choppy sandhills	400	(>260)	260 - 140	<140
Foothills Fescue, Foothills Parkland and Montane (Black)	Thick Black Loamy	1400	(>910)	910 - 490	< 490
	Orthic Black Loamy	1200	(>780)	780 - 420	< 420
	Shallow to Gravel and Limy	1000	(>650)	650 - 350	<350
	Thin Breaks	500	(>325)	325 - 175	<175
Mixed Grass (Dark Brown)	Loamy (>1100m)*	900	(>585)	585 - 315	<315
	Loamy (<1100m) + Limited	600	(>390)	390 - 210	<210
	Thin Breaks, Limey and Shallow to Gravel	300	(>195)	195 - 105	<105
Dry Mixed Grass (Brown)	Loamy	400	(>260)	260 - 140	<140
	Blowout	250	(>160)	160 - 85	<85
	Thin Breaks	150	(>95)	95 - 50	<50

* Elevation

Appendix D: Field 1 Litter



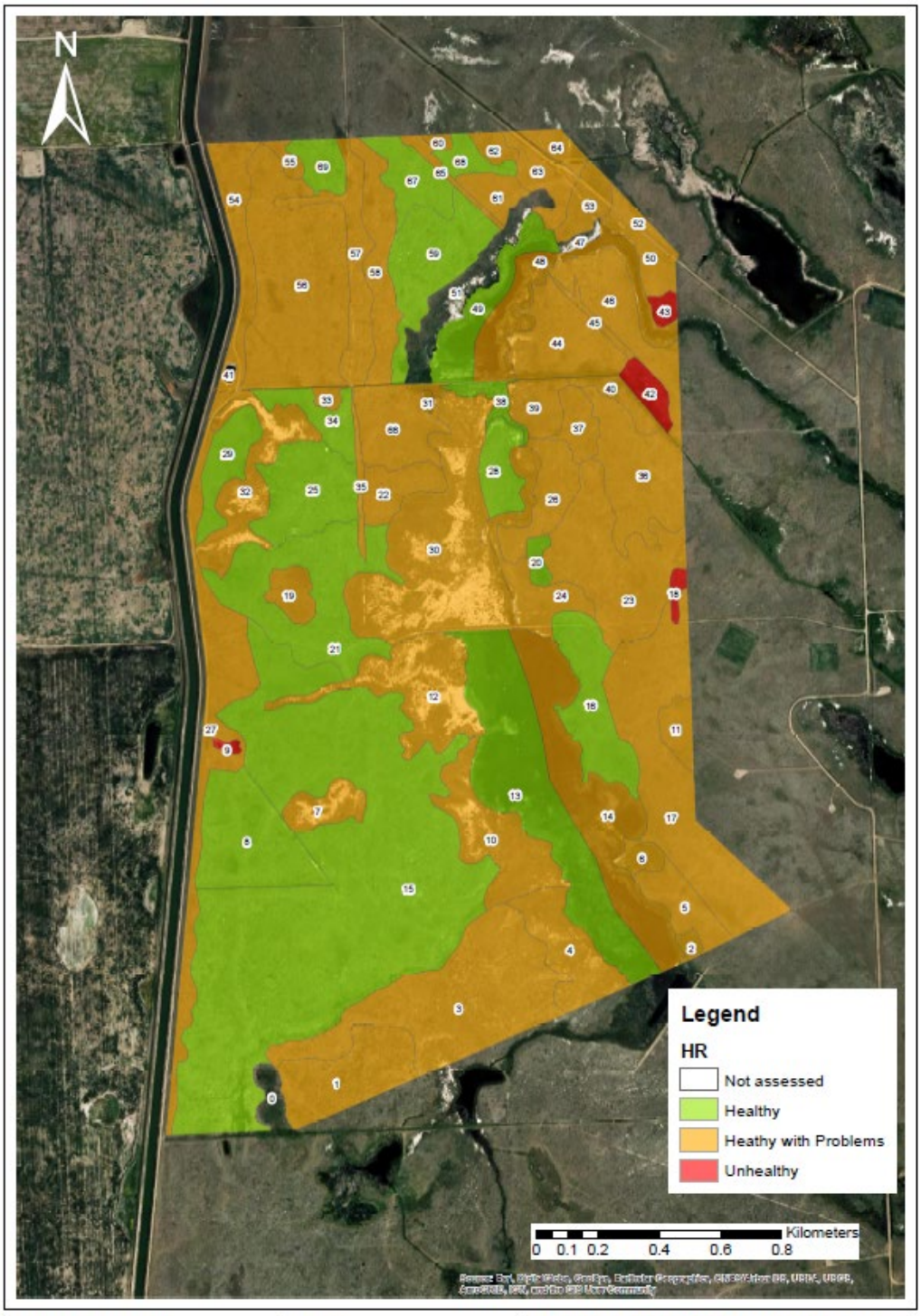
Litter Deliniations lbs/ac				
Site type	Unhealthy	Healthy with Problems	Healthy	High Healthy
Sub irrigated/overflow	<50	51-95	96-150	151+
Blowout	<85	86-160	161-250	251+
Loamy	<140	141-260	261-400	401+

Antelope Creek Habitat Development Area
Field 1
NAD 1983 UTM Zone 10TM
March 10, 2020
1:10,000

Keefer Ecological Services Ltd

Antelope Creek Ranch

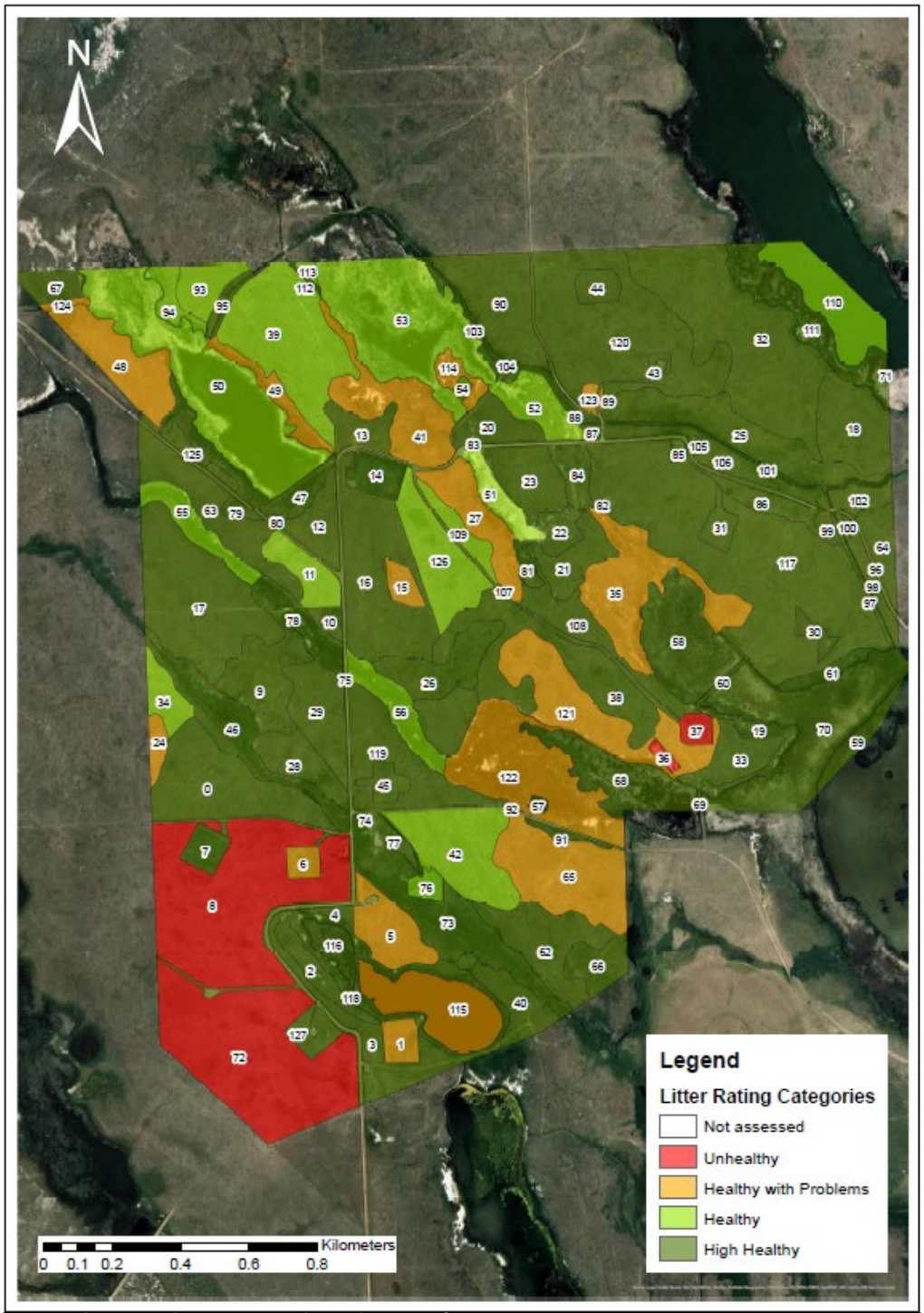
Appendix E: Field 1 Range Health



Range Health Scores	% Score
Healthy	75+
Healthy with Problems	50-75
Unhealthy	0-50

Antelope Creek Habitat Development Area
Field 1
March 10, 2020
1:11,000
Keefer Ecological Services Ltd
NAD 1983 UTM Zone 10TM
Antelope Creek Ranch

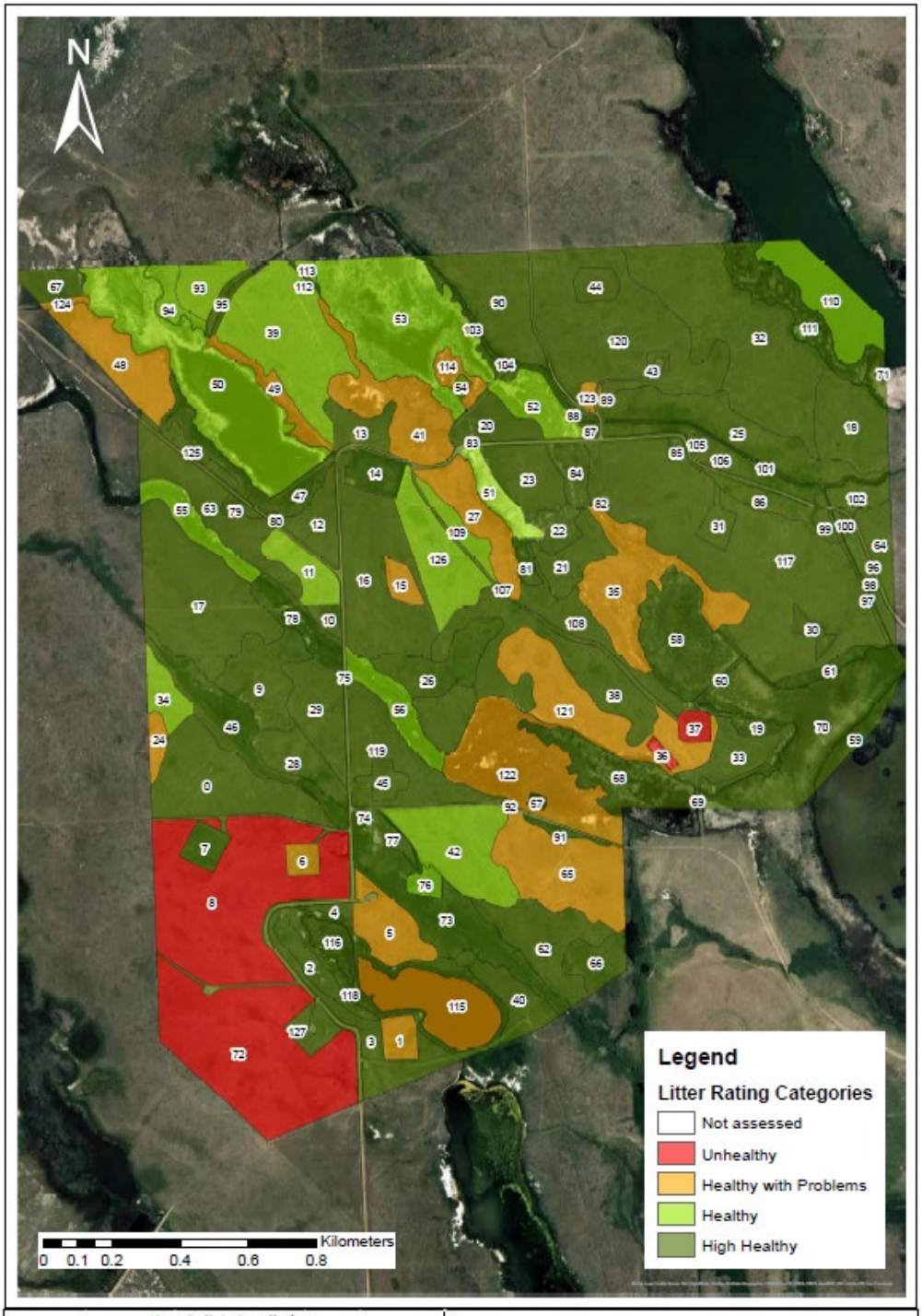
Appendix F: Field 2 Litter



Litter Deliniations lbs/ac				
Site type	Unhealthy	Healthy with Problems	Healthy	High Healthy
Sub irrigated/overflow	<50	51-95	96-150	151+
Blowout	<85	86-160	161-250	251+
Loamy	<140	141-260	261-400	401+

Antelope Creek Habitat Development Area
Field 2
NAD 1983 UTM Zone 10TM
March 10, 2020
1:10,000

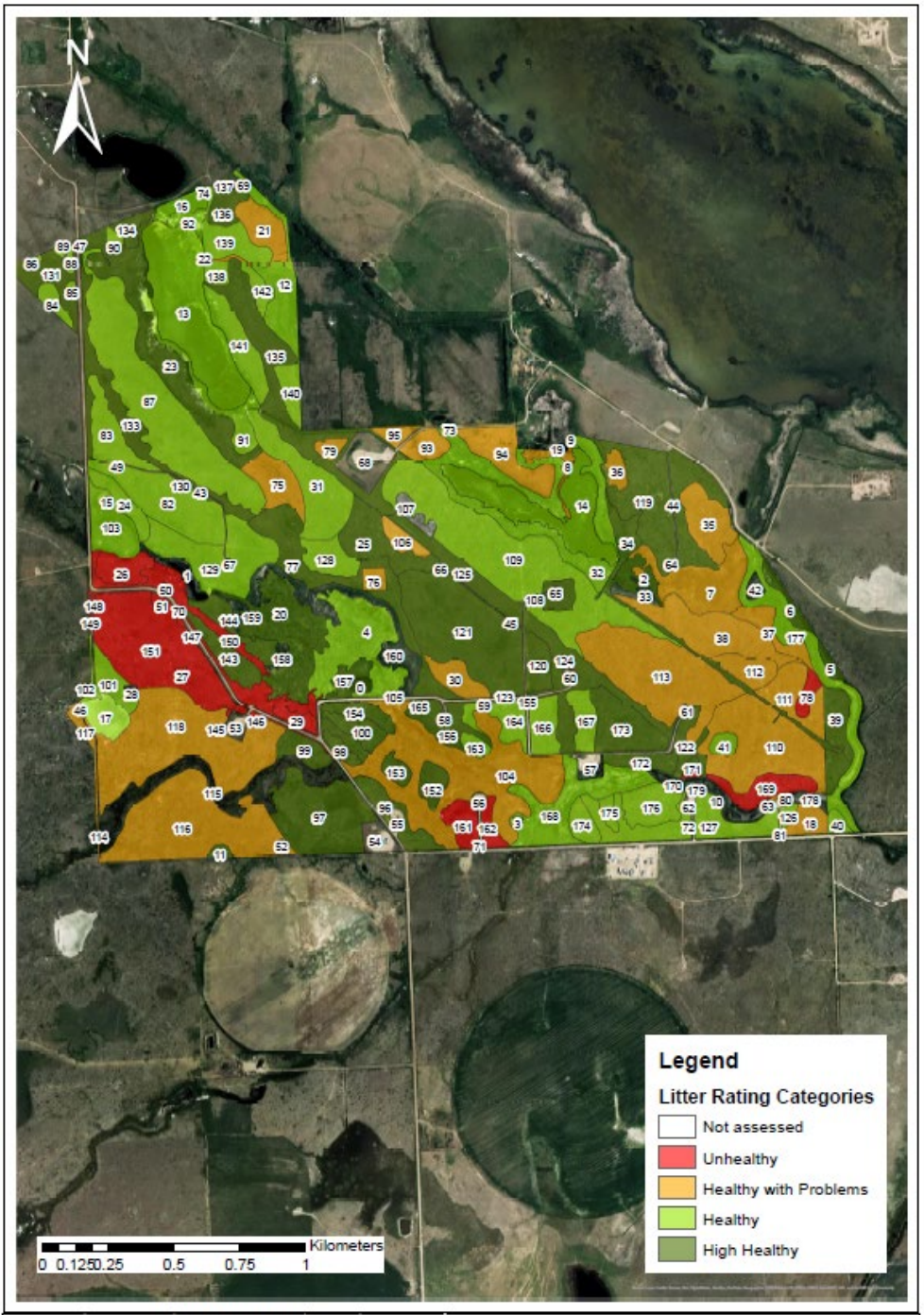
Appendix G: Field 2 Range Health



Litter Deliniations lbs/ac				
Site type	Unhealthy	Healthy with Problems	Healthy	High Healthy
Sub Irrigated/Lowerflo	<50	51-95	96-150	151+
Blowout	<85	86-160	161-250	251+
Loamy	<140	141-260	261-400	401+

Antelope Creek Habitat Development Area
Field 2
NAD 1983 UTM Zone 10TM
March 10, 2020
1:10,000

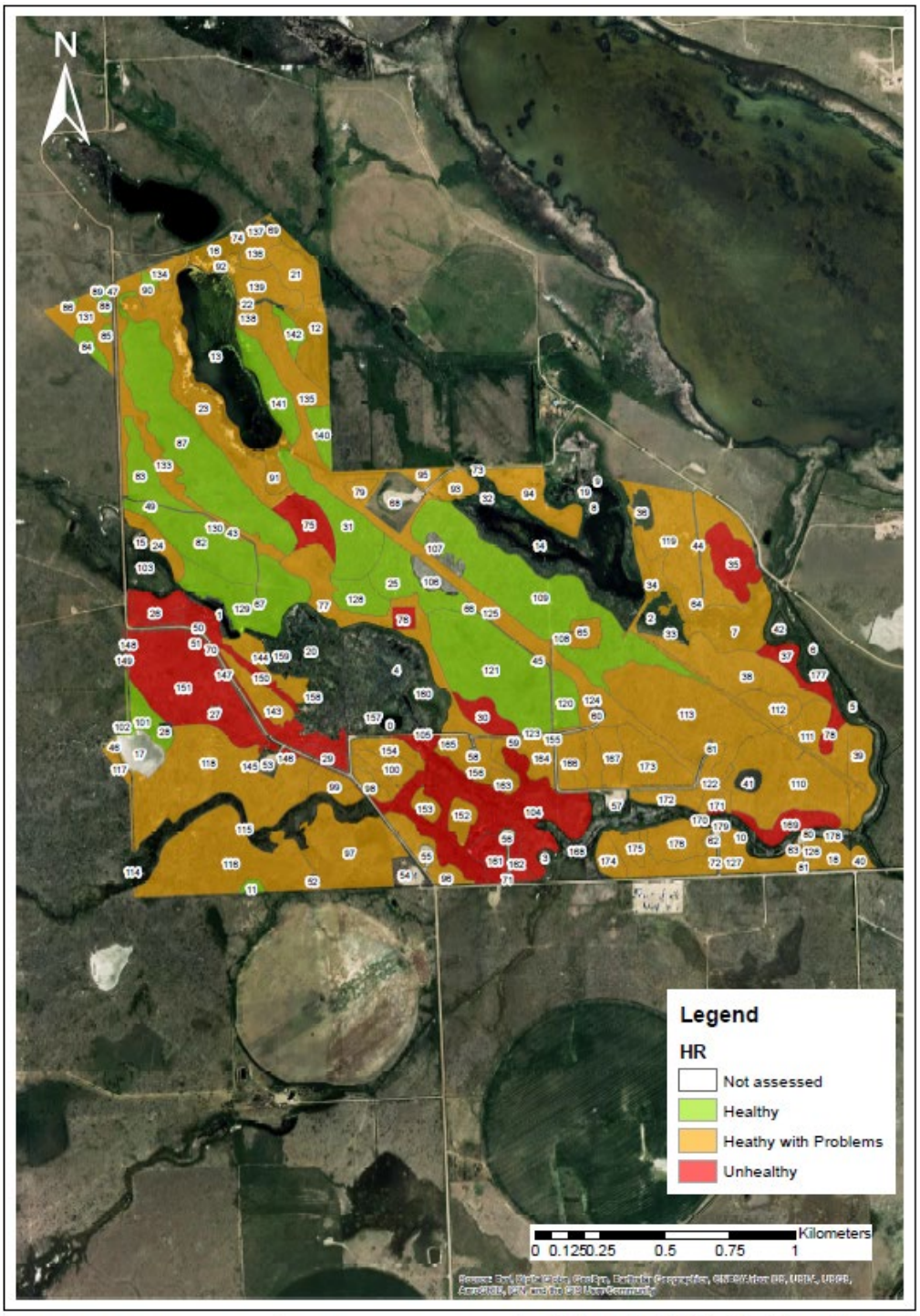
Appendix H: Field 3 Litter



Litter Deliniations lbs/ac				
Site type	Unhealthy	Healthy with Problems	Healthy	High Healthy
Sub irrigated/overflow	<50	51-95	96-150	151+
Blowout	<85	86-160	161-250	251+
Loamy	<140	141-260	261-400	401+

Antelope Creek Habitat Development Area
Field 3
NAD 1983 UTM Zone 10TM
March 10, 2020
1:13,000

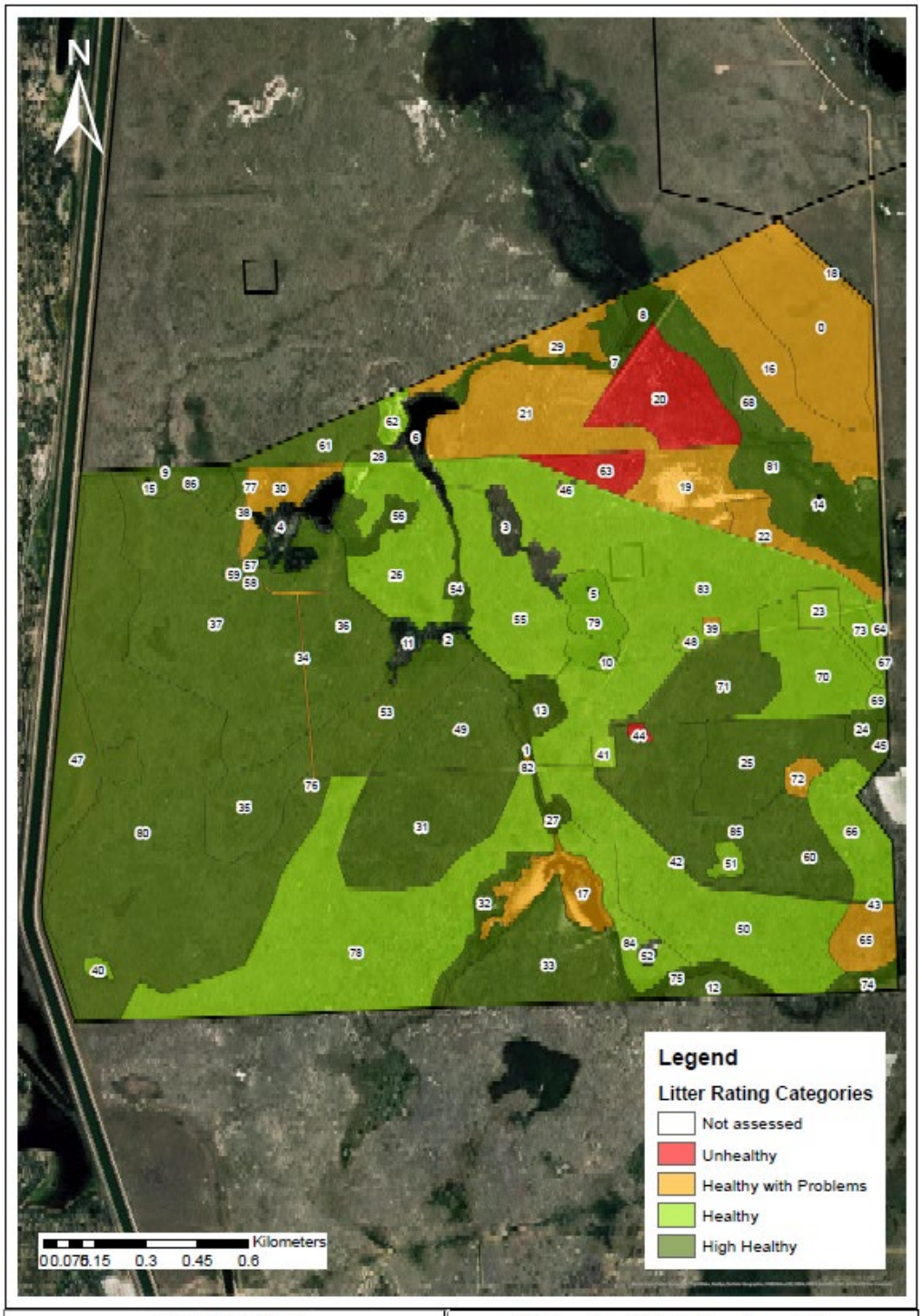
Appendix I: Field 3 Range Health



Range Health Scores	% Score
Healthy	75+
Healthy with Problems	50-75
Unhealthy	0-50

Antelope Creek Habitat Development Area
Field 3
March 10, 2020
1:13,000
Keefer Ecological Services Ltd
NAD 1983 UTM Zone 10TM
Antelope Creek Ranch

Appendix J: Field 4 Litter



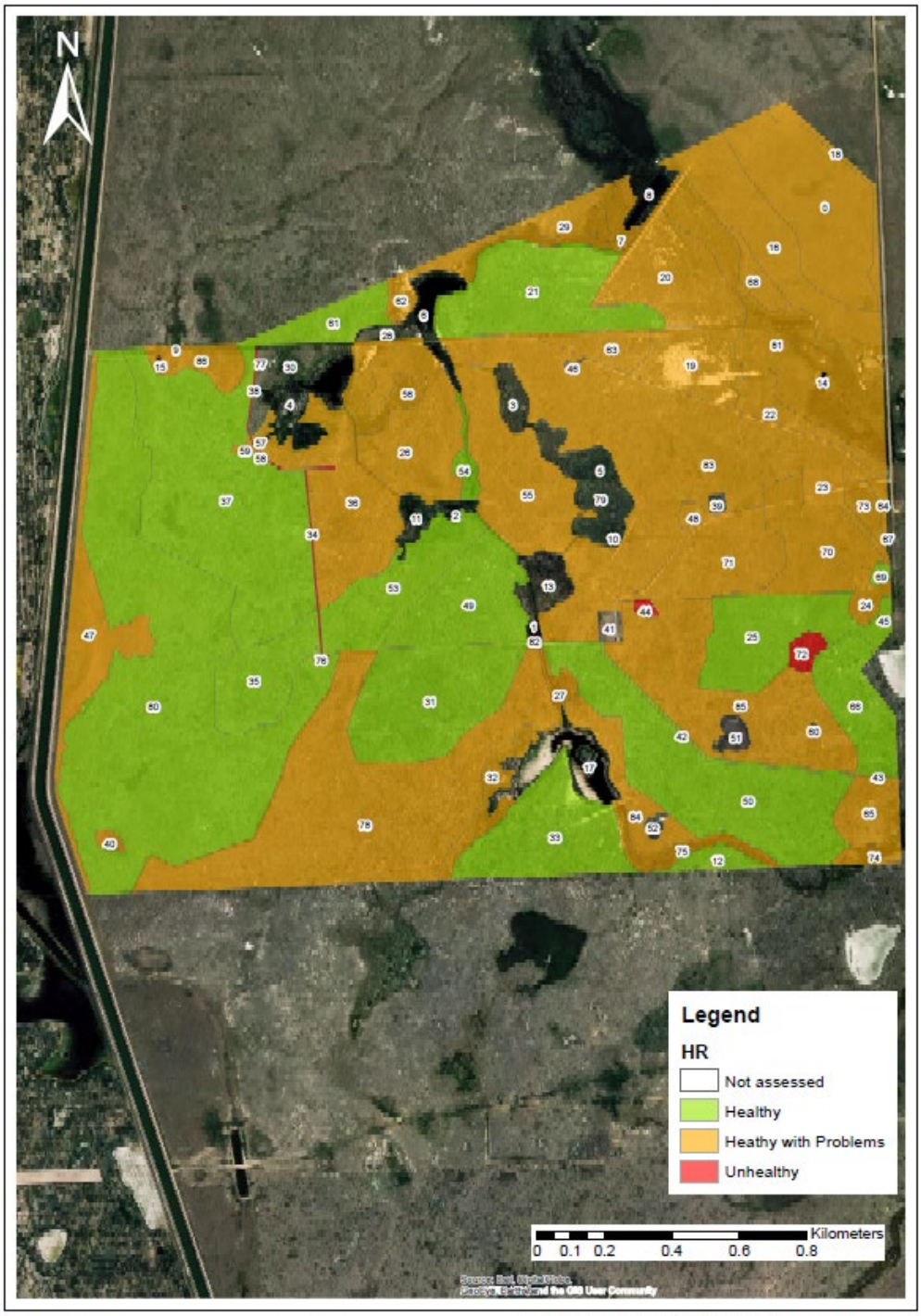
Litter Delineations lbs/ac				
Site type	Unhealthy	Healthy with Problems	Healthy	High Healthy
Sub irrigated and overflow	<50	50-95	96-150	151+
Blowout	<85	85-160	161-250	251+
Loamy	<139	141-260	261-400	401+

Antelope Creek Habitat Development Area
Field 4
NAD 1983 UTM Zone 10TM
March 10, 2020
1:10,000

Keefer Ecological Services Ltd

Antelope Creek Ranch

Appendix K: Field 4 Range Health



Range Health Scores	% Score
Healthy	75+
Healthy with Problems	50-75
Unhealthy	0-50

Antelope Creek Habitat Development Area
Field 4
March 10, 2020
1:10,000
Keefer Ecological Services Ltd
NAD 1983 UTM Zone 10TM
Antelope Creek Ranch

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