SASKATCHEWAN

RANGELAND HEALTH ASSESSMENT

FOR NATIVE GRASSLANDS

FIELD WORKBOOK

2ND EDITION

ACKNOWLEDGEMENTS

This Saskatchewan rangeland health assessment workbook on native grassland was completed in true Saskatchewan fashion through teamwork and building on the good work of our neighbours.

The working group responsible for this update was initiated and led by Rachel Turnquist (Environment and Climate Change Canada). Cassandra Schroeder (then with Saskatchewan Ministry of Agriculture) took on the leadership role when Rachel was on leave, then passed the baton to Bill Houston (Agriculture and Agri-Food Canada) as she took on a new opportunity. Chelsey Siemens (Saskatchewan Ministry of Agriculture) was co-chair of the Working Group. Other Working Group members included: Alexandria Gallon (Parks Canada; and for a portion, Saskatchewan Ministry of Agriculture), Maggi Sliwinski, and Mickenzie Plemel (Parks Canada); Dr. Amanda Muller and Dr. Eric Lamb (University of Saskatchewan); Chet Neufeld (Native Plant Society of Saskatchewan); Jeffrey Harder (Environment and Climate Change Canada); Kerry LaForge (Agriculture and Agri-Food Canada); Krista Connick Todd (South of the Divide Conservation Action Program Inc.); Dr. Lysandra Pyle (University of Saskatchewan, then Alberta Biodiversity Monitoring Institute); Marika Sherman (Saskatchewan Stock Growers Foundation); Matthew Braun (Nature Conservancy of Canada); Renny Grilz (Meewasin Valley Authority); and Ross MacDonald (Ducks Unlimited Canada). Carolyn Gaudet managed the project finances (Saskatchewan Prairie Conservation Action Plan). Tara Mulhern Davidson was the technical writer for the project, bringing together our ideas and edits into one consolidated version.

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Adams, B.W., G. Ehlert, C. Stone, M. Alexander, D. Lawrence, M. Willoughby, D. Moisey, C. Hincz, A. Burkinshaw, J. Richman, K. France, C. DeMaere, T. Kupsch, T. France, T. Broadbent, L. Blonski, A.J. Miller. 2016. Rangeland Health Assessment for Grassland, Forest and Tame Pasture. AEP, Rangeland Resource Stewardship Section.

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Saskatchewan Prairie Conservation Action Plan. 2008. Rangeland Health Assessment, Native Grassland and Forests (1st Edition). Prairie Conservation Action Plan.

Credits

Technical Writer and Photographs: Tara Mulhern Davidson, PAg
Workbook Layout and Cover Design: Suzanne Joyce

Saskatchewan Prairie Conservation Action Plan

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A HISTORY OF SASKATCHEWAN RANGE HEALTH

In 2008, a collaborative rangeland stakeholder committee, coordinated by the Saskatchewan Prairie Conservation Action Plan, published Saskatchewan's first Rangeland Health Assessment Field Workbook.

The initial Saskatchewan edition was based on the Alberta Rangeland Health Assessment Field Workbook which has since been revised. Manitoba developed a Range and Pasture Health Assessment Workbook in 2017. In 2021, Saskatchewan's rangeland community initiated an update of the original version to incorporate new information. A revision of the science-based assessment method improves clarity and consistency between users and fosters collaboration between Saskatchewan's diverse rangeland stakeholders.

This update is for native grassland assessments only. For forest assessment protocols, refer to the 2008 version. Assessing range health is an evolving science. As new information becomes available, this guide may be updated again.

Find Saskatchewan's most current resources related to rangeland at www.saskpcap.org/rangelands.

ABOUT THIS WORKBOOK

Why use this workbook?

A range health assessment is a standardized way to evaluate the overall "health" or function of a rangeland ecosystem relative to its potential. With practical experience and field training, assessors can improve effectiveness and consistency when evaluating range health.

This method is repeatable and is used to document range health at a single point in time. With subsequent assessments, range health can be a tool to compare change over time. A range health assessment can serve as a baseline, as well as be a useful tool for tracking and communicating successes or identifying potential management challenges.

Range management is an art and a science. This workbook guides users through scoring five different range health indicators. It's impossible to confine rangeland into boxes and checklists, however, the scoresheet is designed to prompt observations and field notes to help document ecological processes. Photos, waypoints, and drawings can add valuable context to the scoresheet. As with any field workbook, observers will encounter unique situations that require judgment calls.

Who is this workbook for? Where does it apply?

This workbook can be helpful for producers, landowners, resource managers, conservation organizations, environmental consultants, students, industrial companies, and protected area managers. Anyone with an interest in conserving and maintaining rangeland is encouraged to use this assessment.

This workbook is designed for native grasslands in Saskatchewan. The rangeland health assessment is a tool to help producers, managers, and stakeholders ensure the sustainable management of Saskatchewan's valuable rangeland.

For tame assessment areas, the Alberta tame pasture assessment method may apply. There is information available on rating tame pasture condition in Saskatchewan in Initial Stocking Rate Recommendations for Seeded Pastures in Saskatchewan.

Goals and Objectives

The methods and concepts in this workbook can be adapted and refined to suit the goals, needs, and objectives of different organizations and individuals. Range health assessments can be accomplished using many different data collection methods. Groups or individuals may also modify the scoresheet into a digital data form.

Organizations may have unique ecosystem objectives, habitat targets, or production goals they are working towards. This can impact the level of detail and the scale of the assessment.

When groups, companies, or organizations are planning to conduct range health assessments, collaborative training at the beginning of the season is useful to create consistency among observers.

What are rangelands?

Rangeland is land supporting indigenous, natural, or introduced perennial vegetation, is managed as a natural ecosystem, and is grazed or has the potential to be grazed. Rangelands are complex and diverse and can include native prairie grassland, forested areas, pastures, shrubland, and riparian areas.

Rangeland ecosystems have traditionally been valued as a source of forage for the livestock industry. However, there is growing awareness and research demonstrating numerous functions and values that rangelands provide for society beyond grazing, including those demonstrated in Figure 1 and Table 1. Healthy rangelands and pastures provide ecological goods and services that benefit all walks of life in Saskatchewan.

Figure 1. Values and benefits of Saskatchewan rangeland. (Original image created for Prairie Conservation Action Plan, Tara Mulhern Davidson).

Table 1. Rangeland functions and why they are important

RANGELAND AND PASTURE FUNCTIONS	WHY IS THE FUNCTION IMPORTANT
PRODUCTIVITY	• Healthy range plants use available water and solar energy more efficiently for increased growth and plant production. • Healthy range and pasture plants provide forage and habitat for livestock and wildlife. • Healthy range and pasture plants provide food and habitat for all life forms, including insects, bacteria, and decomposers.
SITE STABILITY	• Stable sites maintain potential plant production. • Stable sites conserve soils that have developed over centuries.
CAPTURE & BENEFICIAL RELEASE OF WATER	• Healthy rangeland stores and filters water, releasing it slowly for plant growth and other functions. • Captured water reduces runoff and minimizes the potential for soil erosion. • Water capture and storage improves ecosystem stability during drought.
NUTRIENT CYCLING & CARBON STORAGE	• Rangelands retain and recycle nutrients that support plant growth and contribute to stable soils. • Rangelands store carbon in a stable below-ground form that withstands grazing or fire. • Rangelands are nutrient-efficient and do not require external fertilizer inputs to sustain growth.
PLANT SPECIES DIVERSITY	• Healthy rangelands maintain a diversity of grasses, forbs, shrubs, and trees, creating landscapes that are resilient to climatic extremes such as drought or flooding. • Diverse plant communities sustain high-quality plants that meet the habitat and forage needs of livestock, wildlife, birds, and other species in the complex web of life.

What is range health and why does it matter?

The term "range health" is the ability of a site to perform key ecological functions relative to the site's potential. Health refers to an overall picture of the fundamental systems that are part of a range ecosystem and how they are present and work together.

"You can't manage what you don't measure." When part of a rangeland system is under stress, the overall function of the entire ecosystem may be impaired.

Healthy rangelands are resilient to disturbance and can withstand pressures and recover quickly.

A range health assessment can:

- provide baseline information and help managers support land management goals;
- be used to identify the presence and scale of rangeland challenges, allowing managers to make effective changes; and
- indicate whether current management practices are having the expected outcomes.

How is range health measured?

Understanding Ecosites and Ecosite Descriptions

Within the Prairie Ecozone of Saskatchewan, there are four ecoregions: the aspen parkland, moist mixed grassland, mixed grassland (including dry mixed grassland), and Cypress upland. These ecoregions are based on long-term climate patterns and major geological features. Within each ecoregion, land is divided into unique ecosites based on topography, soil, and landscape characteristics, such as soil texture, drainage, slope, and topography. Within each ecosite, different plant communities can develop, depending on dynamic factors including disturbance such as grazing, fire, and exotic plant species invasion.

Range health assessments require a basic understanding of plant communities and soils being assessed. *Saskatchewan Rangeland Ecosystems: Ecoregions & Ecosites (Version 2)* contains descriptions of plant communities for different ecosites across the province and is an important tool in the interpretation of ecological status. Each ecosite has a unique reference plant community. A few examples of different ecosites include loam, sandy, saline, clay, thin, overflow, and solonetzic.

Find *Saskatchewan Rangeland Ecosystems: Ecoregions & Ecosites* at www.saskpcap.org/rangelands. This publication series contains descriptions of plant communities for all described ecosites and provides a standard reference to compare to the plant communities observed on the ground.

Saskatchewan Rangeland Ecosystems: Estimation of Percent Cover Values for Species Abundances (also found at www.saskpcap.org/rangelands) helps assessors convert biomass to cover estimates for reference plant communities.

What happens if there is no reference plant community? On page 25, find tips on how to conduct an assessment when a published reference community is unavailable.

The reference plant community changes for different ecoregions. For example, a loam ecosite in the dry mixed grassland ecoregion will support a different plant community than a loam ecosite in the aspen parkland ecoregion.

Range Health Indicators

A range health assessment evaluates five key indicators of ecosystem function. To score the assessment area, a comparison is made between how the site is currently performing relative to the ecosite potential. The assessment guides observers through five indicator questions:

1. What is the plant community?
2. Are invasive weeds present?
3. Are expected vegetation layers present?

} Questions 1-3 (60 points) relate to plant community

4. Is there bare soil or erosion?
5. Is the expected amount and distribution of litter present?

} Questions 4 & 5 (40 points) relate to site stability/ hydrology

Each indicator is weighted according to the relative importance of the range function. At the end of the assessment, an overall health score is calculated, and the site receives a rating of Healthy (75-100%), Healthy with Challenges (50-74%), or Needs Improvement (0-49%). Each indicator is explored in detail in the next section.

Hyperlinks throughout this workbook provide direct access to online resources. Links may change over time, so visit the Resources section to find information in case of a broken link.

Whether you are a producer, a resource manager, or a scientist, anyone can use this workbook to conduct repeatable and consistent range health assessments.

Depending on the goals and objectives of the organization or individual performing an assessment, the range health method can be used in different ways.

- A **rapid assessment** is scoring range health based on estimated (**qualitative**) observations.
- A **range inventory** requires expert training to collect comprehensive data that may include vegetation surveys, quadrat sampling, transects and other **quantitative** measurements. Range inventory data can be used to answer range health assessment questions.

Field Supply Checklist

- Maps, GIS data, aerial images
- Plant and weed identification books
- Range health assessment workbook & scoresheets
- Clipboard, pens/pencils
- Applicable ecosite guides with reference communities
- Camera, drone, and/or tablet
- Extra batteries, charging cords
- GPS
- Spade or soil sampler
- A quadrat frame (50cm x 50cm or 20cm x 50cm)
- Plant litter reference kits
- Safety supplies

Before Going to the Field

Determine the **management unit**, pasture, or field that will be assessed. Management unit, pasture, or field are terms often used interchangeably to describe an area of rangeland isolated (temporarily or permanently) from other management units by fencing or landscape features such as water or slope. Because a management unit is managed separately, it needs to be assessed separately. **Assessments don't cross fence lines.**

Review range information for the site, including:

- **size and location of the field or management unit**;
- **satellite imagery**;
- **field maps**;
- **forage type (i.e., native or tame)**;
- **expected soil type, topography, and expected ecosite;**
- available grazing data, including entry and exit dates, stocking rate, animal type, and movement history;
- locations of fence lines, trails, and stock water sources;
- locations of industrial infrastructure (e.g., oil and gas wells, tanks, compressor stations);

- previous assessments, photos, maps, and reports;
- management history and concerns, including invasive weed management data and past recommendations for the site;
- potential species at risk in the area; and
- climate and weather data.

Choose an Assessment Area that Tells the Story of What is Happening on the Rangeland

Complete the number and type of assessments to effectively and accurately capture what is happening on the range.

The scale and locations selected for assessments will depend on time, budget, and the complexity of the site, but ensure the assessment area represents management, soils, topography, plant communities, and other characteristics observed.

After gathering information, it may be helpful to create a field map of potential ecosites and assessment areas as a starting point.

Accessing *Saskatchewan Rangeland Ecosystems: Ecosite Guide* and related ecosite publications are essential for conducting an assessment. Online tools such as HABISask and the Saskatchewan Soil Information System (SKSIS) help indicate soil unit maps and ecosite maps by ecoregion and legal land location. A step-by-step guide to using these tools can be found in Appendix A.

Selecting an Assessment Area

How an area of rangeland is assessed will have a large impact on the quality of data collected and the accuracy of a range health assessment. **Select an assessment area that best represents the overall area and does not cross a fence line or management boundary.** Vegetation types and their proportions must be represented. Many fields will have several ecosites within them, and each ecosite should be assessed separately.

Take thorough notes during an assessment. This helps validate scores and provides context for follow-up assessments.

The scale of assessment can be at the plant community, field, or other management level. The scale can be adapted to meet the goals of the organization or individual performing the assessment.

Review the information gathered, including the potential ecosite. **Ground-truthing**, the process of validating landscape characteristics and the ecosite on the ground compared to maps, is critical. Once you arrive at the site and before you start the assessment, observe the overall area to verify:

- **expected ecosite**
- **soil texture**
- **slope and slope aspect (e.g. north- or south-facing)**
- **topography**
- **influence of water**
- **stock water sources**
- **field boundary/management unit**

Some **natural variability is normal and expected within the same ecosite**, however, there are key considerations for choosing a site to assess. Select a site that is:

- representative of the overall area;
- within the same ecosite; and
- within a single management unit (i.e., a fenced pasture).

Sample "like-with-like". Make sure the sampling area for each health assessment does not cross boundaries of ecosites, vegetation type (e.g. native grassland to tame pasture), plant communities, differing land management practices (e.g., grazing, weed management, prescribed burns), or climatic influences (e.g., natural fire, flood, hail storm).

Assessments should represent what is happening on the landscape and provide insight into the impact of management. If a single assessment doesn't provide enough information on the function of the field, conduct additional range health assessments.

Figures 2 and 3 demonstrate examples of desktop information collection and on-site ground-truth exercises.

Desktop analysis and ground-truthing example A:

A pre-site desktop analysis using HABISask (Figure 2) shows that a 320-acre field is comprised of approximately 60% loam ecosite (in orange) and the remainder being a thin ecosite (in red). The plan is to conduct one range health assessment for loam (2) and one assessment for thin (1). After arrival at the site and becoming familiar with the field, the assessor determines that a portion of the loam ecosite is relatively ungrazed (3) while another area is heavily grazed (2). The grazing impact on the thin ecosite appears to be consistently low across the entire ecosite. In this case, the assessor chooses to conduct an additional health assessment (3) to accurately represent the ungrazed loam area.

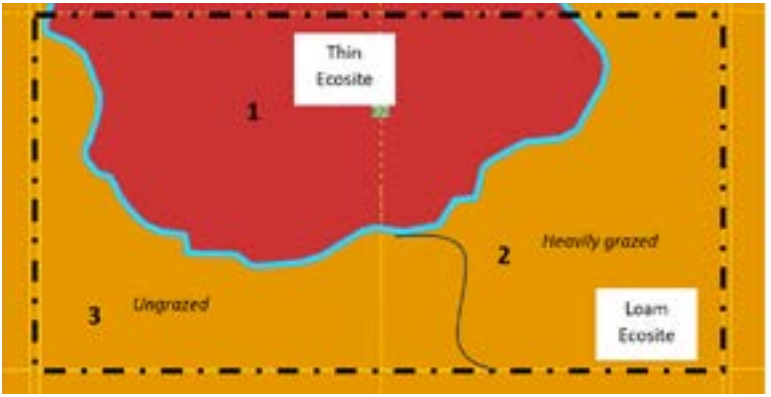

Figure 2. Assessment area example map of soil types and potential ecosites identified on HABISask. (Background image courtesy of the Government of Saskatchewan).

Desktop analysis and ground-truthing example B:

A desktop analysis indicated that the soil map unit for an assessment field was dominantly loam. Once there, the assessor looked at the plant community and soil type and determined that the landscape was a mixture of two different ecosites, loam and solonetzic, as outlined below in Figure 3. Depending on the scale and extent of different ecosites, the observer may choose to conduct a separate assessment for loam and a separate assessment for solonetzic to reflect the differences. Alternately, the assessor may note the differences and complete one assessment for the site that best represents the majority of the area.

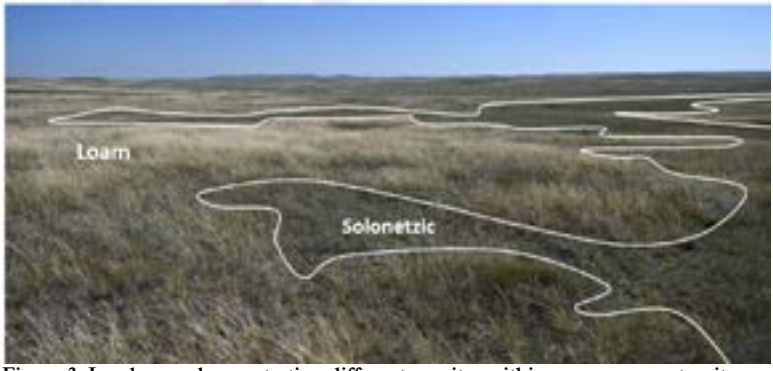

Figure 3. Landscape demonstrating different ecosites within a management unit. (Photo courtesy of Tara Mulhern Davidson).

Refining Ecosites

Ecosites often have great variability and transitions across rangeland. There may be dominant ecosites and detailed ecosites. Understanding the detailed ecosite is helpful to explain some of the variability within a soil polygon or broader ecosite. Whether an observer chooses to assess the dominant ecosite only or conduct an assessment for both the dominant and detailed ecosite will depend on their objectives.

Detailed ecosite example

Expected ecosites are determined by referring to a soils map. Figure 4 shows a polygon on a soils map with an assigned map unit (Fr2). That map unit identifies the soil series and relative quantities. In this case, the soil series for map unit Fr2 are 85% Frontier Orthic brown Chernozem CH and 15% Gleysolic. The dominant soil series corresponds to a dominant ecosite, in this case Loam. The detailed ecosite is LM85/WMD15 which means the site expected to be here is 85% Loam ecosite and 15% Wet Meadow ecosite.

Figure 4. Map Unit Example Map (image courtesy of the Saskatchewan Soil Information System).

Sampling Methods

Vegetation sampling and data collection can be done at several scales and levels of detail depending on objectives, budgets, experience, and priorities of agencies or individuals.

Many organizations have specific assessment criteria for conducting range inventories, and performing a range health assessment may be part of a larger, comprehensive protocol.

Observers may sample a plant community using a 50cm x 50cm quadrat frame or a 50cm x 20cm frame (i.e., the **"Daubenmire frame"**).

Terms are sometimes used interchangeably during range health assessments. **Polygons, soil map units,** and **deciles** are all words that range professionals may use to describe assessment areas. **Transect, plotline, samples, quadrats,** and **frames** are different terms that assessors may use to describe sampling vegetation, litter, and bare soil within specific points on a site. These and other terms can be found in the Glossary.

Quadrat frames can be used for estimating plant species cover, bare soil, and litter production; thereby reducing bias, enhancing repeatability, and providing a more accurate assessment of the ecosite. The larger the number of quadrats sampled, the better the results, but more time is required for the assessment.

Some grassland methods require quadrats to be sampled every 20 paces along a line or transect within the assessment area.

In pastures, one approach is to relate sampling to stock water sources. For each water source, a series of quadrat frames can be sampled along a transect . Sampling too close to a water source or too far can skew results as distance to water is often related to animal impact.

What time of year is best to perform a range health assessment?

Generally, the optimum time to conduct an assessment is when plants have had time to grow and the species are identifiable. June, July, and occasionally August are typical assessment windows in the Prairie Ecozone. In years that are cooler, moister, or drier than normal, the timing of assessments may be adjusted.

To get the most accurate comparison of range health scores for the same site over time, ideally, the observer will perform follow-up assessments at the same time of year. If that's not possible, it is still useful to conduct an assessment, but note the potential differences due to stage of growing season.

If an assessment area is grazed, timing the assessment during or just after a grazing event can impact the assessment. It can also make plant identification more challenging, and potentially create a bias toward observing more bare soil or temporarily reduced structure and litter.

Note the grazing status of the site at the time of the assessment on the scoresheet.

How much time does an assessment take?

Account for time to travel to and from the field, collect data, sample vegetation and litter, and take photos and notes. On complex sites, large fields, challenging topography, or for inexperienced users, it may take a few hours to conduct a range health assessment. With experience, assessments can be completed in less time.

What type of assessment should I do?

Rangelands are naturally variable and may include a patchwork of different ecosystem types within one management unit (e.g., riparian, grassland, and forested). Depending on the ecosystem types present, a different assessment method may be required. Figure 5 outlines a series of questions an assessor can ask to help determine the appropriate method.

Ideally, all ecosystem types should be assessed; however, time constraints often limit the number of assessments that can be completed. The observer must determine which assessment method best represents management goals and impacts.

If there is enough grassland in the field for a meaningful assessment, perform a grassland range health assessment. If multiple ecosystem assessments are conducted (i.e., riparian health assessment, forest health assessment), ensure that the estimated area of the field and assessment type are documented or mapped.

Depending on plant species composition and whether the assessment area is managed as tame, native, forested, or riparian, will help determine which assessment method to use. The following resources may be helpful:

- *SK Riparian Health Assessment for Streams and Small Rivers (Lotic)*
- *SK Riparian Health Assessment for Lakes, Sloughs and Wetlands (Lentic)*
- *SK Native Forest Health Assessment* (starts on page 45 of the 2008 Saskatchewan Range Health)

If the assessment area is primarily a stand of tame species, the observer may want to use the Initial Stocking Rate Recommendations for Seeded Pastures in Saskatchewan or the Alberta tame pasture health assessment method.

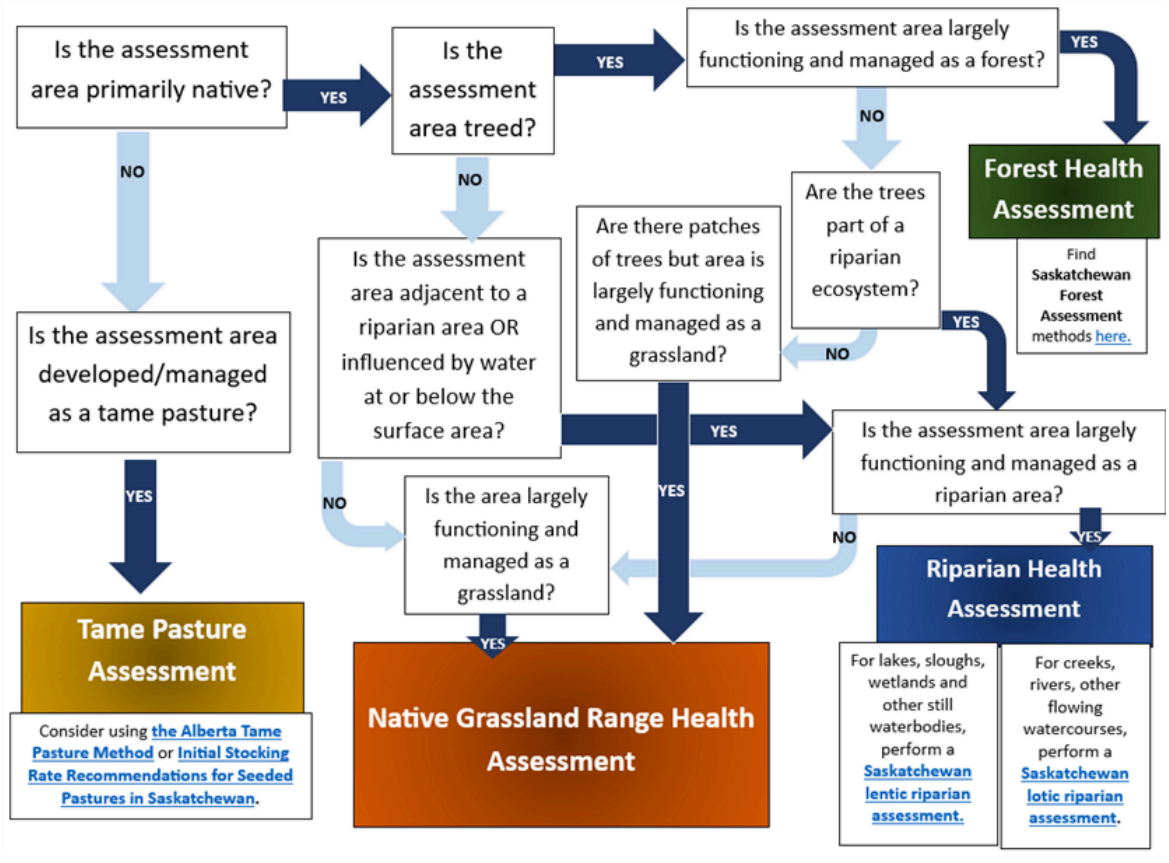

Figure 5. Decision guide for grassland, tame, forest, and riparian assessments. (Original image created for the Prairie Conservation Action Plan by Tara Mulhern Davidson).

Estimating Cover of Vegetation, Bare Soil, Biocrust, and Litter

The ability to estimate the cover of plant species, the extent of exposed bare soil, biocrust, and litter cover is a valuable skill for accurate range health assessment.

Plant cover is defined as the vertical projection of a plant to the ground surface, expressed as a percent of the area of reference (i.e., a 20cm by 50cm plot frame).

Foliar cover is when plant cover is estimated on a foliar level, and the spaces within the vegetation canopy are subtracted from the estimate.

Cover estimates can be performed for an individual plant species, groups of plants, bare soil, biocrust, and litter. The percent total cover may exceed 100% because of overlapping foliage from multiple species when cover values of all individual plant species are added up.

Bare soil is vulnerable to erosion from wind, mechanical movement (including hoof shear), raindrop impact, or overland flow of water. Bare soil is measured by the percent of the area of reference where mineral soil is not protected by live or dead vegetation, rocks (greater than 6.4 cm or 2.5 in), or biocrust (including lichens).

The scoresheet has space to record cover estimates for grasses and grass-like species, forbs, shrubs, and trees to help establish the major components of the plant community under evaluation.

Estimating vegetation cover or bare soil requires training and experience to achieve repeatable observations. Everyone visualizes proportions in different ways. Some assessors put marks on their frame to help visualize tenths or quarters of the area covered.

This workbook uses the foliar concept to assess vegetation cover, as demonstrated in Figures 5 and 6.

An important change in this version of Saskatchewan's range health assessment is that plant community indicators are measured by estimating percent COVER of plants rather than percent dry weight (biomass) of plants.

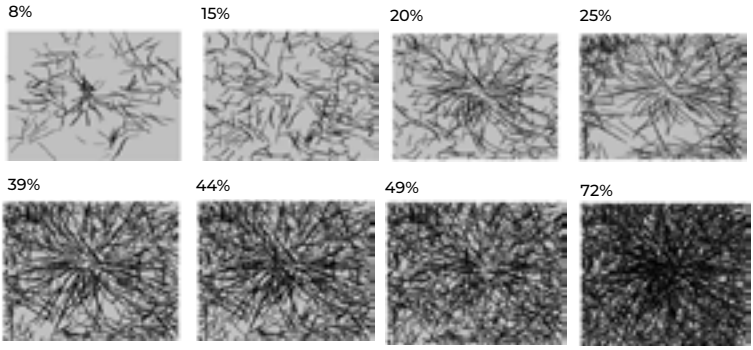

Figure 6. Foliar percent cover value examples. (Images courtesy of the Saskatchewan Research Council).

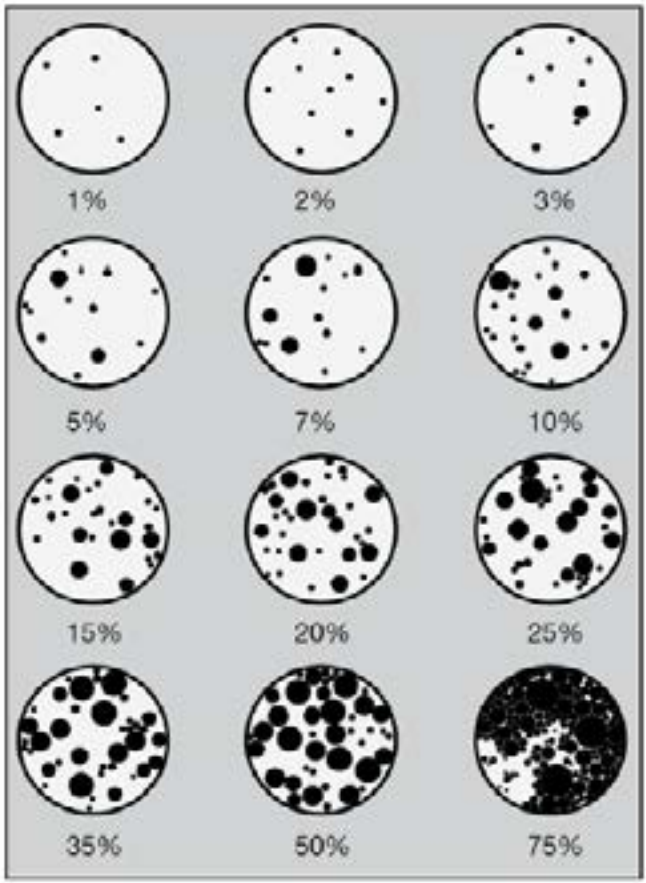

Figure 7. Percent cover examples using dots. (Image courtesy of the Government of Alberta).

INDICATOR 1: What is the plant community composition?

In grassland communities, the type and abundance of plant species on an ecosite are a primary indicator of ecological status and range health. This indicator is allocated the most points on the scoresheet.

Plant species composition influences a site's ability to perform important functions and provide ecological goods and services, including forage production. Range plants occupy diverse ecological niches and have different above-ground structural biomass and below-ground rooting depths.

Identifying Plants for a Range Health Assessment

Questions 1.1 and 1.2 can be answered by identifying a few of the key abundant plant species to help compare the site to the reference plant community. **You do not need to conduct a comprehensive plant survey** to answer Question 1, although some organizations may have their own standards and methods of data collection that include a comprehensive survey.

Plant species composition is assessed by recording cover of species within categories of grasses and graminoids (grass-likes), forbs (wildflowers, weeds, or other broad-leaved plants), and woody plants (shrubs and trees).

An **ecosite** is a distinctive type of land with specific physical characteristics that produces a distinctive plant community unique from other types of land. A **reference plant community** is the potential natural community type for a specific ecosite with little or no disturbance (e.g., ungrazed or lightly grazed). **Ecological status** is the degree of similarity between the present plant community and a reference plant community.

Use the *Saskatchewan Rangeland Ecosystems (Publication 1)* guide to help identify, interpret, and verify ecosites.

As outlined in the introduction, there are two levels of assessment that an observer can perform, a **rapid assessment** or a **range inventory**. Regardless of whether a rapid assessment or range inventory is conducted, **determining the reference plant community for the assessment area is key**.

To answer Questions 1.1 and 1.2, the assessor will estimate and compare the relative **foliar cover** of the plant species within the assessment area to the composition expected in the reference plant community for the ecosite. Note that some original reference plant communities are described in weight (biomass) however *Saskatchewan Rangeland Ecosystems:*

Estimation of Percent Cover Values for Species Abundances is now available at www.saskpcap.org/rangelands to help assessors convert biomass to cover estimates for reference plant communities.

When performing a **rapid assessment**, plant species cover can be estimated by walking through the site and observing the dominant plants in the assessment area. When performing a **range inventory**, plant species composition can be documented by identifying plants and estimating cover according to what is observed in representative samples of **quadrat frames** along a **transect** or other data collection methods.

Determining the Ecosite and Reference Plant Community

Review the *Saskatchewan Rangeland Ecosystems (Publication 1)* to help determine the ecosite. Observe the soil texture on the assessment area and cross-reference to soil maps available on HABISask or Saskatchewan Soil Information System (Appendix A). Soil type can also be verified by inspecting nearby rodent burrows or road cuts (if available). Observe notable landscape features, including slopes, signs of erosion, saline or wet areas, exposed bedrock, gravel, sand, or other characteristics, to verify the ecosite and reference plant community.

Published reference plant community types are available for many ecosites across western Canada. However, **not all Saskatchewan ecosites have reference community data available, or the area assessed may not exactly match any of the described ecosites**.

Saskatchewan Rangeland Ecosystems publications do not represent every possible variation in species composition but they provide expected major trends in the abundance of grasses, forbs, shrubs, and other attributes.

Calculating a Similarity Index

To help compare in-field observations to a reference plant community, a similarity index calculation may be done according to the formula outlined in *Saskatchewan Rangeland Ecosystems (Publication 1)*. When conducting a detailed range inventory, observers can compare the percentages of species observed in their quadrats to the published reference community. Comparing these values and using the lesser of the two creates a percent similarity index that can be used to determine how much the assessment area has been altered from the reference community.

>65% - reference community

50-65% - minor alteration

30-50% - moderate alteration

15-30% - significant alteration

<15% - severe alteration

Similarity index example: An assessment is conducted on a Loam Ecosite in the Mixed Grassland (MG-LM-A).

Observations show percent cover as:

	Reference plant community	Sample quadrat	Lesser value
Western porcupine-grass	31	15	15
Northern wheatgrass	4	15	4
Needle-and-thread	4	15	4
June grass	5	0	0
Pasture sage	7	1	1
Crested wheatgrass	0	3	
Total minor grasses	2	(3)	2
Scarlet mallow		2	
Dotted blazing star		2	
Total minor forbs	6	(4)	4
TOTAL	59	53	30

Percent Similarity = (200*30)/(59+53) = **54 (minor alteration)**

What if the reference plant community is unavailable?

Observation and experience can help assessors interpret a potential reference plant community. To conduct an assessment without a reference plant community, assessors may:

- review and compare the next closest community description;
- use similar community descriptions from adjacent regions (e.g., Alberta or Manitoba);
- review historical plant species records or relevant benchmark data;
- if available, review past range health or range inventory assessments; and
- if available, look for nearby lightly disturbed sites for comparison.

Document plant community and range health indicators for future reference and to potentially inform and update ecosite descriptions.

Understanding how different plant species respond to grazing (i.e., increaser, decreaser) can also be a useful indicator when a reference plant community is unavailable or needs verification.

Decreaser plant species are perennial species that tend to be productive and palatable to grazing animals and decrease in relative abundance under increased and heavy grazing pressure. Examples of decreasers include green needlegrass, purple prairie clover, vetchling, and winterfat.

Can a native plant be an increaser AND a decreaser?
Yes! A plant species can behave differently depending on **where** they are growing. For example, Saskatchewan's provincial native grass emblem, needle-and-thread grass, responds as a **decreaser** in dry mixed and mixed grassland ecoregions and responds as an **increaser** in moist mixed and aspen parkland ecoregions. Other common species, western wheatgrass and northern wheatgrass, respond as **decreasers** in dry mixed and mixed grassland ecoregions, but respond as **increasers** in the aspen parkland.

Increaser plant species are species that are adapted to grazing pressure and will increase in relative abundance under increased and heavy grazing pressure. Examples of increasers are blue grama, goldenrod, and western snowberry. Some increaser species will eventually start decreasing as disturbance pressure escalates beyond normal disturbance regimens.

Non-native forage species, such as Kentucky bluegrass, crested wheatgrass, smooth bromegrass, or yellow sweet clover, can establish and invade native rangeland plant communities. These non-native species tend to thrive under increased and heavy grazing pressure. While these species provide forage, compared to the native reference plant community, their presence reduces biodiversity, decreases habitat quality, and can negatively

affect other indicators of rangeland health. Record the percent cover of non-native species on the scoresheet in Question 1.2. **Do not include invasive or noxious weeds** such as leafy spurge or downy brome, as these invasive weed species are recorded in Question 2.1 and 2.2.

See Appendix B for a list of common range plants, by type, and whether they are increasers, decreasers, or non-native forage species.

When conducting an assessment, ask whether the plant community is clearly dominated by decreasers. If so, it is most like the reference community. Is the site more equally divided between decreasers and increasers? If so, it may demonstrate the community is showing minor alteration. Is it clearly dominated by increasers, but with a component of decreasers? This may demonstrate a community showing moderate alteration.

An important change in Saskatchewan's updated range health assessment is that decreaser, increaser, and non-native forage species are included in scoring 1.2.

Important Plant Ecology Concepts

- **Plant communities** are comprised of different plant species that interact with one another. Trees, shrubs, forbs, and grasses provide a diversity of ecological values.
- **Succession** refers to gradual replacement of one plant community by another over time.
- **Successional pathways** describe the predictable pathway of change in a plant community as it withstands disturbance or recovers from disturbance.
- **Seral stages** are individual steps along a successional pathway. These can be limited by environmental conditions such as soil types and climate – for example dry, sandy soils will limit tree and shrub growth even without fire or grazing. Seral stages begin at the pioneer stage of early seral, and progress to mid-seral, then late seral, and finally reference plant community.
- **Threshold** is when a plant community crosses over a threshold and cannot return to its state similar to the reference plant community or any of its previous seral states.

What is the successional state? What factors cause a shift in plant communities?

Native grassland plant communities evolve and can shift over time as environmental disturbances change. Key stages of plant succession, known as seral stages, are based on plant species composition and reflect the amount, intensity, and duration of past disturbance to the plant community.

Some plant community changes are reversible with rest during the growing season to allow for recovery and seed set. Other successional pathways lead to stable states that are different from the reference plant community or any previous seral states and are relatively resistant to change.

Plant communities are influenced by natural disturbances and human-caused disturbances. While grazing is a natural disturbance under which rangelands evolved, managed grazing is also a human-caused disturbance. Some examples of disturbances that affect plant communities and range health are listed below.

Natural Disturbances that Affect Plant Communities	**Human-Caused Disturbances that Affect Plant Communities**
• Fire	• Fire suppression
• Grazing	• Grazing exclusion
• Prolonged Drought	• Overgrazing
• Extreme Moisture	• Timber removal
• Disease	• Recreation
• Insect damage	• Extreme moisture (e.g. dams or drainage)
	• Herbicide application

A significant and rapid change in plant community composition does not normally occur. A shift in the plant community often occurs over a long time and requires a long recovery period.

When disturbance impacts are reduced or removed, the present plant community may react in several ways. The plant community may:

- remain static;
- move toward the reference plant community;
- cross a threshold and be unable to return to the reference plant community; or
- become occupied by non-native forage species or invasive weeds.

In many plant communities, extended long-term rest or disturbance exclusion allows a few competitive grass species to become dominant over the grasses and forbs that are normally important in the plant community.

When using the *Saskatchewan Rangeland Ecosystems* reference plant communities, consider how plant communities and species respond to different types of disturbance or rest. Each plant species within a community occupies an ecological role. An example of shifting plant communities displayed within the *Saskatchewan Rangeland Ecosystems* publications is shown in Figure 8.

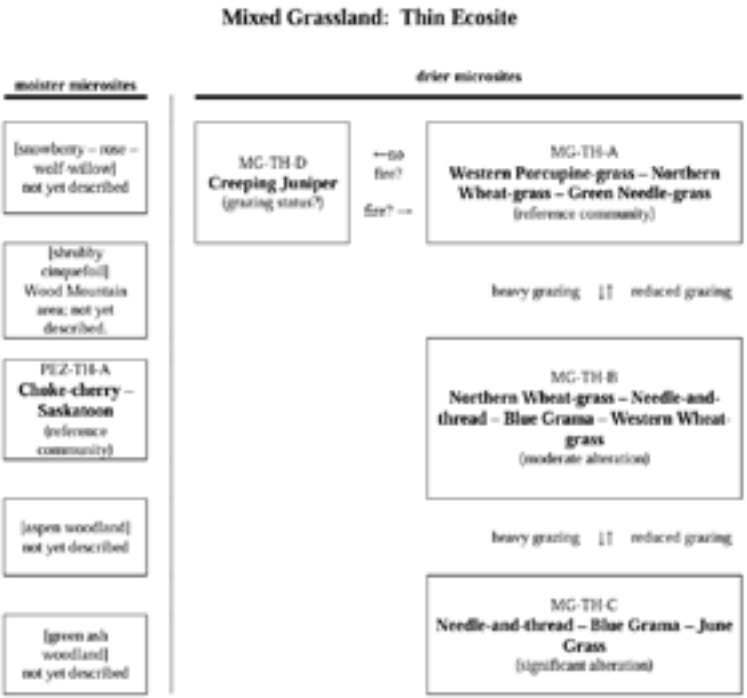

Figure 8. Potential shifting plant communities on thin ecosite within the mixed grassland ecoregion as shown in *Saskatchewan Rangeland Ecosystems Publication 10: Communities on the Thin Ecosite (Version 2)*.

Range Management Goals and Plant Community Composition

Plant communities that closely resemble a reference plant community efficiently capture solar energy, effectively cycle organic matter and nutrients, retain moisture, support wildlife habitat, and provide high potential productivity for the site. In contrast, plant communities that show significant or extreme alteration due to heavy or severe disturbance will have diminished ecological functions, be less stable, produce less forage for livestock, store less carbon, and be more vulnerable to invasion by non-native forage or invasive weed species.

Range management goals, particularly for livestock production, generally favour healthy rangelands with stability and forage production that are common in later seral and reference plant communities. However, a natural amount of diversity in seral stages across the site can be expected and beneficial to accommodate the varied habitat needs of plants and wildlife. For example, grassland bird species like horned larks and burrowing owls prefer heavily grazed rangeland in early seral stages. Other songbirds, such as Sprague's pipits, favour lightly grazed rangeland that closely resembles a reference plant community.

Managing rangeland to achieve a "healthy" score across sites that still maintain patches of high- and low-disturbance will benefit habitat for greater species diversity without compromising ecosystem function. This management goal also provides stability and resilience from a grazing perspective.

Record Other Species

In addition to listing main plant species, assessors may also record other species they observe, including species at risk, grassland songbirds, insects, wildlife, and others.

Question 1.1 and 1.2 Scoring Notes

Use *Saskatchewan Rangeland Ecosystems* to determine the reference plant community for the site and record it on the scoresheet. Walk the overall assessment area to observe and record the estimated percent cover of plants by species in the categories at the top of the scoresheet. Focus on main plant species but also record other indicator species of interest. **Do not include invasive or noxious weeds** such as leafy spurge or downy brome, as these invasive weed species are recorded in Question 2.1 and 2.2.

Question 1.1 Does the plant community resemble the reference plant community?

35 = Plant community composition closely resembles the reference plant community for the site and alteration of the plant community by disturbance is minimal. The percent similarity to the reference plant community is greater than 65%. Decreaser plants are dominant.

24 = Compared to the reference plant community, the plant community shows minor alteration in plant species composition due to disturbances and is 50-65% similar to the reference plant community. Disturbance impact is light to moderate. Decreaser plants are abundant.

17 = Compared to the reference plant community, the plant community shows moderate alteration due to disturbances, and is 30-50% similar to the reference plant community. Disturbance impact is moderate to heavy. Some decreaser plants are present but there is an elevated proportion of increaser or non-native plants.

10 = Compared to the reference plant community, the plant community shows significant alterations due to disturbances and is 15-30% similar to the reference plant community. Disturbance impact is heavy to very heavy. Increaser and non-native plants have become the most abundant.

0 = Compared to the reference plant community, the plant community shows extreme to severe alterations due to disturbances and is less than 15% similar to the reference plant community. Disturbance impact is severe to very severe. The community is almost entirely dominated by increaser and non-native species.

Question 1.2: What is the influence of non-native forage plants on the plant community?

5 = Non-native forage species are absent, or present in small quantities and do not negatively impact ecosystem functions.

3 = Non-native forage species are noticeably influencing the plant community and ecosystem. Non-native forage species like crested wheatgrass, smooth brome, and Kentucky bluegrass are common.

0 = Site is dominated by non-native forage species and the impact on ecosystem function is significant.

INDICATOR 2: Are invasive weed species present?

Invasive weeds are aggressive, rapidly expanding plant species or groups of plant species that are non-native to the rangeland plant community and threaten the integrity and function of the overall landscape.

Invasive weeds, such as leafy spurge, threaten biodiversity, compromise plant community composition, impact vegetation structure and function, reduce litter and soil stability properties, and weaken the overall resiliency and sustainability of ecosystems. Invasive weed species diminish the multiple uses and values of rangeland including habitat quality, forage availability, and carbon sequestration.

Questions 2.1 and 2.2 address the presence of weeds managed under *The Weed Control Act* in Saskatchewan along with invasive weeds that may not yet be designated as prohibited or noxious but pose a threat to Saskatchewan rangeland. See Appendix C for a list of invasive weed species to consider when assessing rangelands in Saskatchewan.

Question 2 considers the degree of invasive weed infestation across the overall assessment area as a function of plant density and patchiness, or evenness. Take note of incidental observations of invasive weeds in adjacent areas, such as along trails, ditches, near berms, spoil piles, or dugouts. While invasive weeds observed outside the assessment area (i.e., the drive to the site) may not count toward the range health score, it's valuable to note and monitor potential risks.

Record known information about how weeds were introduced (e.g., contaminated equipment, dirt hauled in from off-site, reclamation seed, wildlife) and any control efforts.

Managing and controlling invasive weeds is time-consuming and expensive. Invasive weeds can occur on rangeland regardless of health status, and their presence threatens the function and integrity of rangeland. Invasive weeds are less problematic in vigorous, well-managed rangelands, but may still occasionally occur in healthy stands, replacing desirable plant species. Their presence can indicate a degrading plant community or history of disturbance such as construction or heavily grazed areas. Invasive weeds can establish in areas of reduced plant vigour or areas of exposed soil. On any type of rangeland, managers should strive for optimum range health by maintaining plant vigour and vegetation cover to ensure that niches are occupied by desirable native plant species rather than invasive weeds.

Question 2.1 and 2.2 Scoring Notes

On the scoresheet, record the percent cover and density distribution (DD) of all invasive weed species.

Many non-native forage species have invasive tendencies, such as Kentucky bluegrass or smooth brome, however, **these species are not counted in 2.1 and 2.2 as they are addressed in Questions 1.1 and 1.2**.

An important change in Saskatchewan's updated range health assessment is that scoring for cover and density distribution of invasive weeds now matches Manitoba and Alberta's range health standards.

If multiple invasive weeds are on a site, and they have differing density distributions, use the cumulative class score to answer question 2.2

Question 2.1: What is the cover of invasive weeds on the site? Record the collective cover of all invasive weed species to answer question 2.1. Record the percent cover for individual invasive species on the scoresheet. Use Figure 9 to help determine cover categories.

5 = No invasive weed species are present.

3 = Invasive weed species are present, but cover less than 1% of the area.

1 = Invasive weed species are present and cover greater than 1% but less than 15%.

0 = Invasive weed species are present with a total cover greater than 15%.

Question 2.2: What is the density distribution of invasive weeds? Use Figure 10 to help determine the score. Record the distribution of invasive plants by species on the scoresheet.

5 = No invasive weed species are present.

3 = Invasive weed species are present at a low level of infestation (Distribution class 1 to 3)

1 = Invasive weed species infestation is moderate (Distribution class 4 to 7)

0 = Invasive weed species infestation is heavy to severe (Distribution class 8 to 13)

Invasive Weed Example:

Invasive species can impact healthy rangelands, particularly ecosites that naturally have more bare ground and soil erosion. For example, sandy ecosites may have downy brome invasion along trails, roadsides, or other disturbed areas which can easily spread to naturally occurring bare soil between healthy range plants.

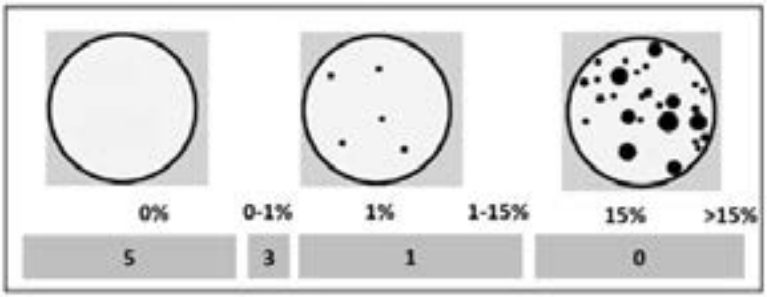

Figure 9. Examples of percent cover and score category for invasive weed species in question 2.1 (Image courtesy of Government of Alberta and Manitoba Forage and Grassland Association).

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		

Figure 10. Density distribution of invasive weed species and score category for question 2.2. This chart can also be used to document density distribution of trees and shrubs for question 3.2. (Image courtesy of Government of Alberta).

INDICATOR 3: Are expected vegetation layers present and is woody encroachment occurring?

Healthy native grasslands have a diversity of plant species that vary by growth form, size, height, and rooting depth. Plants grow in different "layers" called structure. For this indicator, the different layers are referred to as **life-form layers**.

A variety of life-form layers support forage production and wildlife habitat. When plants occupy different layers, they use sunlight, water, and nutrients from different zones above ground (in the vegetation canopy) and below ground (in the soil profile). Nutrient cycling and energy flow are more efficient in plant communities with diverse life-form layers. Within grassland plant communities, life-form layers often co-exist and function together.

Questions 3.1 and 3.2 consider the presence of expected life-form layers over the overall assessment area based on the current conditions. Assess life-form layers relative to the reference plant community as indicated in *Saskatchewan Rangeland Ecosystems* Publications. Benchmark data, photographs, land use history, grazing management information, or adjacent lightly or undisturbed areas can also provide insight.

Biocrusts

A **biocrust** is a valuable life-form layer that lives close to the soil surface. Biocrusts provide a biologically active layer at the soil-plant interface and support early-stage plant succession and related soil microbial activity. Biocrusts consist of complex organisms, including mosses and lichens, and can be a valuable indicator of rangeland health, as they are slow to develop. If damaged, biocrusts have a long recovery period. This layer can be reduced by trampling (hoof impact), recreation (ATV traffic or other trails), or excessive shading. Record the percent cover of biocrusts at the top of the scoresheet and checkboxes in 3.1 regarding biocrust presence and functionality.

Factors Impacting Life-Form Layers

Wildlife and plant species often have diverse habitat requirements. Range managers may implement practices that emulate natural disturbances, such as grazing, prescribed fire, or disturbance exclusion, to allow for a diversity of life-form layers to develop on the landscape. A positive example is a grazing plan that allows for multiple levels of grazing pressure which creates structural diversity to provide habitat for a variety of plants and animals.

Conversely, a lack of natural disturbance due to unsuitable disturbance frequency or intensity can cause life-form layers to be reduced or removed. For example, if an area has been excluded from grazing and fire for many years, taller grass and forb species may persist at the expense of shorter grass and forb species. Another example is if rangeland is continuously and heavily grazed, the site will likely lose the tallest grass layer and become dominated by lower-growing species and some persistent biocrust layers. Both examples result in an imbalance of life-form layers.

Life-form layer diversity example:

Managing for "patch diversity" on rangeland can support more species than managing for a single uniform vegetation structure. For example, northern harriers require tall and dense grass cover. Sharp-tailed grouse require areas of high structural diversity for nesting and areas of low or sparse vegetation for spring mating.

Woody Encroachment

Tree and shrub communities occur as a transitional state between grassland and forest communities, especially in aspen parklands. In drier ecoregions, they are found in varying abundance on moister ecosites.

Woody species can serve land management goals such as slope stabilization and buffer zones that provide wildlife habitat and shade for livestock. Woody cover can also help maintain forage supply during dry years and is especially important for the health and function of riparian areas.

Without disturbance to keep them in check, over time, open, non-woody areas become smaller as they are replaced by trees and shrubs, particularly on moister sites. This is known as **woody encroachment**. Woody species can reduce light and cause other changes in microclimate, enabling shade-tolerant species (such as non-native grasses like Kentucky bluegrass and smooth brome) to outcompete native grassland species. Woody encroachment can pose significant challenges for land managers.

Tree and shrub encroachment can:

- reduce plant community diversity;
- decrease forage supply and grazing capacity;
- shift litter levels, impacting nutrient cycling;
- reduce habitat availability for grassland species that require open areas;

- increase shade-tolerant species, including non-native forage species such as Kentucky bluegrass, which increase under increasing shrub growth; and
- increase in predatory wildlife species that prey on grassland wildlife.

If woody encroachment is noted during the assessment, mark the density distribution (using Figure 10) in the scoresheet and provide comments on the extent, potential impacts, control options, and other observations. Consider the benefits and risks of an increasing woody presence on grassland when making management decisions and recommendations, including potential brush control management strategies.

Question 3.1 and 3.2 Scoring Notes

Structural layers in grasslands may include:

1. biocrust and ground cover (moss, lichen, clubmoss)
2. short grasses and forbs
3. mid-grasses and medium forbs
4. shrubs and half-shrubs

An important change in Saskatchewan's updated range health assessment is that biocrusts and woody encroachment are now included and addressed in questions 3.1 and 3.2

Some reference plant communities outline expected structure in *Saskatchewan Rangeland Ecosystems Publications*. This information is useful, particularly if a structural layer is missing on the assessment area.

If unsure how many structural layers should be present or whether a layer is reduced, check for disturbance impact on the plants by looking for reduced vigour or plant stress. Increased or heavy browsing of shrubs such as willow or saskatoon may indicate that more desirable plant species have been reduced or eliminated by grazing or browsing.

Look at the layers, not the species. For example, if the reference plant community for an assessment area is plains rough fescue but the site is dominated by smooth bromegrass, the site still possesses a midgrass layer.

- If a plant community loses one life-form layer but gains another, score deductions should be made based on the loss, as it deviates from the reference plant community. For example, if a short grass layer is expected in the reference plant community, but the area shows it is missing due to shading from an increased tall grass layer, the short grass layer should be scored as reduced or absent.
- If two structural layers are moderately reduced by 25-50% of their

expected cover, reduce the score to 5 points.

- If four layers are moderately reduced by 25-50% of their expected cover, reduce the score to 2 points.
- If one layer appears to be more abundant than expressed in the reference plant community, determine whether or not other layers are reduced at the expense of this increase.
- When a natural disturbance has removed a life-form layer, note the missing layer and the potential cause. Examples of natural disturbances may include insect damage, drought, or fire.
- In 3.2, consider the overall assessment area and determine the actual percentage of the area covered by shrubs. Use 15% as a flat rate of cover.
- Some published reference plant communities for ecosites such as subirrigated or wet meadow may have natural or expected shrub cover in excess of 15%. In this case, note that the woody shrub portion would fall within expected levels and the site may score full marks.

Question 3.1: Are expected vegetation layers present?

7 = The life-form layers closely resemble the reference plant community.

5 = Compared to the reference plant community, one life-form layer is absent or reduced by more than 50% expected cover OR two layers are moderately reduced by 25-50%.

2 = Compared to the reference plant community, two life-form layers are absent or reduced by more than 50% expected cover; OR four layers are moderately reduced by 25-50%.

0 = Compared to the reference plant community, three life-form layers are absent or considerably reduced by 50% expected cover or greater.

Question 3.2: Is woody vegetation or shrub encroachment problematic?

3 = Woody vegetation is present as expected compared to the reference plant community.

1 = Woody vegetation exceeds expected levels by 1-15% cover compared to the reference plant community.

0 = Woody vegetation exceeds expected levels by over 15% cover.

3.1 Scoring example for vegetation layers:

A site has the following expected layers:
Tall shrubs: 1% cover
Mid-grasses & forbs: 25% cover
Short grasses: 10% cover
Half-shrubs: 3% cover

If the assessed site has similar amounts to the expected layers, it will score 7 points. If the site was assessed with 11% mid-grasses, which is a reduction of more than 50% cover for one layer, the site will score 5 points. If the site was assessed with 11% mid-grasses and 4% short grasses, that indicated two life-form layers reduced by more than 50%, and the site would score 2 points. If the site had reduced mid-grasses and short grasses (as above) and the tall shrub layer was absent, the site would **score 0 points**.

3.2 Scoring example for woody encroachment:

A site is expected to have 3% shrub cover and the assessor observes 3% cover. That is expected and scores 5.
If the same site is assessed but shrub cover is observed at 10%, that is 7% above what is expected and the site is scored as 3 points.
If the same site is assessed and shrub cover is observed at 20%, that is 17% above what is expected and the site is **scored as 0 points**.

In Figure 11, a series of images demonstrate a diverse plant community as it loses structure. There are four layers in the top image (biocrust and ground cover; short grasses and forbs; mid-grasses and medium forbs; and shrubs). The same plant community shows a reduction in mid-grasses and medium forb layer and shrub layer in the middle image. The bottom image shows the same community reduced to two layers (biocrust and ground cover; short grasses and forbs).

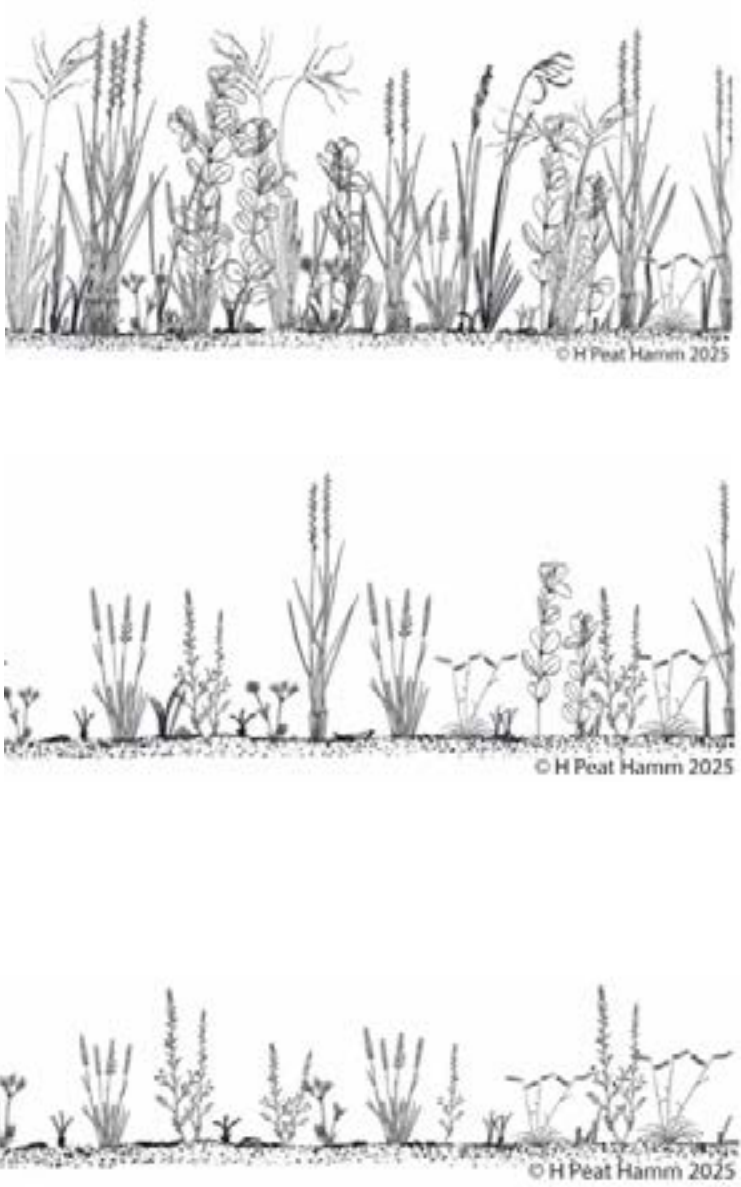

Figure 11. A reduction in life-form layers within a plant community. (Original images created for the Prairie Conservation Action Plan by Heather Peat Hamm).

INDICATOR 4: How much bare soil and erosion are on the site?

Soil is the foundation of rangelands. Rangelands have varying degrees of natural soil stability depending on soil type, topography, climate, and plant cover.

Vegetative cover protects soil from water erosion (including the impact of raindrops), slows down overland flow, maintains infiltration and permeability, enhances carbon sequestration, and reduces wind erosion. Vegetation also provides the potential for the soil microbiome to remain active relative to bare, unvegetated soils.

Bare soil leads to erosion which can cause off-site movement of soil particles, organic matter, nutrients, and contaminants. This can reduce soil fertility, decrease moisture-holding capacity, increase carbon loss, and have longer-term impacts such as diminished forage production and reduced site stability.

Most healthy rangeland plant communities are stable and have adequate vegetation cover to prevent soil erosion. Some ecosites, such as badlands, solonetzic, thin, overflow, dunes, or steep river slopes, have more naturally occurring bare soil and erosional processes.

The ecosite and reference plant community is founded on soil type, however, it also informs the amount of expected natural bare soil and the type and extent of soil erosion that may occur. Expected amounts of naturally occurring bare soil vary across ecosites. If the ecological site is normally unstable (e.g., badlands, dunes, steep river slopes), look for management-caused erosion over and above natural or geologic rates.

Find the expected bare soil and litter cover amounts in the relevant *Saskatchewan Rangeland Ecosystems* publication or refer to Table 2.

Table 2. Expected bare soil ranges for common Saskatchewan ecosites as listed in *Saskatchewan Rangeland Ecosystem* Publications.

Ecoregion	Ecosite	% Expected Bare Soil
Dry Mixed Grassland	Loam	1%
	Thin	3-4%
	Overflow/Subirrigated	5-19%
	Solonetzic	8%
Mixed Grassland	Loam	0-1%
	Solonetzic	4%
	Sand/Sandy Loam	5-9%
	Dunes	12%
Aspen Parkland	Overflow/Subirrigated	0%
	Loam	0-1%
	Sand/Sandy Loam	5%
Cypress Upland	Loam	0%

Questions 4.1 and 4.2 consider the extent of bare soil and erosion across the overall assessment area. There may be deviations on a microsite level within the site. When observing soil erosion, look at the overall assessment area, the ground level, and under plant cover to see if there is any movement of litter or soil.

Factors Causing Higher-than-expected Bare Soil and Soil Erosion

Management practices that maintain adequate vegetation cover and minimize exposed soil can reduce the risk of erosion and optimize water infiltration and permeability. Some bare soil is normal and naturally expected for certain ecosites, such as badlands, sandy, or dune sites. Management practices should aim to prevent erosion beyond what is naturally expected for the site.

People, livestock, and wildlife can affect bare soil on rangeland. Figure 12 shows how human-caused bare soil increases as disturbance levels increase.

Management-caused bare soil can be caused by fire, livestock trailing, overgrazing, excavation, or disturbances such as ATV use, oil and gas development, or recreational impacts. Additionally, while not always directly caused by humans, the effects of wildlife overpopulation can increase bare soil and promote soil erosion.

What impact can wildlife have? Wild mammals, big or small, can affect ecosystems due to grazing activities and soil alteration. Whether there is increased activity from Richardson's ground squirrels, a cornerstone species, or impacts from large herds of elk or deer, when over the expected amounts, wildlife can reduce the potential ecosystem function of rangelands.

Reduced live plant and litter cover from excessive disturbance can lead to erosion. Indicators of severe disturbance include abundant trailing, rutting, manure, hoof tracks, and plant pedestaling, as demonstrated in Figure 13. Slopes are particularly sensitive to disturbance and may show signs of rutting, hoof shearing, and soil exposure.

Rodent-burrowing activity from ground squirrels or pocket gophers is normal and ecologically important for healthy rangeland. However, on a landscape level, it is typically limited in its extent and impact on bare soil observed over the entire assessment area. Bare soil from rodent burrows tends to increase on heavily disturbed sites and can occur more frequently on rangelands with non-native forage or invasive weed species. On heavily grazed or modified sites, a significant portion of bare soil from rodent-burrowing should be considered as management-caused, and the source of the impact should be noted on the scoresheet.

Wildlife activity can increase bare soil and hoof shearing if large groups of mammals congregate on rangeland. Similar to bare soil caused by rodent burrowing activity, treat bare soil abundance from wildlife activity as management-caused and note the source of the impact on the scoresheet.

Question 4.1 and 4.2 Scoring Notes

To determine management-caused bare soil, estimate total bare soil over the entire assessment area. Subtract the amount expected to naturally occur for a specific ecosite community as outlined in the *Saskatchewan Rangeland Ecosystems* publications.

Question 4.1
How much bare soil is present on the site? _____
How much is expected to be present compared to the reference community? _____
Is there management-caused bare soil beyond what is expected for the site?

Observed bare soil percentage - expected bare soil percentage = Management-caused bare soil

5 = Management-caused bare soil is less than 10%
3 = Management-caused bare soil is between 10 and 20%
1 = Management-caused bare soil is between 20 and 50%
0 = Management-caused bare soil is greater than 50%

4.2 Is there more soil erosion than expected for this site? Check relevant boxes on scoresheet for types of soil erosion noted.

10 = No sign of soil erosion or fine plant litter movement.

7 = Some evidence of micro-erosion beyond the site's potential natural limit. Short and shallow flow patterns. Old erosion features are stabilized. Exposed soil is slightly greater than expected for the site.

3 = Moderate amounts of soil movement or deposition of soil/litter. Flow patterns are branched or scouring may be evident. Erosion is active but soil is not moving off-site. Exposed soil is greater than expected but vegetation (live plants and litter) still covers most of the site. Signs of hoof shearing may be evident in localized patches.

0 = Extreme amounts of soil movement including soil moving off-site. Flow patterns are obvious and fan deposits may be present. Rills are abundant and deep. Gullies are deep with sharp edges. Erosion features are active. Plants are pedastalled with exposed roots and rocks or sitting on the surface. Hoof shearing may be common across the site, beyond localized patches. There is evidence of instability.

Bare soil and erosion scoring example A:

A dune ecosite, which is naturally more unstable, in the mixed grassland ecoregion may be expected to have 12% bare soil, as indicated in *Saskatchewan Rangeland Ecosystems Publication 9*. A range assessment indicates that there is 35% bare soil on a site, due to increased livestock activity attracted by nearby gas wells.

35% - 12% = 27% This percentage falls between 20-50% and the area would **score 1 for Question 4.1.**

Bare soil and erosion scoring example B:

A loam ecosite in the aspen parkland ecoregion is expected to have 1% bare soil, as indicated in *Saskatchewan Rangeland Ecosystems Publication 4*. A large herd of elk recently spent significant time within the assessed area, impacting soils, litter, and vegetation. Observations show that the assessment area has 5% bare soil. Because of the intensity of impact, this bare soil is considered management-caused.

Following the formula, 5% actual bare soil less 1% expected soil equals 4%. This is less than 10% and **Question 4.1 would score 5 points.**

The assessment area has more soil erosion than expected, including hoof shear, trailing, and compaction. There is no evidence of soil moving offsite, however, a rainfall or wind event would cause moderate amounts of soil and litter movement. **Question 4.2 would score 3 points.**

In situations like this, notes and photographs are useful additions.

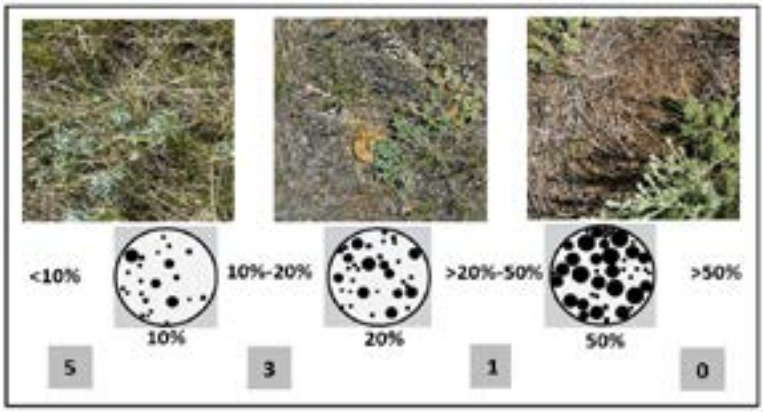

Figure 12. Increase in management-caused bare soil as disturbance levels increase. (Photos courtesy of Tara Mulhern Davidson; images courtesy of Government of Alberta).

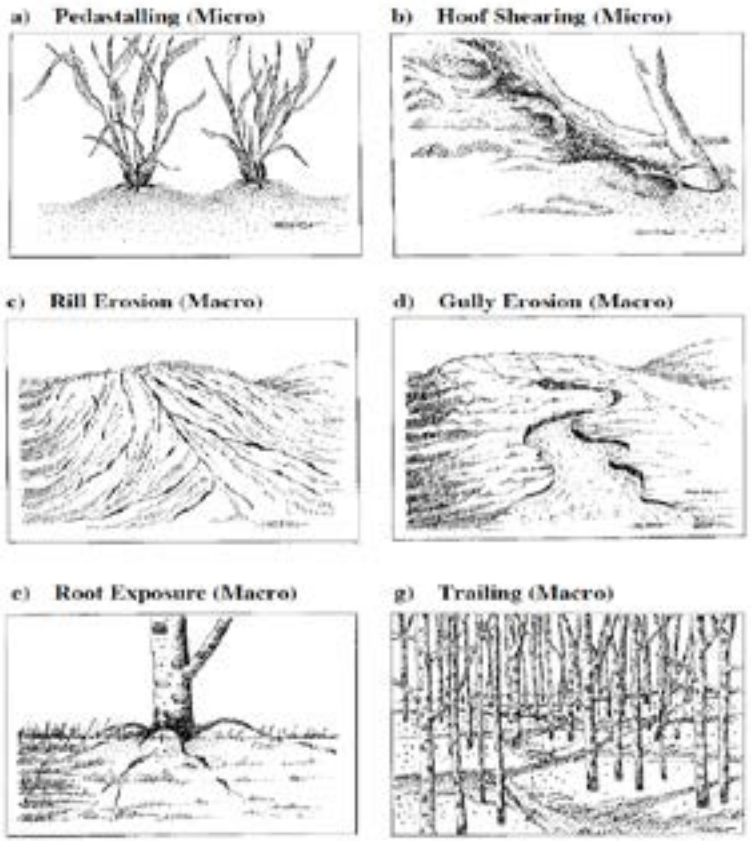

Figure 13. Increase in management-caused bare soil as disturbance levels increase. (Images courtesy of Government of Alberta).

INDICATOR 5: Litter, Hydrologic Function, and Soil Protection

Litter is dead plant residue. This includes material that can still be standing, freshly fallen, or slightly decomposed, and is shown in Figure 14. Litter includes ungrazed residue from prior years' growth. Litter plays a valuable role in biodiversity, hydrology, and site stability. When an assessment is conducted late in the season, current year's growth may appear yellow or bronze while previous year's growth is typically grey and partially broken down.

Litter enhances water retention and nutrient cycling and is closely linked to site stability, bare soil, soil temperature, and recycling carbon into the soil and below-ground stores. Litter is an important habitat component for grassland birds and other wildlife. At times, standing litter may also be a source of forage for wildlife and livestock.

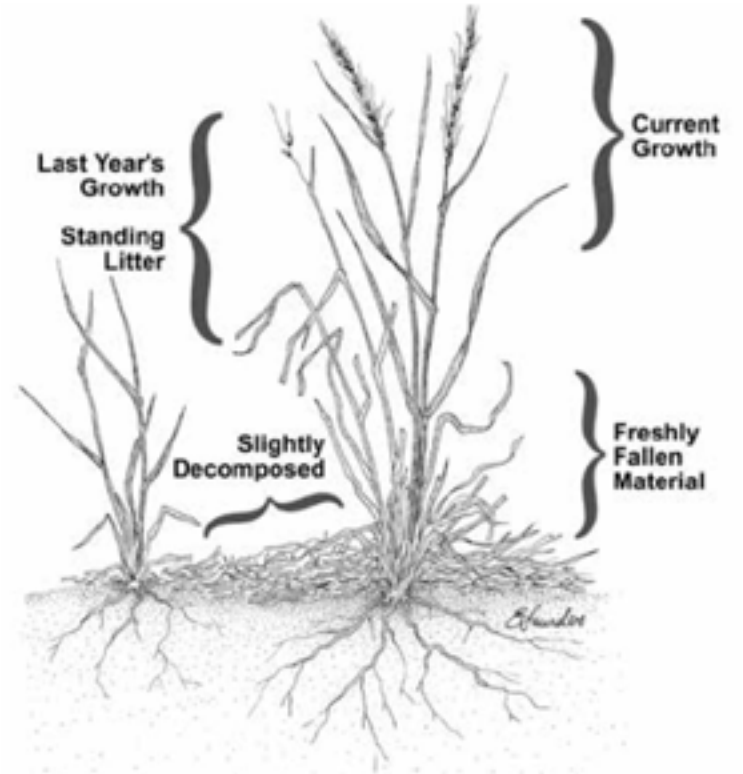

Figure 14. Litter in various stages. (Image courtesy of Government of Alberta)

Litter aids water infiltration by slowing runoff and creating a path into the soil. Litter conserves soil moisture by reducing evaporation, decreasing soil erosion from wind and water, and minimizing raindrop impact on the soil surface.

Litter acts as a physical barrier or a blanket that can moderate temperature fluctuations at the soil's surface. On a hot day, the temperature of the soil surface covered by adequate litter will be cooler than a site with reduced litter levels. On the other hand, sites with excessive litter may experience delayed warming in the spring. Standing dead plant material left as carryover from the previous season can catch and retain snow and eventually add to the litter layer.

On drier sites, litter reserves are closely linked to forage yields. Reduced litter on a site can decrease forage yields by about 50% in mixed-grass prairie.

Can there be too much litter? Litter is generally considered beneficial, but excess litter can be a problem, causing a shift in plant communities and subsequent function. Sites with excess litter favour species that can persist in low light conditions. For example, Kentucky bluegrass can thrive because of its thick, tough leaves that push up through the litter. American vetch is another excess litter "survivor" because it climbs upward.

What about plant communities that don't have enough litter? A plant community that has shifted away from desirable plant species toward a biocrust-dominant site where plants are replaced by clubmoss or other ground cover species will result in lower litter production.

While litter is valuable, there is a limit, particularly in moister grassland sites. Excessive litter can reduce germination, restrict new growth, reduce productivity and flowering of existing plants, tie up nutrients, and decrease biodiversity. Excess litter can shift plant communities toward species that flourish in lower light conditions, including non-native forage species or invasive weeds. Excess litter can cause stunted plants, low stem density, lack of flowering stems, and signs of rotting or other plant stress. Figure 15 illustrates what excess litter can look like on Saskatchewan rangelands.

Factors Impacting Litter Levels

Some ecosites may naturally have low or even no litter present. Ecosites such as solonetzic sites, dune sites, thin sites, or excessively rocky sites, can have low expected litter levels due to high amounts of naturally occurring bare soil and limited natural production of the site.

Consider what disturbances may be altering the distribution of litter. Some sites should have more litter than what is observed, which may be due to a plant community shift. Events such as fire, persistent drought,

Figure 15. An example of what excess litter can look like on Saskatchewan rangeland. (Original image created for the Prairie Conservation Action Plan by Heather Peat Hamm).

hail storms, or grasshopper damage can alter litter levels on a site. Any changes affecting litter should be noted.

Litter may be evenly present across an entire site; however, a natural amount of patchiness and diversity, referred to as heterogeneity, is expected and beneficial. Management practices can cause a shift in litter levels across a landscape. The reduction of litter levels can change in a relatively short timeframe, even from one year to the next, depending on management practices, such as grazing, or environmental events such as fire. Building litter levels can take much longer.

What if expected litter levels are unavailable?

There are gaps in information for expected litter levels in Saskatchewan. Users need to rely on observation and interpretation to help determine a reasonable expected litter level for their site. The *Saskatchewan Rangeland Ecosystems* publications include litter cover (%) for many ecosites, which can help inform observers. Historical information, previous assessments, past benchmarks, or a comparison of potential nearby lightly grazed sites can all help assessors determine a potential expected litter level for the assessment area.

An important change in Saskatchewan's updated range health assessment is that excess litter is now factored into scores.

Question 5.1 and 5.2 Scoring Notes

Observe the amount of litter distributed across the overall assessment area and compare it to what is expected on a similar ecosite. Assess whether the litter is diverse and patchy, uniform and even, in excess, or sparse. Uniformly low or uniformly high litter levels indicate a management impact.

Question 5 considers the ability of a site to retain soil water based on the weights of organic residue. Litter weight estimates (in pounds per acre or kilograms per hectare) are made by hand-raking litter from a 0.25m^2 frame from representative areas across the site. This visual estimation is demonstrated in Figure 15.

"Litter kits" can be useful tools to help observers visually estimate how much litter is raked from a site. For example, if you want a litter bag demonstrating 585 lb/ac, use a conversion factor of 35.55 to determine how many grams of litter should be weighed and placed in a labeled Ziploc bag. (585 lb/ac divided by 35.55 equals 16.5g of litter).

Compare raked samples to expected litter normal (average amounts) as indicated in Table 3. In this table, expected litter ranges are presented for sites that are Healthy (135% to 65% of average litter levels); Healthy with Challenges (65% down to 35% of average litter levels), and sites that Needs Improvement (litter levels falling below 35% of average).

To avoid skewing litter estimates, when raking, do not include any plant growth from the **current** season. Avoid collecting biocrust species such as mosses and lichens, and avoid sampling frames with livestock or wildlife manure.

Question 5: Is the expected amount and distribution of litter present? Record estimated litter mass and expected litter amounts on the scoresheet.

Litter on assessment area is:
Excessive ☐ **Reduced** ☐ **Similar to Expected** ☐

25 = Litter amounts are in the range of 65 to 135% of what is expected under moderate disturbance. Litter distribution closely resembles the reference ecosite.

13 = Where litter is reduced, it is present at 35 to 65% of what is expected and distribution shows minor alteration compared to the reference ecosite. Where litter is excessive, amounts exceed 135% of expected, and plants are beginning to show negative impacts through reduced vigour.

6 = Where litter is reduced, it is present at less than 35% of what is expected in the reference ecosite and few places with adequate litter are left remaining. Where litter is excessive, amounts exceed 135% of expected, and plants are noticeably and negatively impacted through reduced vigour and stem density.

0 = Litter is greatly reduced or absent entirely compared to the reference ecosite. The extent and distribution of exposed soil has increased and there is little to no standing or fallen litter due to severe alteration.

Litter Scoring Example:

A sandy ecosite within the mixed grassland ecoregion has been assessed. Litter rakes across five quadrat frames show an average weight of 585 lb/ac. There is some heterogeneity but generally, the amounts appear fairly uniform.

There is no expected litter weight available for this site, however the user can use available information to answer the question. Plants are vigorous and biodiversity seems high, so it appears that litter is not too excessive. The published litter normal for a presumably more productive loam site (mixed grassland) is 600lb/ac, indicating the amount on the observed site is not reduced. The site scored high in most of the other categories, indicating that observations are generally meeting expectations across other indicators.

If the observer decides 600lb/ac could be a reasonable expected litter normal, then:

585lb ÷ 600lb = 98% of expected litter is present

The assessor checks the "similar to expected" box and **scores Q5 as 25 points**.

Figure 16. Varying litter levels and estimated weights from hand-raking from a 50 cm by 50 cm frame. To convert pounds per acre (lb/ac) into kilograms per hectare (kg/ha), multiply values by 1.12. (Original image series created by Tara Mulhern Davidson for the Saskatchewan Prairie Conservation Action Plan).

Table 3. Expected litter weights for common Saskatchewan ecosites.

Ecoregion	Ecosite	Expected Litter (lb/ac)			
			Healthy	Healthy with challenges	Needs improvement
		Average	135-65%	65-35%	<35%
Dry Mixed Grassland	Loam	400	540-260	260-140	<140
	Solonetzic	250	338-160	160-85	<85
	Thin	150	203-95	95-50	<50
Mixed Grassland	Clay	856	1156-556	556-300	<300
	Loam	600	810-390	390-210	<210
	Thin	300	405-195	195-105	<105
Moist Mixed Grassland	Solonetzic	685	925-445	445-240	<240
Aspen Parkland	Dunes	400	540-260	260-140	<140
	Loam	1500	2025-975	975-525	<52
	Sand	800	1080-520	520-280	<280
	Sandy	1100	1485-715	715-385	<385
Cypress Upland	Loam	900	1215-585	585-315	<315

*Updated from Litter accumulation and productivity in Saskatchewan native rangelands, Saskatchewan Agriculture Development Fund (ADF) Project Final Report, 2024. Other values originally published in *Rangeland Health Assessment: Native Grassland and Forest, 2008*.

INTERPRETING THE RESULTS OF A RANGE HEALTH ASSESSMENT

Range health assessments can help document and support sustainable land management practices. A range health assessment describes how an ecosite functions relative to its potential at a point in time. It can provide a baseline, track successes or challenges, identify areas of management that need to be fine-tuned, or validate current practices.

Natural events and processes, such as drought, wildfire, insect damage, flood, disease, hail, and extreme winds, can affect how an ecosystem functions, as can human-caused disturbances.

Regular range health assessments, along with weather records, grazing data, management history, and photographs, can be used as tools to help create a resilient ecosystem that withstands natural and man-made disturbances.

What does the overall range health score tell you?

The range health score is the sum of all the health indicator questions. It is a cumulative measure of the health and function observed and measured in the overall assessment area. To interpret results, it is helpful to consider the health categories as a whole, as well as individual indicators.

Healthy (75-100%)

All of the key functions and range health indicators are being performed. This sends a positive message about the current management practices. It may indicate that current practices, including stocking rate, livestock distribution, burning, mowing, weed management, or grazing practices, are adequately maintaining range health. The ecosite is functional for wildlife and livestock.

Healthy with Challenges (50-74%)

Some key functions and range health indicators are not being performed to their full potential. This score is an early warning of the need for minor or major adjustments in management practices, followed by further monitoring. There may be a reduction in support for different types of wildlife and decreased grazing potential. Recovery to a healthy score may be accomplished within a few years or longer.

Needs Improvement (0-49%)

Few of the key functions and range health indicators are being performed satisfactorily. A rating in this category calls for urgent action. Current management practices, such as grazing, idleness, stocking rates, livestock distribution, or improper disturbance are limiting the health and function of the range. It may take years for the site to regain a healthy status and livestock grazing and wildlife habitat opportunities are significantly reduced. In some circumstances, sites in the Needs Improvement category may never regain a healthy status.

What do the individual health indicator scores tell you?

To further understand potential concerns and opportunities for management improvements, look at the individual indicator questions. All indicators are interrelated, and understanding scores for each function will help outline potential management strategies. It isn't possible to heal one problem without addressing the others, however, often one management adjustment will improve multiple indicators.

Questions 1, 2 and 3 relate to plant community composition and structure and are allocated the most points (60) out of the entire score. High scores for these indicators will contribute to a healthy rating. Medium and low scores for these indicators show the disturbance impact on the site is moderate or more and the plant community is shifting away from being dominated by decreaser plants to a community dominated by increasers species and undesirable plants, including woody encroachment and invasive weeds. The site may be moving away from structural diversity toward fewer life-form layers. Low scores for this group of indicators will reflect a significant negative impact on the site's function.

Question 4 relates to soil protection, and question 5 relates to hydrological function (litter). Collectively, these indicators are allocated 40 points.

High scores for 4.1 and 4.2 demonstrate that soil is covered and erosion is managed within what is expected for the ecosite. Medium scores demonstrate that bare soil and soil erosion may be increasing. Left unmanaged, the functional potential of the site will deteriorate, and these indicators will score lower. Erosion processes can accelerate, bare soil can provide a niche for invasive weeds and other undesirable plant species to flourish, biocrust and soil microbial processes are altered, and water infiltration is reduced. The ability and speed of a site to recover from soil erosion and increased bare soil depends on the severity of the impact, the climate, growing conditions, and the vegetation production potential of the ecosite.

High scores for question 5 (litter) indicate plant residue is recycled, moisture is retained, and appropriate litter is available for cover and nesting for wildlife and birds. Medium scores for litter indicate that litter levels are deviating from normal, which impacts water retention, water, and nutrient cycling. Low litter scores due to insufficient litter may demonstrate that too much plant growth is being removed by grazing or other management. Water infiltration is reduced, fewer nutrients are recycled, and habitat may be limited to species that tolerate little litter cover. Low scores due to excessive litter accumulation can cause reduced plant vigour, interrupt effective nutrient cycling, and shift plant communities toward an undesirable plant community that prefers cooler, shaded environments.

Changes in plant community composition and structure tend to occur over a long time relative to other indicators. As such, implementing practices to improve plant communities will take several years before range health scores show improved results for those categories. Management changes designed to improve other indicators, such as increasing depleted litter levels, may show progress after two or three growing seasons.

The Value of Disturbance and Heterogeneity

Rangelands evolved under natural disturbances. Too much or too little disturbance can affect function. Plant diversity is likely to improve with moderate disturbance pressures such as grazing or prescribed fire. For example, some native seeds require access to sunlight, saturation with water, digestion, or fire to germinate.

Disturbance can impact heterogeneity or "patchiness" on the landscape, which can improve biodiversity. Wildlife and bird species have diverse habitat requirements, and grazing livestock have diverse nutritional needs. Managing disturbance to achieve a heterogeneous landscape that is rich in plant species and structural diversity will support a broad spectrum of habitat and forage for wildlife, grazing animals, and other species.

Disturbances can be manipulated to accomplish specific goals

Disturbance can be adapted by varying the frequency, timing, and intensity. The frequency refers to how often a disturbance occurs. This could mean how often a plant is grazed or how regularly a site is burned. The timing of disturbance refers to the time of year it is occurring. For example, spring can be a sensitive time of year to graze many plants because they are drawing on energy stores to produce shoots and flowers. Alternately, spring may be an effective time to conduct a prescribed burn to help control and further weaken undesirable plants when they are already vulnerable. Intensity of disturbance refers to how much of the plant is removed or how intensely the disturbance impacts the soil surface. The more frequent and intense a disturbance is on rangeland, the more time is needed to recover.

Principles of Range Management

There are four principles at the core of range (grazing) management:

1. Balance forage supply and demand. Control the amount of plant material removed and ensure there is enough remaining to sustain ecological processes.
2. Manage distribution. Fencing, water development, salt and mineral placement, herding, and stockmanship can prevent overgrazing while ensuring grazing is targeted where needed. For example, grazing can be encouraged to manage brush, suppress weeds or enhance habitat.
3. Provide effective rest. Allowing plants to rest and recover during the growing season (spring and summer) will ensure they replenish their energy stores and remain productive.
4. Avoid grazing during sensitive periods. Grazing rangeland at sensitive times for plant growth or when soils are sensitive will impact range health and require a longer recovery time.

Range management is an art and science. Range is a living landscape full of nuance and subtleties. Caring for and managing Saskatchewan's rangeland requires observation, curiosity, patience, and an appreciation for this valuable ecosystem. A range health assessment can be an effective tool to help managers understand rangeland, its many functions, and aim to manage this resource to its full potential.

GLOSSARY

Bare soil: percent of the area of reference where mineral soil is not protected by live or dead vegetation, rocks (greater than 6.4 cm or 2.5 in), or biocrust (including lichens).

Biocrust: biologically active life-form layer that lives at the soil-plant interface. Includes complex organisms such as mosses and lichens.

Daubenmire frame: a 50cm x 20cm quadrat frame used to help estimate cover, estimate vegetation cover or biomass, or litter biomass.

Decile: a separate plant community within an assessment area that is a minimum of 10% of the site.

Decreaser: perennial species that tend to be productive and palatable to grazing animals and decrease in relative abundance under increased and heavy grazing pressure. Examples of **decreasers** include green needlegrass, purple prairie clover, vetchling, and winterfat.

Ecological functions: specific to this workbook, net primary production, soil/site stability, capture and slow release of water, nutrient and energy cycling, and plant species diversity.

Ecological status: is the degree of similarity between the present plant community and the reference plant community.

Ecological processes: the water cycle (the capture, storage, and redistribution of precipitation), energy flow (conversion of sunlight to plant and animal matter), and nutrient cycle (the cycle of nutrients through the physical and biotic components of the environment).

Ecoregions: a relatively large area of land that contains a geographically distinct pattern of recurring ecosystems. Each ecoregion is associated with characteristic combinations of soil, landforms and the associated plant and animal communities. There are 11 ecoregions in Saskatchewan.

Ecosite: a distinctive type of site with specific physical characteristics, including soil and topography, and a specific potential natural community, differing from other kinds of sites in its ability to produce vegetation and to respond to management.

Ecozone: the broadest ecological grouping, defining, on a subcontinental scale, the major physiographic features of the country (e.g., Prairies, Rocky Mountains, Canadian Shield).

Foliar Cover: vegetation canopy is estimated on a foliar level, and the spaces within the vegetation canopy are subtracted from the estimate.

Frame: a field tool, sometimes referred to as a quadrat, used to estimate vegetation or litter cover or biomass. See Quadrat.

Graminoids: grasses and grass-like (e.g., sedge, rush) plant species.

Ground-truth: a validation process comparing expected site characteristics identified in aerial photos and maps with on-the-ground site characteristics such as vegetation type, soil texture, and topography.

Half-shrub: A perennial plant with a woody base whose annually produced stems die each year.

Increaser: species that are better adapted to grazing pressure and will increase in relative abundance under increased and heavy grazing pressure. Some increaser species will eventually start decreasing as disturbance pressure escalates beyond normal disturbance regimens. Examples of **increasers** are blue grama, goldenrod, and western snowberry.

Indicators for range and pasture health are those components of the ecosystem whose characteristics are used as an index that would otherwise be too difficult, inconvenient, or expensive to measure. To illustrate, litter is an indicator of hydrologic functioning.

Invasive weeds: aggressive, rapidly expanding plant species or groups of plant species that are non-native to the rangeland plant community and threaten the integrity and function of the overall landscape. Invasive weeds can include noxious weeds (managed under *The Weed Control Act* in Saskatchewan), along with invasive weeds that may not yet be designated as prohibited or noxious but pose a threat to Saskatchewan rangeland.

Life-form layers: plant structural layers that vary by growth form, size, height, and rooting depth. Examples include biocrust/ground cover, short grasses and forbs, medium grasses and forbs, and shrubs. Forests would have additional life-form layers such as tall shrubs and trees.

Litter: dead plant residue. This includes material that can still be standing, freshly fallen, or slightly decomposed.

Management unit: an area of rangeland isolated (temporarily or permanently) from other management units by fencing or landscape features such as water or slope. A management unit is managed separately and must be assessed separately. In many cases, a management unit is a pasture or field.

Microclimate: a small zone, within a landscape, that experiences a difference in soil water, temperature, and other climate variables, compared to the larger ecosite.

Non-native forage species: plant species that may have been introduced into and benefit cultivated lands, but are undesirable when they invade native rangeland plant communities. Their presence reduces biodiversity, decreases habitat quality, and can negatively affect other indicators of rangeland health.

Noxious invasive weeds: weed species designated and regulated under *The Weed Control Act* in the province of Saskatchewan. Leafy spurge, absinthe, and common tansy are examples of Saskatchewan noxious weeds.

Plant communities: a group of different plant species that interact with one another. For a range health assessment, the current plant community is compared to the reference plant community.

Plant cover: vertical projection of a plant to the ground surface, expressed as a percent of the area of reference (i.e., a 20cm by 50cm plot frame). Percent cover is estimated by looking vertically down on the quadrat and estimating the percent of the area covered by the species. Gaps between the leaves or branches should be subtracted.

Plotline: a linear pattern that an assessor may walk to sample vegetation and make observations to conduct a range health assessment.

Polygon: an area being assessed, may coincide with a soil map unit.

Quadrat: a frame used to visually assess plant cover, litter cover, bare soil or other parameters to conduct a range health assessment. See Frame.

Qualitative: estimated observations. For example, an assessor uses qualitative observations to conduct a rapid range health assessment instead of measurements and sampling vegetation with a quadrat.

Quantitative: comprehensive data collection and measurements. For example, an assessor uses expert skills to conduct range surveys in an established method to conduct a range inventory.

Range condition: a previously used scoring method that compared the plant community only to the expected community and calculated a rating of Excellent, Good, Fair, or Poor. This method doesn't use range health indicators such as vegetation structure, bare soil, litter, or invasive weeds. This method is explained in *Range Plan Development*.

Range health considers the degree to which the integrity of the soil, vegetation, water, and air, as well as the ecological processes of the range ecosystem, are balanced and working together.

Range Inventory: a survey method requiring expert training to collect comprehensive data that may include vegetation surveys, quadrat sampling, transects and other quantitative measurements. (from the 2025 workbook and loosely based on 2008 version)

Rangeland: land supporting indigenous, natural, or introduced perennial vegetation, is managed as a natural ecosystem, and is grazed or has the potential to be grazed. Rangelands are complex and diverse and can include native prairie grassland, forested areas, pastures, shrubland, and riparian areas.

Rapid assessment: scoring range health based on estimated (qualitative) observations. Reference Plant Community: the potential natural community that will establish on an ecosite under current climatic conditions.

Resilience: the ability of rangelands and pastures to respond to disturbance by resisting damage and recovering quickly.

Riparian (lotic and lentic): transitional zones between an aquatic ecosystem and the surrounding upland area. Lotic riparian areas are flowing watercourses such as rivers or streams. Lentic riparian areas are still waterbodies, such as lakes or wetlands.

Samples: locations within an assessment area where data is collected, often using a quadrat, to document plant cover, bare soil, litter cover and amount.

Seral stages: individual steps along a successional pathway. These can be limited by environmental conditions such as soil types and climate – for example, dry, loam soils will limit tree and shrub growth even in the absence of fire or grazing. Seral stages begin at the pioneer stage of early seral, and progress in succession to mid-seral, then late seral and finally reference plant community or climax.

Similarity Index: percent similarity between the vegetation observed and documented within the assessment area and the reference plant community for the ecosite.

Soil map unit: The areas shown on a Saskatchewan soil map. *Saskatchewan Rangeland Ecosystems* use soil map units to help identify potential reference plant communities.

Soil microbiome: diverse microbial ecosystem within the soil.

Succession: gradual replacement of one plant community by another over time. Successional pathway : predictable pathway of change in the plant community as it recovers from disturbance over time.

Threshold: a point at which a plant community cannot return to its state similar to the reference plant community or any of its earlier seral states.

Transect: a route travelled during an assessment, with observations and data collection occurring at various points. May also include a line of samples collected within an assessment.

Woody encroachment: an increase in abundance of woody species into areas that previously were not present in abundance, and do not exist within a reference plant community. Without an appropriate disturbance regime, woody species may naturally replace grassland areas.

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Appendix A – Online Tools and Resources for Range Health Assessments

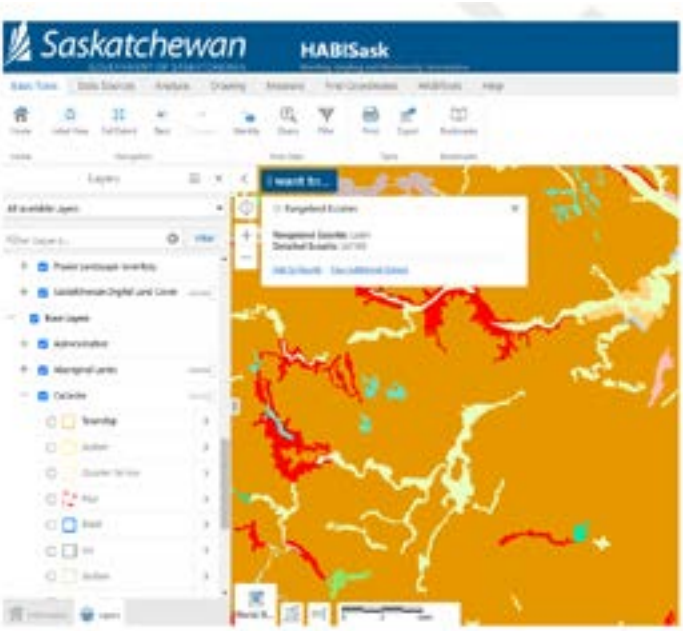
Saskatchewan Rangeland Ecosystems: Ecoregions & Ecosites (Version 2) is an essential resource for conducting a range health assessment. This document and all ecosite guides are currently accessible at www.saskpcap.org/rangelands.

There are currently two public online tools to determine soil types and ecological sites, HABISask and the Saskatchewan Soil Information System (SKSIS).

1. Go to HABISask
    - Click on **Data Sources** tab then **Map Layers**
    - Under **Operational Layers**, click **Ecological Classification** and open the drop-down menu by clicking the plus sign. Check boxes beside **Natural Ecoregions** and **Rangeland Ecoregions**
    - Scroll down in the left-hand menu to find and expand (by clicking the plus sign) **Base Layers**.
    - Expand the **Cadastre** drop-down menu. Check boxes beside **Township**, **Section** and **Quarter Section**.
    - Zoom into area of interest. Uncheck Township, Section, and Quarter Section to click on ecosite colour to determine recommended ecosite.
    - Find the relevant Saskatchewan ecosite guide on www.saskpcap.org/rangelands
    - Once in the field, ground-truth to verify the ecosite is correct.

Ecosites can vary greatly. Within HABISask, sites are identified in dominant ecosites and detailed ecosites. For example, a dominant site is listed as loam, however, the detailed ecosite may indicate LM85/SO15. This means the site is 85% loam and 15% solonetzic, and has a different reference plant community that reflects this diversity.

Observers may assess these detailed ecosites separately, depending on this variability and their goals.



2. Visit Saskatchewan Soil Information System (SKSIS)
   - scroll to the bottom where a legal land description can be entered in Search by LLD section
   - under Theme drop-down menu, select Map Unit
   - click on the location on map where the soils unit is desired
   - scroll to the bottom to the Information section and click on Map Tab
   - the dominant ecosite for the soils unit is listed under Dominant Ecosite using its abbreviation. Click on the information icon for the list of all ecosite abbreviations (i.e. SD = Sand).
   - review the appropriate guide (e.g. Communities on Sandy and Sandy Loam Ecosites)
   - once in the field, ground-truth to verify the ecosite is correct

APPENDIX B – COMMON RANGE PLANT SPECIES AND THEIR GRAZING RESPONSE

A plant species' response to increased and heavy grazing pressure determines whether it is an "increaser" or a "decreaser." **Decreasers** tend to be productive and palatable, decreasing in relative abundance under increased grazing pressure. **Increasers** tend to adapt better to grazing pressure, increasing in relative abundance. **Invaders** are non-native species that increase in relative abundance in natural grasslands.

Non-native forage species* or **non-native shrubs/trees**** can establish and invade native rangeland plant communities. These species may be beneficial in altered ecosystems such as tame pastures; however, they have invasive properties and are considered less desirable in natural grassland areas. Their presence can reduce biodiversity, impact community structure, alter habitat, and have other negative effects on range health.

Table B1. Grasses, grass-likes, forbs, shrubs, and trees and their responses to grazing according to ecoregion.

	Dry Mixed/ Mixed Grassland	**Moist Mixed Grassland**	**Aspen Parkland**
Grasses			
Alkali cord grass *(Sporobolus hookerianus)*	Increaser	Increaser	Increaser
Awned/bearded wheatgrass *(Elymus trachycaulus subsp. subsecundus)*	Decreaser	Decreaser	Decreaser
Big bluestem *(Andropogon gerardi)*	-	Decreaser	Decreaser
Blue grama *(Bouteloua gracilis)*	Increaser	Increaser	Increaser
Canada bluegrass *(Poa compressa)*	-	Invader	Invader
Canada/marsh reed grass *(Calamagrostis canadensis)*	Increaser	Increaser	Increaser/ Decreaser
Canada wildrye *(Elymus canadensis)*	Decreaser	Decreaser	Decreaser
*Crested wheatgrass *(Agropyron cristatum)*	Invader	Invader	Invader
Foxtail barley *(Hordeum jubatum)*	Increaser	Increaser	Increaser
Fringed brome grass *(Bromus ciliatus)*	Decreaser	Decreaser	Decreaser

Green needle grass *(Nasella viridula)*	Decreaser	Decreaser	Decreaser
Hooker's oatgrass *(Helictochloa hookeri)*	Decreaser	Decreaser	Decreaser
June grass *(Koeleria macrantha)*	Increaser	Increaser	Increaser
*Kentucky bluegrass *(Poa pratensis)*	Invader	Invader	Invader
Little bluestem *(Schizachyrium scoparium)*	Increaser	Increaser	Increaser
Mat muhly *(Muhlenbergia richardsonis)*	Increaser	Increaser	Increaser
Needle-and-thread *(Hesperostipa comata)*	Decreaser	Increaser	Increaser
Northern wheatgrass *(Elymus lanceolatus*	Decreaser	Decreaser	Increaser
Plains/prairie muhly *(Muhlenbergia cuspidata)*	Increaser	Increaser	Increaser
Plains reedgrass *(Calamagrostis montanensis)*	Increaser	Increaser	Increaser
Plains rough fescue *(Festuca hallii)*	Decreaser	Decreaser	Decreaser
Porcupine grass *(Hesperostipa spartea)*	-	Decreaser	Decreaser
Prairie dropseed *(Sporobolus heterolepis)*	Decreaser	Decreaser	Decreaser
Prairie sandgrass *(Sporobolus rigidus)*	Increaser	Increaser	Increaser
*Quackgrass *(Elymus repens)*	Invader	Invader	Invader
*Redtop *(Agrostis stolonifera)*	Invader	Invader	Invader
*Reed canary grass *(Phalaris arundinacea)*	Invader	Invader	Invader
Sand reed grass *(Calamovilfa longifolia)*	Increaser	Increaser	Increaser
Sand ricegrass *(Eriocoma hymenoides)*	Decreaser	Decreaser	Decreaser
Sandberg's bluegrass *(Poa secunda)*	Increaser	Increaser	Increaser
Sheep fescue *(Festuca ovina)*	Increaser	Increaser	Increaser
Slender wheatgrass *(Elymus trachycaulus)*	Decreaser	Decreaser	Increaser
*Smooth brome grass *(Bromus inermis)*	Invader	Invader	Invader

*Timothy *(Phleum pratense)*	Invader	Invader	Invader
Western porcupine grass *(Hesperostipa curtiseta)*	Decreaser	Decreaser	Increaser
Western wheatgrass *(Pascopyrum smithii)*	Decreaser	Increaser	Increaser
Grass-like Plants			
Low sedge *(Carex duriuscula)*	Increaser	Increaser	Increaser
Sun-loving sedge *(Carex pensylvanica)*	Increaser	Increaser	Increaser
Thread-leaved sedge *(Carex filifolia)*	Decreaser	Increaser	Increaser
Forbs			
American vetch *(Vicia americana)*	Decreaser	Decreaser	Decreaser
*Alfalfa *(Medicago sativa)*	Increaser	Increaser	Increaser
Beardtongue species *(Penstemon sp.)*	Increaser	Increaser	Increaser
Blazingstar *(Liatris punctata)*	Decreaser	Decreaser	Decreaser
Broomweed *(Gutierrezia sarothrae)*	Increaser	Increaser	Increaser
Buffalo bean/Goldenbean *(Thermopsis rhombifolia)*	Increaser	Increaser	Increaser
*Cicer milk vetch *(Astragalus cicer)*	Invader	Invader	Invader
Colorado rubberweed *(Hymenoxys richardsonii)*	Increaser	Increaser	Increaser
Cream-coloured vetchling *(Lathyrus ochroleucus)*	-	Decreaser	Decreaser
Gaillardia *(Gaillardia aristata)*	Increaser	Increaser	Increaser
Gumweed *(Grindelia squarrosa)*	Increaser	Increaser	Increaser
Hairy golden aster *(Heterotheca villosa)*	Increaser	Increaser	Increaser
*Hairy vetch *(Vicia villosa)*	Invader	Invader	Invader
Locoweed species *(Oxytropis species)*	Increaser	Increaser	Increaser
Moss phlox *(Phlox hoodii)*	Increaser	Increaser	Increaser
Northern bedstraw *(Galium boreale)*	Increaser	Increaser	Increaser
Pale comandra *(Comandra umbellata)*	Increaser	Increaser	Increaser
Pasture sage/Fringed sage *(Artemisia frigida)*	Increaser	Increaser	Increaser

Prairie coneflower *(Ratibida columnifera)*	Increaser	Increaser	Increaser
Prairie crocus *(Pulsatilla patens)*	Increaser	Increaser	Increaser
Prickly pear cactus *(Opuntia polyacantha)*	Increaser	Increaser	Increaser
Purple prairie clover *(Dalea purpurea)*	Decreaser	Decreaser	Decreaser
Pussytoes/Everlasting species (*Antennaria* species)	Increaser	Increaser	Increaser
Scarlet mallow *(Sphaeralcea coccinea)*	Increaser	Increaser	Increaser
Silver-leaf psoralea *(Pediomelum argophyllum)*	Increaser	Increaser	Increaser
Spiny ironplant *(Xanthisma spinulosum)*	Increaser	Increaser	Increaser
Three-flowered avens *(Geum triflorum)*	Increaser	Increaser	Increaser
Two-grooved milkvetch *(Astragalus bisulcatus)*	Increaser	Increaser	Increaser
*White sweet clover *(Melilotus albus)*	Invader	Invader	Invader
Wild licorice *(Glycyrrhiza lepidota)*	Increaser	Increaser	Increaser
Wild peavine *(Lathyrus venosus)*	Decreaser	Decreaser	Decreaser
Woolly yarrow *(Achillea millefolium)*	Increaser	Increaser	Increaser
*Yellow sweet clover *(Melilotus officinalis)*	Invader	Invader	Invader
Trees & Shrubs			
Aspen poplar/trembling aspen *(Populus tremuloides)*	Increaser	Increaser	Increaser
Balsam poplar *(Populus balsamifera)*	Increaser	Increaser	Increaser
Beaked hazelnut *(Corylus cornuta)*	Increaser	Increaser	Increaser
Bearberry *(Arctosphylos uva-ursi)*	Increaser	Increaser	Increaser
**Caragana *(Caragana arborescens)*	Invader	Invader	Invader
Chokecherry *(Prunus virginiana)*	Decreaser	Decreaser	Decreaser
Cranberry species *(Viburnum species)*	Decreaser	Decreaser	Decreaser
Greasewood *(Sarcobatus vermiculatus)*	Increaser	Increaser	Increaser

Green alder *(Alnus alnobetula)*	Increaser	Increaser	Increaser
Northern gooseberry *(Ribes oxyacanthoides)*	Increaser	Increaser	Increaser
Nuttall's saltbush *(Atriplex gardneri)*	Decreaser	Decreaser	Decreaser
Pincherry *(Prunus pensylvanica)*	Decreaser	Decreaser	Decreaser
Red-osier dogwood *(Cornus sericea)*	Decreaser	Decreaser	Decreaser
Rose species (*Rosa* species)	Increaser	Increaser	Increaser
Saskatoon *(Amelanchier alnifolia)*	Decreaser	Decreaser	Decreaser
Shrubby cinquefoil *(Dasiphora fruticosa)*	Increaser	Increaser	Increaser
**Siberian elm *(Ulmus pumila)*	Invader	Invader	Invader
Silver sagebrush *(Artemisia cana)*	Increaser	Increaser	Increaser
Western snowberry/buckbrush *(Symphoricarpos occidentalis)*	Increaser	Increaser	Increaser
Winterfat *(Krascheninnikovia lanata)*	Decreaser	Decreaser	Decreaser
Wolfwillow *(Elaeagnus commutata)*	Increaser	Increaser	Increaser

*Non-native forage species
**Non-native shrub/tree species

APPENDIX C – NOXIOUS, PROHIBITED* AND OTHER INVASIVE WEEDS+ IN RANGELANDS

When evaluating range health, consider the species in Table C1. This is an evolving list of species that may threaten range health, including species designated as prohibited or noxious as per *The Weed Control Act*. Other weed species that may not yet be designated as prohibited or noxious but are considered to be especially problematic on Saskatchewan rangelands may be listed or considered as well. There may also be localized populations of plants not listed that exhibit invasive tendencies and pose a risk to range health, which can be recorded on the scoresheet.

Table C1. Noxious, prohibited and other invasive weeds on Saskatchewan rangelands.

Common Name (scientific name)	**Growth-Form**
Absinthe (*Artemisia absinthium*)	Perennial forb
Baby's breath (*Gypsophila paniculata*)	Perennial forb
Black henbane (*Hyoscyamus niger*)	Annual/ Biennial forb
Bladder campion (*Silene vulgaris*)	Perennial forb
Bull thistle (*Cirsium vulgare*)	Biennial forb
Canada thistle or creeping thistle+ (*Cirsium arvense*)	Perennial forb
European buckthorn (*Rhamnus cathartica*)	Shrub
Common burdock (*Arctium minus*)	Biennial forb
Common crupina* (*Crupina vulgaris*)	Perennial forb
Common tansy (*Tanacetum vulgare*)	Perennial forb
Creeping bellflower (*Campanula rapunculoides*)	Perennial forb
Dalmatian toadflax* (*Linaria dalmatica*)	Perennial forb
Dame's rocket (*Hesperis matronalis*)	Biennial/short-lived perennial forb
Diffuse knapweed* (*Centaurea diffusa*)	Biennial forb
Downy brome (*Bromus tectorum*)	Winter annual/annual grass
Field bindweed (*Convolvulus arvensis*)	Perennial forb
Field scabious* (*Knautia arvensis*)	Perennial forb
Flowering rush* (*Butomus umbellatus*)	Aquatic perennial forb
Greater burdock± (*Arctium lappa*)	Biennial forb

Hoary alyssum (*Berteroa incana*)	Biennial forb
Japanese brome (*Bromus japonicus*)	Winter annual/annual grass
Leafy spurge (E*uphorbia virgata*, previously referred to as *Euphorbia esula*)	Perennial forb
Medusahead± (*Taeniatherum caput-medusae*)	Winter annual grass
Narrow-leaved hawksbeard (*Crepis tectorum*)	Winter annual/annual forb
Nodding thistle+ (*Carduus nutans*)	Biennial forb
Oxeye daisy (*Leucanthemum vulgare*)	Perennial forb
Purple loosestrife (*Lythrum salicaria*)	Aquatic perennial forb
Russian knapweed (*Acroptilon repens*)	Perennial forb
Saltcedar* (*Tamarix ramosissim*a)	Shrub
Scentless chamomile (*Tripleurospermum inodorum*)	Annual/biennial forb
Spotted knapweed* (*Centaurea stobe*)	Perennial forb
Ventenata± (*Ventenata dubia*)	Winter annual grass
Woolly burdock (*Arctium tomentosum*)	Biennial forb
Yellow starthistle* (*Centaurea solstitialis*)	Winter annual
Yellow toadflax (*Linaria vulgaris*)	Perennial forb

*Prohibited

+Other invasive weed, including nuisance, and species not currently found in Canada but in nearby jurisdictions.

SASKATCHEWAN GRASSLAND RANGE HEALTH ASSESSMENT SCORESHEET

Field/Management Unit:	Observer:	Date:
Ecoregion & Ecosite:	Latitude/Northing:	Longitude/Easting:
Ref. Plant Community:	Legal Land Description/Waypoint:	

Long-term Grazing Intensity:

Ungrazed ☐ Light ☐ Moderate ☐ Heavy ☐

Management Activities Impacting Site:

Grazing ☐ Fire ☐ Weed Control ☐ Unknown ☐

Timing of Assessment Compared to Livestock Grazing:

Already Grazed ☐ Currently Grazed ☐ Will be Grazed this Season ☐ Unsure ☐ Ungrazed (circle long/short-term) ☐

MAJOR PLANT SPECIES

Grasses & Grass-likes	% CVR	Forbs	% CVR	Shrubs & Trees	% CVR	DD Class	Site Characteristics	
							% Bare Soil	
							% Biocrust Cover	
							% Litter Cover	
							% Total Veg Cover	
							Litter Mass	

Question 1.1: Does the plant community resemble the **reference plant community**?	Score
Plant community composition **closely resembles** the reference plant community, alteration by disturbance is minimal. The percent similarity to the reference plant community is >65%. Decreaser plants are dominant.	35
Plant community shows **minor alteration** in plant species composition due to disturbances, and is 50-65% similar to the reference plant community. Disturbance impact is light to moderate. Decreaser plants are abundant.	24
Plant community shows **moderate alteration** due to disturbances, and is 30-50% similar to the reference plant community. Disturbance impact is moderate to heavy. Some decreasers present but there is an elevated proportion of increaser or non-native plants.	17
Plant community shows **significant alteration** due to disturbances and is 15-30% similar to the reference plant community. Disturbance impact is heavy to very heavy. Increaser and non-native plants have become most abundant.	10
Plant community shows **extreme to severe alteration** due to disturbances and is less than 15% similar to the reference plant community. Disturbance impact is severe to very severe. The community is almost entirely dominated by increaser and non-native species.	0

Question 1.2: What is the influence of **non-native plants** on the plant community?	Score
Non-native forage species are absent or present in small quantities and do not negatively impact ecosystem functions.	5
Non-native forage species are noticeably influencing the plant community and ecosystem. Non-native forage speies like crested wheatgrass, smooth brome, and Kentucky bluegrass are common.	3
The site is dominated by non-native plants. The impact on ecosystem function is significant.	0

Non-native plant species

Question 2.1 What is the **cover** of **invasive weeds**?	Score
No invasive weed species are present.	5
Invasive weed species are present at less than 1% cover of the area.	3
Invasive weed species are present and cover 1 to 15% of the area.	1
Invasive weed species are present with a total cover greater than 15%.	0

Question 2.2 What is the **cumulative density distribution (DD)** of invasive weeds?	Score
No invasive weed species are present.	5
Invasive weed species are present at a low level of infestation. (Distribution class 1 to 3)	3
Invasive weed infestation is moderate (Distribution class 4 to 7).	1
Invasive weed infestation is heavy to severe (Distribution class 8 to 13).	0

Invasive Species	% cover	DD class		Non-native Species	% cover

Subtotal ____

Question 3.1 Are expected **vegetation layers** present? Biocrust is present & functional ☐ Biocrust is present but appears damaged ☐ Biocrust is excessive ☐ Biocrust is reduced or absent in open areas ☐	Score
The life form layers closely resemble the reference plant community.	7
One life form layer is absent/reduced by >50% expected cover OR two layers are moderately reduced by 25-50%.	5
Two life form layers are absent or reduced by >50% cover, OR four layers are moderately reduced by 25-50%.	2
Three life form layers are absent or considerably reduced by 50% cover or greater.	0

Question 3.2 Is **woody vegetation** or **shrub encroachment** problematic?	Score
Woody vegetation is present as expected.	3
Woody vegetation presence exceeds expected levels by 1-15% cover.	1
Woody vegetation exceeds expected levels by more than 15% cover.	0

Question 4.1: How much **bare soil** is present on the site? Is there management-caused bare soil beyond what is expected for the site? Actual % less Expected % =	Expected bare soil:	Actual bare soil:	Score
Management-caused bare soil is less than 10%.			5
Management-caused bare soil is between 10 and 20%.			3
Management-caused bare soil is between 20 and up to 50%.			1
Management-caused bare soil is greater than 50%.			0

Question 4.2: Is there more **soil erosion** than expected for this site? **YES** **NO** Types of soil erosion found: Rills ☐ Pedestalling ☐ Hoof shear ☐ Trailing ☐ Compaction ☐ Slight soil movement ☐ Gullies ☐ Moderate soil movement ☐ Excessive rodent-burrowing ☐	Score
No signs of soil erosion or fine plant litter movement beyond the natural extent for the site.	10
Some evidence of micro-erosion beyond the site's potential natural limit. Short and shallow flow patterns. Old erosion features are stabilized.	7
Moderate amounts of soil movement, flow patterns are branched. Erosion is active but not moving off-site.	3
Extreme amounts of soil movement including soil moving off-site.	0

Question 5: Is the expected amount and distribution of litter present? Litter on site is: Excessive ☐ Reduced ☐ Similar to Expected ☐	Expected litter:	Actual litter mass:	Score
Average litter amounts range from 65 to 135% of expected. Litter distribution closely resembles the reference site.			25
Where litter is reduced, it is present at 35-65% of expected. Distribution shows minor alteration. Where litter is excessive, amounts exceed 135% of expected and plants are starting to show some negative impact through reduced vigour.			13
Where litter is reduced, it is present at less than 35% of expected. Few places with adequate litter are remaining. Where litter is excessive, amounts exceed 135% of expected and plants are noticeably and negatively impacted through reduced vigour and stem density.			6
Litter is greatly reduced or absent entirely compared to the reference site. The extent and distribution of exposed soil has increased and there is little to no standing or fallen litter due to severe alteration.			0

Comments and Recommendations:

Circle Category

Healthy **(75-100%)**
Healthy with Challenges **(50-74%)**
Needs Improvement **(0-49%)**

Total Score _____

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