Saskatchewan Rangeland Ecosystems
Publication 1

Ecoregions and Ecosites

Version 2

A project of the Saskatchewan Prairie Conservation Action Plan

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1. INTRODUCTION

Ecosystem classification is one of the building-blocks of sustainable range management. Rangeland ecosystems vary with climate, with landform and soil features, and with the history of grazing and other influences. The ecosystems that result from these factors have different plant species, different levels of production, and different management requirements. Therefore, it makes good ecological sense to classify and map the different types of rangeland ecosystems as a basis for planning. This information can be used for setting stocking rates, planning grazing systems, identifying habitat for various wildlife species, designing species-at-risk surveys, and planning vegetation management treatments.

In Saskatchewan, this process was first placed on a systematic basis in 1990, when Zoheir Abouguendia published *Range Plan Development: a Practical Guide to Planning for Management and Improvement of Saskatchewan Rangeland*. The classification of regions and range sites used by Abouguendia has been modified somewhat in *Saskatchewan Rangeland Ecosystems*, but is based on the same concepts.

Within range sites, the vegetation composition depends on the level of grazing impact as well as other factors. In *Range Plan Development,* this type of variation was represented by the **range condition scale**, which gives a high score to the potential community for the site, and lower scores to communities that have been altered by grazing impact. In recent years, range scientists have found that vegetation changes may be too complicated to represent by a single scale. They have also found that some changes may be difficult to reverse, so that communities may not move back up the scale when conditions change. Because of these findings, the current approach is to represent vegetation change by **state-and-transition diagrams**, showing a number of different community types that could occur on a given site, and the types of transitions from one community to another. In this approach, there could be transitions between communities caused by grazing impact, but there could also be transitions in different directions related to fire or exotic invasion.

Alberta has led the way in Canada in moving to this approach, with a series of publications describing community types in relation to range sites (Adams et al. 2003, 2004, 2005). Funding from Agriculture and Agri-Food Canada's Greencover Canada Program made it possible to start this work in Saskatchewan. The Prairie Conservation Action Plan (PCAP), a partnership of 27 groups representing the livestock industry, federal and provincial agencies, conservation groups, and universities, formed a steering committee to work on several projects related to range health. *Saskatchewan Rangeland Ecosystems* is one of the products of this PCAP initiative. It covers the ecoregions, ecosites and communities of the Prairie Ecozone of Saskatchewan.

Saskatchewan Rangeland Ecosystems is a series of publications in a three-ring binder format. Publication 1 presents the classification of ecoregions and ecosites, and gives detailed guidelines for identifying ecosites. The publication also explains how communities within ecosites were classified and described. Publications 2 and 3 are large tables developed as information tools to help users to identify rangeland ecosites from soils information. The remaining publications provide descriptions of the plant communities found on each ecosite:

- Publication 4 - Loam Ecosite
- Publication 5 – Sand and Sandy Loam Ecosites
- Publication 6 – Clay Ecosite
- Publication 7 – Solonetzic Ecosite
- Publication 8 – Gravelly Ecosite
- Publication 9 – Dunes Ecosite
- Publication 10 – Thin Ecosite
- Publication 11 – Badlands Ecosite

The original *Saskatchewan Rangeland Ecosystems* publications were released in 2007. Funding at that time did not allow classification of communities in the moist to wet and/or saline ecosites. Also most woody types in the upland ecosites were not described. Additional funding became available in 2013-2014, allowing these gaps to be filled. Revisions were made to the 2007 publications, including added descriptions of many woody types, and reclassification of the grasslands on the Thin Ecosite. Three additional publications were developed:

- Publication 12 – Overflow and Subirrigated Ecosites
- Publication 13 – Meadow and Marsh Ecosites
- Publication 14 – Saline Ecosites

Saskatchewan Rangeland Ecosystems, Version 2, was released in 2014, providing a relatively complete picture of the rangeland types found in the Prairie Ecozone of Saskatchewan.

2. RANGELAND ECOREGIONS

The first step in ecosystem classification is to divide the province into ecological regions or **ecoregions**. Ecoregions are broad zones that are determined mainly by climate. The composition and productivity of rangeland is different in a moist climate compared to a dry climate, even if the soil material is the same. This means that the classification of rangeland ecosites must be nested within the broader ecoregions.

The original range site classification by Abouguendia (1990) used the Brown, Dark Brown, and Black Soil Zones as regions. In the driest of these, a “Dry Brown” subzone was separated by the level of annual precipitation. After Abouguendia’s guide was published, Padbury and Acton (1994) developed a standard ecoregion classification for the province, integrated with Canada’s national ecological land classification (ESWG 1996). Within the grassland part of Saskatchewan (the Prairie Ecozone), there are four ecoregions, which are closely related to the soil zones:

- Aspen Parkland - similar to the Black Soil Zone
- Moist Mixed Grassland - similar to the Dark Brown Soil Zone
- Mixed Grassland - similar to the Brown Soil Zone
- Cypress Upland - local area with strong elevation changes, rising from Brown to Dark Brown to Black soils

Both soil zones and ecoregions reflect the patterns of climate across the province, from warmer and drier in the Mixed Grassland (Brown Soil Zone) to cooler and moister in the Aspen Parkland (Black Soil Zone). In the Cypress Upland, precipitation increases and temperature decreases with rising elevation. The moisture available for plant growth depends partly on inputs from precipitation, but is also affected by losses to evaporation. Therefore Hogg's (1994) **climatic moisture index**, which is defined as annual precipitation minus annual potential evapotranspiration[1], was used. Positive numbers indicate an excess of precipitation over evaporation, as occurs in moist forest climates. Negative numbers indicate drier grassland climates, in which there is less moisture from precipitation than could potentially be evaporated. Moisture index values range from 0 to -175 mm in the Aspen Parkland, -175 to -250 mm in the Moist Mixed Grassland, and below -250 mm in the Mixed Grassland (Figure 1). The Cypress Upland shows a rise in moisture index with elevation.

The standard ecoregions shown in Figure 1 form the basis for the new range classification. However, it was necessary to make some modifications.

First, the Mixed Grassland Ecoregion includes a fairly wide range of moisture index values. Study of the patterns of vegetation suggests that a drier subregion should be recognized, with a moisture index of -325 mm as the approximate boundary. This boundary was modified by elevation patterns north and south of the Cypress Hills, as discussed below. The main area will be referred to as **Mixed Grassland**, and the drier area as **Dry Mixed Grassland**.

In the Moist Mixed Grassland Ecoregion, there were not enough data to clearly distinguish plant communities from those in the ecoregions to the north and south. Therefore, the drier parts (moisture index below -225 mm) were combined with the Mixed Grassland for community classification. The moister parts of the Moist Mixed Grassland (moisture index above -225 mm) were combined with the Aspen Parkland.

In the **Cypress Upland**, ecological conditions change rapidly with elevation. The moisture index map (Figure 1) reflects this in a general way, but is not precise enough to accurately represent the region. Therefore, elevation data were used directly in drawing boundaries[2]. Fescue grassland occurs mainly above elevations of 1,000 m (3,300 feet) on the north slope, and 1,050 m (3,450 feet) on the south slope. Mixed Grassland occurs below these elevations. At lower elevations, both north and south of the Cypress Hills, Mixed Grassland gives way to Dry Mixed Grassland. On the north slope, this transition occurs at about 775 m (2,550 feet). On the south slope of the Cypress Hills, and extending eastward to the south slope of the Wood Mountain Upland, the transition to Dry Mixed Prairie varies from 950 m (3100 feet) in the west to 850 m (2800 feet) in the east.

The modified ecoregion map is shown in Figure 2. The general ecological differences among the regions are summarized in Table 1.

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[1] Potential evapotranspiration is the amount of evaporation that would occur if there were no shortage of soil moisture. In the method used by Hogg (1994), potential evapotranspiration is estimated from monthly temperature and solar radiation.

[2] This analysis used elevation boundaries that were developed for soil zones in the Cypress Hills by Saskatchewan Assessment Management Agency, and a field survey of the distribution of fescue grassland by Saskatchewan Environment.

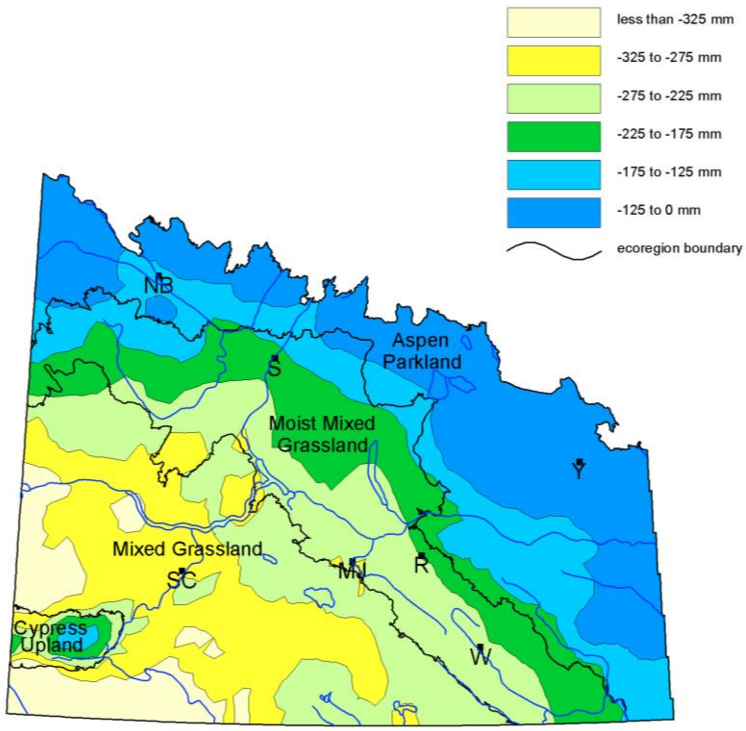


Figure 1 Climatic moisture index for the 1961-90 period in the Prairie Ecozone of southern Saskatchewan. Ecoregion boundaries are shown for comparison.

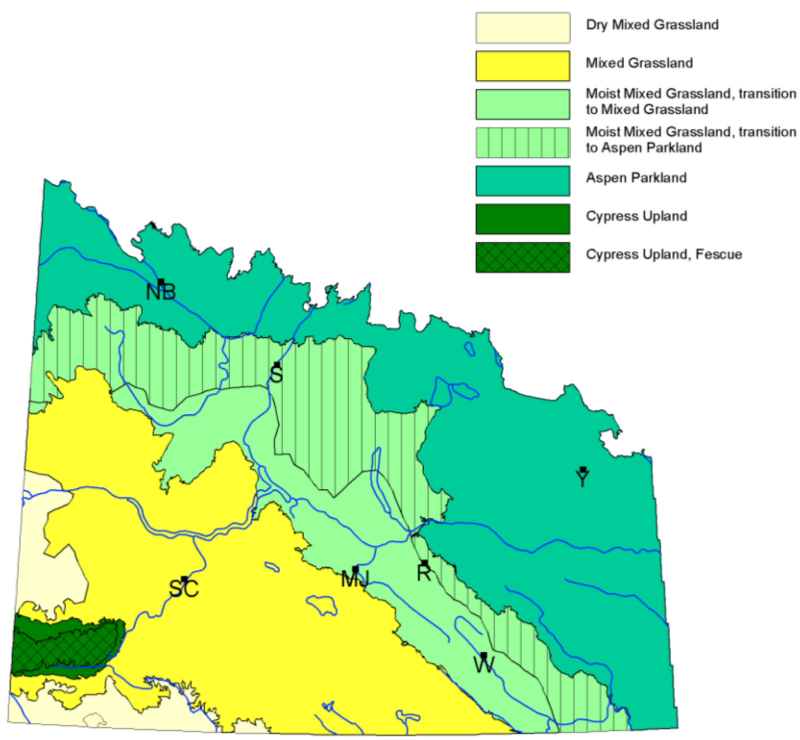


Figure 2 Rangeland ecoregions (modified from Ecoregions of Saskatchewan)

Table 1 General differences among rangeland ecoregions.

	Ecoregion			
	Dry Mixed Grassland	**Mixed Grassland***	**Aspen Parkland****	**Cypress Upland, Fescue**
climate moisture index (mm)	below -325	-325 to -225	-225 to 0	-225 to 0
zonal soils	Brown Chernozems	Brown and some Dark Brown Chernozems	Dark Brown and Black Chernozems	Dark Brown and Black Chernozems
reference community on Loam Ecosite	Northern Wheat-grass – Needle-and-thread	Western Porcupine-grass – Northern Wheat-grass	Plains Rough Fescue – Northern Wheat-grass	Plains Rough Fescue
potential production on Loam Ecosite (kg/ha)	600 to 1,000	1,000 to 1,500	1,500 to 3,400	1,600 to 3,300

* Also applies to drier parts of Moist Mixed Grassland Ecoregion, and lower elevations in Cypress Upland Ecoregion.
** Also applies to moister parts of Moist Mixed Grassland Ecoregion.

3. RANGELAND ECOSITES

3.1 Ecosite Classification

The ecoregions described in the previous section are defined by broad patterns of climate. Within these regions, rangeland is divided into ecological sites or **ecosites**, which are defined by more local factors. SRM (1989) defined an ecological site as: "A kind of land with a specific potential natural community and specific physical site characteristics, differing from other kinds of land in its ability to produce vegetation and to respond to management".

Within a local area such as a ranch or a community pasture, it can be assumed that the climate is more or less uniform. Therefore, the variation in growing conditions is mainly related to ecosite. Differences in physical site factors, such as topography, soil texture, moisture regime, and salinity create different environments for plant growth. For example, a pasture in the Mixed Grassland may be partly made up of rolling hills with well-drained, loam-textured soils. The potential plant community[3] on this land is dominated by western porcupine-grass and northern wheat-grass. However, depressions between the hills may have wet soils that support sedge meadows. Another part of the pasture may be a sand plain with lower water-holding capacity, on

[3] The potential plant community was defined by SRM (1989) as: "The biotic community that would become established on an ecological site if all successional sequences were completed without interferences by man under the present environmental conditions." This is usually interpreted to be the community that develops under ungrazed to lightly grazed conditions, and with no invasion of exotic plants.

which the potential plant community is dominated by needle-and-thread and sand reed-grass. The loamy upland, the wet meadows, and the sand plain are different ecosites: they have different physical site factors, and they support different potential plant communities.

Abouguendia (1990) presented the classification of range sites that has been used in Saskatchewan in recent years. The ecosites used in the present report (Table 2) are based on Abouguendia's classification, with some modifications:

- "Dunesand" has been split into "Low Dunes" and "High Dunes" based on experience with ecological mapping in dunesand areas.
- "Burnout" has been renamed "Solonetzic" to conform to soil survey terminology.
- "Sandy" has been renamed "Sandy Loam" to avoid confusion with the Sand Ecosite.
- Ecosites on moist to wet ecosites, including "Wetland", "Closed Depression", and "Saline Lowland" have been replaced with the zonation terminology used by wetland ecologists: "Wet Meadow", "Shallow Marsh", "Deep Marsh", and their saline counterparts (Walker and Coupland 1970, Stewart and Kantrud 1972, Millar 1976).
- Definitions of ecosites have been written, with specific criteria to aid in use of soil survey information for mapping.

Table 2 Classification of rangeland ecosites of southern Saskatchewan.

GROUP	ECOSITE		DEFINITION
DRY	**Badlands (BD)**		Sparsely vegetated landscapes with >10% exposure of bedrock. Areas mapped as Badlands may include vegetated islands that are too small to map separately.
	Thin (TH)		• Landscapes with predominantly steep slopes (>20%) (excluding Badlands or Dunes); and/or • Landscapes with truncated soil profiles resulting from high natural levels of erosion (excluding Badlands or Dunes).
	Gravelly (GR)		Landscapes with gravelly soils at the surface, or with a thin surface layer of finer material over a gravel substrate.
	Dunes (DN)	**Low Dunes (LD)**	Landscapes with sand dunes creating local relief of 1 to 3 metres, and/or slope steepness of 5% to 15%. Potential vegetation includes a mosaic of cover types (grassland, shrubland, woodland) associated with aspect and slope position. Usually with complete plant cover on all slope positions.
		High Dunes (HD)	Landscapes with sand dunes creating local relief of more than 3 metres, and/or slope steepness >15%. Potential vegetation includes a mosaic of cover types (grassland, shrubland, woodland) associated with aspect and slope position. South-facing slopes and ridges often have sparse vegetation or bare sand.
	Solonetzic (SO)		Landscapes with soils in the Solonetzic Order, characterized by a hard, impermeable B-horizon which is high in sodium. Often with scattered depressions ("burnouts" or "blowouts") where the soil has been eroded down to the B-horizon).
ZONAL	**Sand (SD)**		Stable well-drained upland ecosites with coarse-textured soils (sand, loamy sand), but without dune topography.
	Sandy Loam (SL)		Stable well-drained upland ecosites with moderately coarse-textured soils (sandy loam).
	Loam (LM)		Stable well-drained upland ecosites with medium to moderately fine-textured soils (loam, silt loam, clay loam).

GROUP	ECOSITE		DEFINITION
	Clay (CY)		Stable well-drained upland ecosites with fine to very fine-textured soils (clay, heavy clay).
MOIST TO WET	**Overflow (OV)**	**Overflow (OV)**	Well-drained sites (no mottles or gleying), but on alluvial landforms (floodplains, alluvial fans) that receive additional moisture from stream overflow or run-in.
		Solonetzic Overflow (OVSO)	Overflow sites with Solonetzic soils
		Saline Overflow (OVSA)	Overflow sites with saline soils
	Subirrigated (SUB)		Moist low-lying sites that are rarely flooded. Imperfectly drained soils show signs of intermittent saturation, such as faint to distinct mottles (e.g. Gleyed Chernozems). This ecosite was called Dry Meadow in the first version of this publication.
	Wet Meadow (WMD)		Wet low-lying sites that are normally flooded for 3-4 weeks in spring. Poorly drained soils show signs of prolonged saturation, such as dull colours or prominent mottles (Gleysolic soils). Potential vegetation includes diverse communities of fine-textured grasses, sedges, and forbs, sometimes with tall willows.
	Marsh (MH)	**Shallow Marsh (SMH)**	Wetlands that are normally flooded until July or early August. Gleysolic or Organic Soils. Potential vegetation includes simpler communities of intermediate-sized grasses and sedges.
		Deep Marsh (DMH)	Wetlands that are normally flooded throughout the growing season (non-use areas). Potential vegetation consists of a few species of tall, coarse graminoids (e.g. cattails, bulrushes).
	Fen Peat (FP)		Wetlands with peat accumulation (Organic soils). Potential vegetation can consists of sedge stands or swamp birch and willow shrublands.
SALINE	**Saline Upland (UPSA)**		Drier transitional or upland sites with saline soils. Salt may appear on the surface in dry periods. Potential vegetation includes a mixture of salt-tolerant plants and plants typical of normal upland ecosites.
	Saline Subirrigated (SUBSA)		Moist low-lying sites that are rarely flooded, with saline soils. Potential vegetation is dominated by salt-tolerant plants. Formerly called Saline Dry Meadow.
	Saline Wet Meadow (WMDSA)		Wet low-lying sites that are normally flooded for 3-4 weeks in spring, with saline soils. Potential vegetation is dominated by salt-tolerant plants.
	Saline Marsh (MHSA)	**Saline Shallow Marsh (SMHSA)**	Wetlands that are normally flooded until July or early August, with saline soils. Potential vegetation is dominated by salt-tolerant plants.
		Saline Deep Marsh(DMHSA)	Wetlands that are normally flooded throughout the growing season (non-use areas), with saline soils. Potential vegetation consists of a few species of salt-tolerant plants.

These ecosites may encompass considerable variation. The Badlands, Thin and Dunes Ecosites, as well as hummocky areas of Loam Ecosite, show variation related to slope steepness, slope aspect[4], and slope position. South-facing slopes create warmer and drier site conditions than those facing north, while crests and knolls are particularly dry. Even in more level terrain, low spots may be moister or more saline than the average for the ecosite. In wetlands, each ecosite represents an arbitrary slice of the moisture gradient; for example, the upper edge of the Wet Meadow zone is somewhat better drained than the lower edge of this zone. Unfortunately, splitting the classification more finely to represent all of these variations is impractical. In most

[4] Aspect is the direction that a slope faces. South-facing slopes tend to be warmer and drier than north-facing slopes.

cases, the available data could be used to characterize the average condition for the ecosite, but not all of the variants.

Internal variation is particularly pronounced for saline ecosites, with pronounced differences in species composition depending on the level of salinity. For some purposes, it is useful to subdivide these ecosites. Salinity classes used by Stewart and Kantrud (1971) and Millar 1976) were integrated as shown in Table 3.

Table 3 Salinity classes used in wetlands.

conductivity (mmho/cm)	Stewart and Kantrud 1971	Millar 1976	classes used in current work
0 - 0.5	fresh	fresh	fresh
0.5 - 2	slightly brackish		
2 - 5	moderately brackish	moderately saline	somewhat saline
5 - 15	brackish		moderately saline
15 - 45	subsaline	saline	saline
>45	saline	hypersaline	[not used]

In the absence of conductivity measurements, these classes can be interpreted from species composition. Stewart and Katrud (1971) and Millar (1976) showed the species associated with each range of salinity. For example, the Saline Shallow Marsh Ecosite may be dominated by sedges or spike-rush in somewhat saline areas, by three-square bulrush in moderately saline areas, and by red samphire in saline areas. This information was used in the classification of plant communities for these ecosites.

The ecosite definitions in Table 2 may overlap in some cases. The following key for identifying ecosites based on soil and landscape features (Table 4) shows the logical priority of the various characteristics. For example, a site may have very steep slopes and sandy loam textures. The slope characteristic comes earlier in the key than the texture characteristic, so the site would be placed in the Thin Ecosite rather than the Sandy Loam Ecosite.

3.2 Mapping of rangeland ecosites

The Land Resource Unit of Agriculture and Agri-Food Canada has developed a seamless digital soil map for southern Saskatchewan. The areas on the map are linked to databases of soil properties. These databases made it possible to translate the soil map into a map of rangeland ecosites.

First, the database of soil series was used to determine equivalent rangeland ecosites, by interpretation of properties such as mode of deposition, parent material texture, gleying and mottling, salinity, and erosion (see Tables 2 and 3 in Section 3.1). The result was the Soil Series Table (Publication 2), in which individual series can be looked up to determine the equivalent rangeland ecosite. However, soil maps do not show soil series directly. Rather, they show soil map units, which are complexes of soil series. Each map unit has a dominant series, and the rangeland ecosite corresponding to that series was assigned to the map unit. The result was the

Map Unit Table (Publication 3), in which the most probable rangeland ecosite for each map unit can be looked up. Ecosite assignments were then modified using other attributes of the mapped areas, including surface texture and slope class.

Table 4 Key for identifying rangeland ecosites based on soil and landscape features.

a. Exposed bedrock	Badlands
a. Not exposed bedrock	
b. Saline	
c. Gleysols	
d. Marsh soils	Saline Shallow Marsh, Saline Deep Marsh
d. Other Gleysols	Saline Wet Meadow
c. Gleyed series in other orders (e.g. Gleyed Chernozems)	Saline Subirrigated
c. Not Gleysol or Gleyed	
d. Alluvial landforms including floodplains, fans, aprons	Saline Overflow
d. Not alluvial landforms	Saline Upland
b. Not saline	
e. Organic soils	Fen Peat
e. Gleysols	
f. Marsh soils	Shallow Marsh, Deep Marsh
f. Other Gleysols	Wet Meadow
e. Gleyed series in other orders (e.g. Gleyed Chernozems)	Subirrigated
e. Not Gleysol or Gleyed	
g. Dunesand (coarse-textured, eolian mode of deposition)	
h. Steep slopes (slope classes 6 and 7)	High Dunes
h. Moderate slopes (slope classes 4 and 5)	Low Dunes
h. Gentle slopes (slope classes 1, 2, and 3)	Sand
g. Not Dunesand	
i. Alluvial landforms including floodplains, fans, aprons	
j. Solonetzic	Solonetzic Overflow
j. Not Solonetzic	Overflow
i. Not alluvial landforms	
k. Very steep slopes (slope class 7)	Thin
k. Not very steep slopes (slope classes 1, 2, 3, 4, 5, 6)	
l. Eroded soil profile	Thin
l. Not eroded soil profile	
m. Solonetzic	Solonetzic
m. Not Solonetzic	
n. Gravelly texture or gravel substrate	Gravelly
n. Not gravelly	
o. Coarse texture (s, fs, ls, lfs)	Sand
o. Moderately coarse texture (sl, fl, vl)	Sandy loam
o. Medium to moderately fine texture (l, sil, cl, sicl, scl, fcl vcl)	Loam
o. Fine texture (c, sic, hc)	Clay

The final assignment of ecosites to mapped areas was used to generate the Rangeland Ecosite Map (see pp. 12-13). Because the focus of the classification is native grassland, the map was limited to the Prairie Ecozone (ESWG 1996). The map was also limited to areas of rangeland, by using the Saskatchewan Research Council's South Digital Land Cover map to mask out non-rangeland (cropland, forage, farms/settlements, roads, and water).

The Rangeland Ecosite Map shows the general pattern of ecosites across southern Saskatchewan. A digital version of the map, which will be distributed separately, can be used to zoom in on a particular area and show the pattern of rangeland ecosites at a larger scale. However, the underlying soil maps are intended to be used at a scale of 1:100,000, and are too generalized for mapping at finer scales. For mapping a small area (e.g. a map of a ranch at 1:10,000) the Rangeland Ecosite Map can be used for a "first draft". However, the map should then be refined by field observations and interpretation of air photos.

3.3 Steps in Identifying Rangeland Ecosites

Identifying ecosites depends on the knowledge and experience of the observer. The following list of steps illustrates a detailed identification process using all available information:

- read the soil map for the area
- look at the land surface
- dig a soil pit and look at the soil profile
- determine the texture of the soil
- look at the vegetation
- read the descriptions of the possible ecosites, and pick the most appropriate

More experienced observers will develop shortcuts, and may not always follow every step. However, everyone will benefit from doing more complete assessments (including examination of the soil profile) from time to time to improve their identifications. The steps are discussed in Sections 3.3.1 and 3.3.2, while Section 3.4 gives more detailed descriptions of the individual ecosites.

3.3.1 Using soil maps to identify rangeland ecosites

The first step in identifying rangeland ecosites is to read the soil map for the area. The soils of southern Saskatchewan have been mapped by the Land Resource Unit of Agriculture and Agri-Food Canada. Soil maps and reports can be ordered from:

The Saskatchewan Land Resource Centre
5C26 Agriculture Building
University of Saskatchewan Campus
51 Campus Drive
SASKATOON SK S7N 5A8
(306) 975-4060
http://www.ag.usask.ca/departments/scsr/land/map/index.html

The areas shown on a soil map are called **map units**. Each map unit has a different distribution of **soil series** within it. For example, the soil map for the area around Saskatoon (Acton and Ellis 1978) shows that Biggar soils (Dark Brown soils formed on gravelly parent materials) occur in three map units: Biggar 1, Biggar 2, and Biggar 3. In all three, the dominant soil series (the one occupying the largest area) is Biggar Orthic Dark Brown. However, in the Biggar 2 map unit there is also a significant area of Biggar Orthic Regosols, while in Biggar 3 there is a significant area of Biggar Carbonated and/or Saline Chernozemic Dark Brown soils. Usually, the rangeland ecosite is based on the dominant soil series in the map unit. The soil map also shows the surface soil texture and the slope class in each mapped area.

The Map Unit Table (Publication 3) shows how to determine the most likely rangeland ecosite based on the soil map unit. The Soil Series Table (Publication 2) shows how to determine the rangeland ecosite if the soil series is known. For example, if the map unit is Biggar 3, the Map Unit Table shows that the most likely ecosite is Gravelly. However, ecosites can be determined in more detail by using the soil series makeup of the map unit. In Biggar 3, the dominant series (Biggar Orthic Dark Brown) corresponds to the Gravelly Ecosite, while the secondary series (Biggar Carbonated and/or Saline Chernozemic) corresponds to the Saline Upland Ecosite.

The Map Unit Table shows that the surface texture and slope class shown on the soil map may be used in identifying ecosites in some cases. For example, a soil which would normally be considered Sandy Loam Ecosite may have a surface texture of gravelly sandy loam. In this case, the ecosite would change to Gravelly. Similarly, a soil which would normally be considered Loam Ecosite may occur on very steep slopes (slope class 7), which would change the ecosite to Thin. Areas of wind-blown sand are usually mapped as Antelope, Vera, or Edam soils. However, the ecosite depends on the topography. Areas of gentle relief (slope classes 1, 2, or 3) are considered Sand Ecosite, areas of moderate relief (slope classes 4 or 5) are considered Low Dunes Ecosite, and areas of steep slopes (slope classes 6 or 7) are considered High Dunes Ecosite.

On the Rangeland Ecosite Map (see pages 12-13), ecosites have already been determined using the above relationships. A digital version of this map, which is available from the author, allows users to zoom in on areas of interest.

Determining the rangeland ecosite from soil maps or the Rangeland Ecosite Map will often give the right answer. However, because these maps are somewhat generalized, the information may not be detailed enough to identify the rangeland ecosite being considered. The land surface and the soil profile must be examined in the field to ensure that the ecosite has been determined correctly.

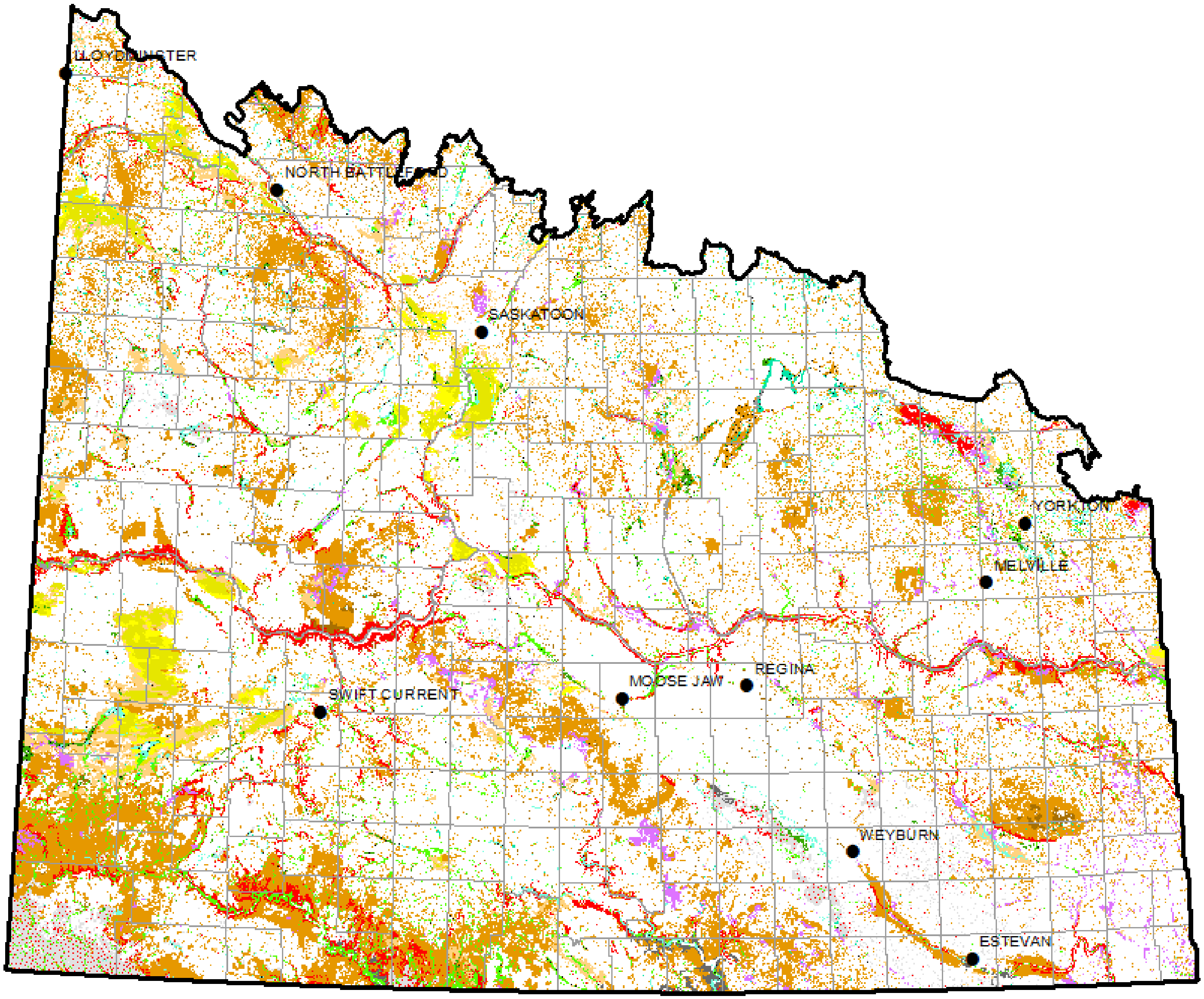
Rangeland Ecosites of Southern Saskatchewan

Legend

Clay	Thin	Wet Meadow
Loam	Badlands	Saline Wet Meadow
Sandy Loam	Saline Upland	Marsh
Sand	Overflow	Saline Marsh
Low Dunes	Saline Overflow	Cities
High Dunes	Solonetzic Overflow	RM boundaries
Gravelly	Subirrigated	
Solonetzic	Saline Subirrigated	

1:3,000,000

0 75 150 300 Kilometers



LLOYDMINSTER
NORTH BATTLEFORD
SASKATOON
YORKTON
MELVILLE
MOOSE JAW
REGINA
SWIFT CURRENT
WEYBURN
ESTEVAN

3.3.2 Examining rangeland ecosites in the field

To identify rangeland ecosites in the field, first look at the shape and appearance of the land surface. Some features to look for:

- steep slopes – steepness is measured as a percentage: if the land rises 1 metre over a horizontal distance of 5 metres, the steepness is 20%.
- signs of erosion – e.g. formation of rills and gullies, individual plants that appear to be on pedestals because soil around them has been washed away.
- alluvial landforms – land surfaces that have been formed by moving water. These will always occur in lower parts of the landscape, such as valley bottoms. Alluvial landforms include:
  - floodplains – level areas bordering streams that are deposited by occasional flooding when the stream is high.
  - alluvial fans and aprons – gently sloping areas at the foot of a steep slope or the mouth of a coulee, formed by soil washed down from the higher land.
- wet areas
- saline areas – usually low-lying areas with white salt crusts appearing on the soil surface, and with salt-tolerant plant species (halophytes) making up at least 5% of the community.
- sand dunes – land surfaces in which sand has been pushed up into hills and ridges by wind action.
- exposed bedrock

Dig a soil pit about 60 cm (2 feet) deep, and study the layers (soil horizons). Soil layers may also be viewed in road-cuts. Consult a soils textbook or seek advice from a soils expert to recognize features in the soil profile. Some of the features that are used in identifying rangeland ecosites include:

- Signs of erosion – e.g. soils where the A-horizon[5] appears to be thinner than normal because topsoil has been removed.
- Regosolic soil profiles – soils with very little development of horizons, usually on land that has been recently deposited by wind or water.
- Chernozemic soil profiles – typical grassland soils with a dark-coloured A-horizon.
- Solonetzic soil profiles – soils with a hard, impermeable B-horizon[6] with a columnar structure.
- Gleyed soils – soils that appear similar to upland Chernozemic or Solonetzic soils, but with faint to distinct mottles within 50 cm of the surface, indicating intermittent saturation with water.
- Gleysolic soil profiles – soils formed by prolonged saturation with water, and characterized by dull gray colours or prominent rust-colored mottles[7].
- Layers of gravel.
- Soil texture of the various horizons.

[5] The A-horizon is the uppermost soil layer, which in grassland soils is a dark-coloured topsoil.
[6] The B-horizon is the subsoil layer below the A-horizon, and has been modified by material washed out of the A-horizon.
[7] Mottles are spots of different color interspersed with the dominant soil color.

Soil texture is how coarse or fine the soil is, and is determined by the proportions of different particle sizes: sand, silt, and clay. Determining soil texture in the field is a skill that requires training and practice. However, Table 5 gives a key that should lead to approximately the correct texture class. To use this key, take a handful of soil from the profile, and add water to form a moist ball that can be worked in the hand. Try to form the moist soil into a ribbon. Add more water and rub the wet soil between the fingers to determine how it feels: a gritty feel indicates sand; a smooth, soapy feel indicates silt; and a sticky feel indicates clay.

Table 5 Key for determining soil texture by hand (modified from Thien 1979).

1 soil does not form a ball..	sand
1 soil forms a ball	
2 soil does not form a ribbon..	loamy sand
2 soil forms a weak ribbon less than 2.5 cm long before breaking	
3 soil feels very gritty..	sandy loam
3 soil feels very smooth..	silt loam
3 neither grittiness nor smoothness predominates..	loam
2 soil forms a medium ribbon 2.5 to 5 cm long before breaking	
4 soil feels very gritty..	sandy clay loam
4 soil feels very smooth..	silty clay loam
4 neither grittiness nor smoothness predominates..	clay loam
2 soil forms a strong ribbon 5 cm or longer before breaking	
5 soil feels very gritty..	sandy clay
5 soil feels very smooth..	silty clay
5 neither grittiness nor smoothness predominates..	clay

After examining the land surface and the soil profile, use Table 6 to determine the rangeland ecosite. Before making a final decision, look at the descriptions of the ecosites in Section 3.4 to make sure that you have picked the most appropriate one.

Table 6 Key for identifying rangeland ecosites in the field.

a. Exposed bedrock	Badlands
a. Not exposed bedrock	
b. Saline sites	
c. Wet sites, soils poorly drained (Gleysols)	
d. Normally flooded throughout the summer	Saline Deep Marsh
d. Normally flooded until July or early August	Saline Shallow Marsh
d. Normally flooded for 3 to 4 weeks in spring	Saline Wet Meadow
c. Moist sites, but rarely flooded; soils imperfectly drained (e.g. Gleyed Chernozems)	Saline Subirrigated
c. Well-drained sites, no mottling or gleying in soil	
d. Alluvial landforms, extra moisture from run-in or stream overflow	Saline Overflow
d. Not alluvial landforms; transitional to upland ecosites	Saline Upland
b. Not saline	
e. Wet sites with peat accumulation	Fen Peat
e. Wet sites with poorly drained mineral soils (Gleysols)	
f. Normally flooded throughout the summer	Deep Marsh
f. Normally flooded until July or early August	Shallow Marsh
f. Normally flooded for 3 to 4 weeks in spring	Wet Meadow
e. Moist sites, but rarely flooded; soils imperfectly drained (e.g. Gleyed Chernozems)	Subirrigated
e. Well-drained sites, no mottling or gleying in soil	
g. Alluvial landforms, extra moisture from run-in or stream overflow	
h. Solonetzic soils	Solonetzic Overflow
h. Not Solonetzic	Overflow
g. Not alluvial landforms	
i. Sand dunes	
j. Local relief more than 3 metres	High Dunes
j. Local relief 1 to 3 metres	Low Dunes
j. Local relief less than 1 metre	Sand
i. Not sand dunes	
k. Slopes steeper than 20%	Thin
k. Not steep slopes	
l. Signs of erosion	Thin
l. Not eroded	
m. Solonetzic soils	Solonetzic
m. not Solonetzic	
n. Gravelly material	Gravelly
n. Not gravelly	
o. Coarse texture (sand, loamy sand)	Sand
o. Moderately coarse texture (sandy loam)	Sandy Loam
o. Medium to moderately fine texture (loam, silt loam, clay loam)	Loam
o. Fine texture (clay)	Clay

3.4 Descriptions of rangeland ecosites

Badlands (BD)

Badlands Ecosites are areas where the bedrock material is exposed, with very little vegetation cover. Badlands in southern Saskatchewan usually consist of clay deposits. They are not solid rock, but they are called "bedrock" because they are much older than the glacial deposits that make up most of the Saskatchewan landscape. These exposed bedrock clays erode very rapidly, forming steep slopes with many water channels where vegetation is slow to establish. In transitional areas, if there is at least 10% bedrock exposure, the ecosite should be called Badlands. Areas mapped as Badlands Ecosites may include vegetated islands that are too small to map separately.

Soils corresponding to the Badlands Ecosite include Exposure and Short Creek.

Things to look for in identifying the Badlands Ecosite:
- Soil map shows Exposure or Short Creek soils.
- Exposed uniform clay material.
- Obvious signs of water erosion (even livestock manure may be washed away)
- Very low vegetation cover.
- Plant indicators
  - povertyweed
  - rabbit-brush
  - rillscale
  - Nuttall's atriplex
  - silver sagebrush

Thin (TH)

Most Thin Ecosites are on steep slopes, such as the sides of large valleys. Rainwater tends to run off over the surface on these slopes, so there is more water erosion than on other landforms. This means that the soil does not build up a normal A-horizon because material is continually being removed from the surface. Whether or not the slope is steep, any area in which the A-horizon is very thin as a result of high natural levels of erosion should be considered Thin Ecosite.

On soil maps, most areas of Thin Ecosite are mapped as the Hillwash Complex. Thin Ecosites may also occur on eroded and regosolic series of a variety of other soil associations.

Note that some steep slopes are placed in ecosites other than Thin. Steep slopes with exposed bedrock should be placed in the Badlands Ecosite, and steep slopes of wind-blown sand should be placed in the High Dunes Ecosite.

Things to look for in identifying the Thin Ecosite:
- Steep slopes (greater than 20%, i.e. the land rises more than 1 metre over a distance of 5 metres).
- Very thin A-horizon.

- Obvious signs of water erosion, such as rills, gullies, and pedestalled plants, even in undisturbed areas (e.g. ungrazed areas).
- Plant indicators
  - plains muhly
  - thread-leaved sedge
  - broomweed
  - creeping juniper

Gravelly (GR)

Gravelly Ecosites are well-drained uplands with gravel at the surface, or with a thin surface layer of finer material over a gravel substrate. Gravelly Ecosites are usually found on glacio-fluvial plains, where gravel and sand have been deposited by streams flowing out of the melting glaciers.

Soils corresponding to Gravelly ecosites include Chaplin, Biggar, Whitesand, Glenbush, and Welby. Gravelly ecosites may also be found on soil series with gravel substrates or gravelly surface textures in a variety of other associations.

Things to look for in identifying the Gravelly Ecosite.

- Soil map shows soils that are found on gravel deposits (e.g. Chaplin).
- Soil map shows gravelly texture (e.g. gsl – gravelly sandy loam)
- Soil profile shows a significant layer of gravelly material, either at the surface or as a subsoil underlying finer material.

Dunes (DN)

Dunes are sand deposits that have been acted on by wind to create distinctive hills and ridges. The young, recently eroded soils in Dunes tend to be Regosols – soils with little development of a soil profile, often with only the first signs of an A-horizon. Dunes usually have more woody cover than other landscapes in the prairies. The potential vegetation consists of a mosaic of grassland, shrubland, and forest, varying with aspect[8] and slope position. Dunes usually occur over fairly large blocks of land. Within these blocks of dunes, it is often possible to map out areas of higher relief (High Dunes) and lower relief (Low Dunes).

High Dunes (HD)

The High Dunes Ecosite consists of landscapes in which the tops of the dunes tend to be more than 3 metres (10 feet) above the hollows. Ridges are often sharp, and slopes tend to be steep (more than 15%). Ridge-tops and south-facing slopes often have sparse vegetation or patches of bare sand. In some cases, whole dunes are bare, and the wind is actively moving the soil – these are called active dunes. Normally an area mapped as High Dunes would include a number of individual dunes as well as the hollows between them.

[8] Aspect is the direction that a slope faces. South-facing slopes are warmer and drier than north-facing slopes.

Things to look for in identifying the High Dunes Ecosite:

- Soil map shows soils formed on sand dunes (e.g. Antelope, Vera, Edam, Dunesand) with slope class 6 or 7.
- Sand material with characteristic dune-shaped hills
- High local relief
- Steep slopes
- Plant indicators
  - sand grass
  - sand dropseed
  - Indian rice-grass
  - lance-leaved psoralea
  - silver sagebrush
  - creeping juniper
  - chokecherry

Low Dunes (LD)

The Low Dunes Ecosite consists of landscapes in which the tops of the dunes are roughly 1 to 3 metres (3 to 10 feet) above the hollows. These areas appear to have been stabilized for a long time, and the hills tend to be rounded off and have gentle to moderate slopes (5% to 15%). There is usually complete vegetation cover over all slope positions. Between dunes, there may be patches where the terrain is almost flat, usually covered with grassland. If these level areas are large enough, they should be mapped out separately as Sand Ecosite.

Things to look for in identifying the Low Dunes Ecosite:

- Soil map shows soils formed on sand dunes (e.g. Antelope, Vera, Edam, Dunesand) with slope class 4 or 5.
- Sand material with characteristic dune-shaped hills
- Low to moderate local relief
- Gentle to moderate slopes
- Plant indicators
  - sand grass
  - sand dropseed
  - lance-leaved psoralea
  - hairy golden-aster
  - silver sagebrush
  - creeping juniper
  - chokecherry

Solonetzic (SO)

The Solonetzic Ecosite consists of uplands with Solonetzic soils. These are soils that are high in sodium, which causes clay particles to disperse and form a hard, impermeable B-horizon. Digging a cross-section of this B-horizon shows a series of round-topped columns. A distinctive feature of some Solonetzic soils is a scattering of shallow depressions (called "burnouts" or "blowouts") where the soil has been eroded down to the hard B-horizon. Burnouts may be completely bare, or western wheat-grass and other plants may have recolonized them. Solonetzic soils tend to support lower grassland production compared to other well-drained uplands (Chernozemic soils).

Soils corresponding to the Solonetzic Ecosite include Brooking, Echo, Estevan, Flaxcombe, Gilroy, Grandora, Hanley, Instow, Kelstern, Kettlehut, Kindersley, Macworth, North Portal, Onion Lake, Robsart, Rosemae, Speers, Tantallon, Trossachs, Tuxford, Waseca, and Wingello.

Things to look for in identifying the Solonetzic Ecosite:

- Soil map shows Solonetzic soils.
- Soil surface shows scattered burnouts.
- Soil profile shows hard B-horizon with round-topped columnar structure.
- Plant indicators
    - western wheat-grass colonizing burnouts

Sand (SD)

The Sand Ecosite consists of stable, well-drained uplands with coarse-textured soils (sand, loamy sand), but without dune topography. Soils are Chernozems, characterized by a dark A-horizon and none of the features of Solonetzic or Gleysolic soils. Sand Ecosites are usually on sand plains deposited by meltwater from the glaciers. Sand Ecosites may appear as level grassland patches within or adjacent to sand dunes, or they may occur without any neighbouring dunes.

Soils corresponding to the Sand Ecosite include Antelope, Vera, Edam, or Dune Sand, with low relief (slope class 1 to 3).

Things to look for in identifying the Sand Ecosite.

- Soil map indicates sand texture.
- Soil texture determined in the field is sand or loamy sand.
- Land surface is level or undulating, but not formed into dunes.
- Plant indicators
    - spear-grasses usually dominant
    - sand grass
    - sand dropseed
    - hairy golden-aster
    - lance-leaved psoralea

Sandy Loam (SL)

The Sandy Loam Ecosite consists of stable, well-drained uplands with moderately coarse-textured soils (sandy loam). These soils are usually found on glacio-fluvial deposits (i.e. plains of sandy material deposited by streams of water melting from the glaciers). Soils are Chernozems, characterized by a dark A-horizon and none of the features of Solonetzic or Gleysolic soils.

Soils corresponding to the Sandy Loam Ecosite include Hatton, Asquith, Meota, Nisbet, Perley, and Shell Lake. Note that in some cases these soils may have a surface texture of loamy sand. However, the parent material of these soils is usually sandy loam, and the Sandy Loam Ecosite should be used.

Things to look for in identifying the Sandy Loam Ecosite:

- Soil map indicates sandy loam texture.
- Well-drained uplands.
- Soil texture determined in the field is sandy loam.
- Plant indicators
  - spear-grasses usually dominant

Loam (LM)

The Loam Ecosite consists of **s**table, well-drained uplands with medium to moderately fine-textured soils (loam, silt loam, clay loam). Soils are Chernozems, characterized by a dark A-horizon and none of the features of Solonetzic or Gleysolic soils. The Loam Ecosite accounts for more of the rangeland in Saskatchewan than any other ecosite. Much of the area of Loam Ecosite is found on moraines, which are deposits of glacial till – a mixture of rocks, sand, silt, and clay deposited directly from the melting ice. If there are scattered rocks, but there is fine material between them, the deposit is glacial till. Moraines may cover large areas with a distinctive rolling “knob-and-kettle” topography, and almost all of this area will fall in the Loam Ecosite. However, some areas of Loam Ecosite are found on glacial lake-bed deposits with medium-textured sediments. Other Loam Ecosites are on loess deposits, which are blankets of silty material deposited by the wind.

Some of the soils that support Loam Ecosites include:

- glacial till deposits, e.g. Amulet, Ardill, Climax, Edgeley, Fremantle, Frontier, Haverhill, Horsehead, Lorenzo, Mayfair, Naicam, Oxbow, Paddockwood, Pelly, Ryerson, Wadena, Weyburn, Whitewood, Yorkton
- glacial till deposits that are influenced by underlying bedrock, e.g. Cypress, Fairwell, Fife Lake, Jones Creek, Klintonel, Rocanville, Scotsguard, Wood Mountain.
- medium-textured glacial lake-bed deposits, e.g. Arcola, Birsay, Blaine Lake, Bradwell, Bredenbury, Canora, Craigmore, Cudworth, Cutknife, Elstow, Fox Valley, Hamlin, Hoey, Kamsack, Krydor, Scott, Shellbrook, Tiger Hills, Valor, Weirdale.
- loess deposits, e.g. Swinton.

Note that in some cases, these soils may have a surface texture of sandy loam. However, the parent material of these soils is usually loam to clay loam, and the Loam Ecosite should be used.

Things to look for in identifying the Loam Ecosite:

- Soil map indicates loam, silt loam, or clay loam texture.
- Well-drained uplands.
- Soil texture determined in the field is loam, silt loam, or clay loam.
- Moraine deposits (knob-and-kettle topography, rocks in the soil).
- Plant indicators
  - both spear-grasses and wheat-grasses usually important.

Clay (CY)

The Clay Ecosite consists of stable well-drained uplands with fine to very fine-textured soils (clay, heavy clay). Soils are Chernozems or Vertisols. Much of the area of Clay Ecosite is found on flat glacial lake-bed deposits like the Regina Plain.

Soils corresponding to the Clay Ecosite include Allan, Balcarres, Bear, Indian Head, Keatley, Meadow Lake, Melfort, Regina, Sceptre, Sutherland, Tisdale, Touchwood, and Willows.

Things to look for in identifying the Clay Ecosite:

- Soil map shows clay or heavy clay textures
- Glacial lake beds – flat plains with heavy soils.
- Soil texture determined in the field is clay or heavy clay
- Plant indicators
  - high dominance of northern or western wheat-grass

Overflow (OV)

Overflow Ecosites receive additional moisture because of their topographic position, but are not wet enough to support wetland vegetation. Some Overflow ecosites are along floodplains of streams, where they are occasionally flooded when the stream overflows during high water. Others are at the foot of a slope or the mouth of a coulee (e.g. alluvial fan deposits), where runoff from the higher land supplies extra moisture. The vegetation is typically more productive than on normal upland sites. However, the soil does not show the mottling or gleying that indicates Meadow or Marsh Ecosites, and plants requiring moist soils, such as tall sedges, are not present.

Things to look for in identifying the Overflow Ecosite:

- Soil map shows soils that develop on alluvial or colluvial deposits (e.g. Alluvium, Runway, Eastend, Ellisboro, Gap View, Horse Creek, Lark Hill, Rock Creek, Tantallon, Val Marie, Wascana, White Fox).
- Valley bottom sites, including floodplains along streams and fans developed at the foot of the valley slope.
- Soil profile does not indicate imperfect or poor drainage (no mottling or gleying)
- Plant indicators
  - northern and western wheat-grass
  - silver sagebrush
  - western snowberry
  - Woods rose

Solonetzic Overflow (OVSO)

The Solonetzic Overflow Ecosite consists of Overflow sites with Solonetzic soils. These are often found along floodplains in southwestern Saskatchewan. While the ecosite would be expected to receive additional moisture from stream overflow, there are frequent bare patches (burnouts) and overall productivity is low.

Things to look for in identifying the Overflow Solonetzic Ecosite:

- Soil map shows soils that develop on alluvial or colluvial deposits (e.g. Alluvium Solonetzic soils, Runway Solonetzic soils, Hellfire, McEachern, Morgan, Porcupine Creek, and solonetzic series of other soils on alluvial deposits).
- Valley bottom sites, including floodplains along streams and fans developed at the foot of the valley slope.
- Soil profile does not indicate imperfect or poor drainage (no mottling or gleying)
- Soil profile shows hard B-horizon with round-topped columnar structure
- Scattered burnouts
- Plant indicators
    - northern wheat-grass
    - western wheat-grass
    - silver sagebrush

Saline Overflow (OVSA)

The Saline Overflow Ecosite consists of Overflow sites with saline soils. These may be found along floodplains in southwestern Saskatchewan. High salinity is indicated by white salt crusts on the soil and/or the presence of salt-tolerant plants.

Soils corresponding to the Saline Overflow Ecosite include Alluvium Saline soils, Flat Lake Complex, Grill Lake Complex, and saline series of other soils on alluvial landforms (e.g. Runway, Eastend, Ellisboro, Gap View, Horse Creek, Lark Hill, Rock Creek, Tantallon, Val Marie, Wascana, White Fox).

Things to look for in identifying the Overflow Saline Ecosite:

- Soil map shows soils that develop on alluvial or colluvial deposits
- Valley bottom sites, including floodplains along streams and fans developed at the foot of the valley slope.
- Soil profile does not indicate imperfect or poor drainage (no mottling or gleying)
- White salt crust on soil surface
- Salt-tolerant plants are abundant:
    - salt grass
    - greasewood

Subirrigated (SUB)

The Subirrigated Ecosite consists of low-lying land that is moist but rarely flooded. Imperfectly drained soils are similar to upland soils, but show signs of occasional saturation such as faint to distinct mottles (e.g. Gleyed Chernozems). Subirrigated Ecosites may be found along floodplains, but are moister than the Overflow sites. The vegetation may include moist grasslands, shrublands or woodlands, and typically shows a mixture of upland species with more moisture-requiring species (e.g. mid-sized sedges).

In Version 1 of Saskatchewan Rangeland Ecosystems, this ecosite was referred to as “Dry Meadow”. However, because Version 2 includes shrublands and woodlands, not just herbaceous communities, on this ecosite, the term "Dry Meadow" is no longer considered appropriate. The term "Subirrigated" is widely used in rangeland classifications in the U.S. and in Alberta. The Subirrigated Ecosite is roughly equivalent to the term "Low Prairie" used in wetland classifications for the land above the Wet Meadow zone.

Soils corresponding to the Subirrigated Ecosite include Alluvium Gleyed soils and gleyed series of a variety of other Chernozemic or Solonetzic soils.

Things to look for in identifying the Subirrigated Ecosite:

- Low land, but not usually flooded.
- Usually bordering wetter ecosites (Wet Meadow, Marsh).
- Soil profile is similar to upland soils (Chernozemic or Solonetzic), but with faint to distinct mottling within 50 cm of the surface.
- Plant indicators
  - western wheat-grass
  - slender wheat-grass
  - Kentucky blue grass
  - wild licorice
  - dandelion
  - western snowberry
  - Woods rose
  - saskatoon
  - chokecherry
  - red-osier dogwood
  - balsam poplar
  - cottonwood
  - Manitoba maple
  - green ash

Wet Meadow (WMD)

The Wet Meadow Ecosite consists of low-lying wetlands that are normally flooded for three to four weeks in spring. Poorly drained soils show signs of prolonged saturation, such as dull colours or prominent mottles (Gleysolic soils). The vegetation tends to be diverse, with flowering herbs and a variety of grasses, sedges, and rushes. The grass and sedge species found on Meadow Ecosites are shorter and finer-leaved than on Marsh Ecosites. Tall willows may be scattered through the grassland, especially in the Aspen Parkland Ecoregion.

Soils corresponding to the Wet Meadow Ecosite include Alluvium Gleysolic soils, Meadow Complex, Big Muddy, or gleysolic series of a variety of other soil associations.

Things to look for in identifying the Wet Meadow Ecosite:

- Low-lying wetlands that are usually flooded in spring
- Soil profile shows Gleysol profile with dull colours and/or prominent mottles
- Plant indicators
  - marsh reed-grass
  - northern reed-grass

  - fowl blue-grass
  - tufted hair-grass
  - woolly sedge and other medium-sized sedges
  - Baltic rush
  - basket willow, pussy willow, beaked willow, yellow willow

Shallow Marsh (SMH)

The Shallow Marsh Ecosite consists of wetlands that are normally flooded until July or early August. Poorly drained soils show signs of prolonged saturation, such as dull colours or prominent mottles (Gleysolic soils). The vegetation is less diverse than on Meadow Ecosites, and the dominant grasses and sedges are taller and coarser.

Soils corresponding to the Shallow Marsh Ecosite include Marsh Complex and Wetland Complex.

Things to look for in identifying the Shallow Marsh Ecosite:

- Low-lying wetlands that are flooded for extended periods (until July or early August in an average year)
- Soil profile shows Gleysol profile with dull colours and/or prominent mottles
- Plant indicators
  - awned sedge
  - water sedge
  - beaked sedge
  - spangletop
  - manna-grass
  - giant bur-reed
  - slough grass
  - creeping spike-rush
  - reed canary-grass
  - water smartweed
  - water parsnip

Deep Marsh (DMH)

The Deep Marsh Ecosite consists of wetlands that are normally flooded throughout the growing season. The vegetation consists of a few species of very tall, coarse grasses and sedges (e.g. cattails, bulrushes). Deep Marsh Ecosites would be mapped as non-use areas for livestock.

Soils corresponding to the Deep Marsh Ecosite include Marsh Complex and Wetland Complex.

Things to look for in identifying the Deep Marsh Ecosite:

- Almost always flooded
- Vegetation consists of tall emergent plants
- Plant indicators
  - cat-tail

- soft-stem bulrush
- hard-stem bulrush
- common reed

Fen Peat (FP)

The Fen Peat Ecosites consists of wetlands in which organic matter accumulates as peat (Organic soils), because of slow decomposition of plant remains. Peatlands usually develop in forested areas, but Fen Peat is sometimes found in the moister parts of the Prairie Ecozone. Fens are somewhat enriched in nutrients, usually because they are influenced by groundwater flowing from adjacent mineral terrain. The potential vegetation varies from sedge stands to willow or swamp birch shrublands.

Soils supporting the Fen Peat Ecosite include Bagwa Lake, Fen Peat, Lavallee Lake, Moss Peat, Sedge Peat, and Sturgeon Lake. These soils are usually found in the boreal forest, with only occasional occurrences in the Prairie Ecozone in locations with a reliable water supply (e.g. springs on valley slopes).

Things to look for in identifying the Fen Peat Ecosite:

- Soil maps shows organic soils
- Soil profile shows peat more than 40 cm deep

Saline Upland (UPSA)

The Saline Upland Ecosite consists of drier transitional or upland sites where the soil is saline. Salt may appear on the surface in dry periods. Potential vegetation includes species of normal upland prairie (spear-grasses, wheat-grasses, etc.), but with a significant component of salt grass. Because of the high proportion of non-halophytic species, communities on Saline Upland are considered only somewhat saline.

Soils supporting the Saline Upland Ecosite include saline series of a variety of Chernozemic or Solonetzic soils.

Things to look for in identifying the Saline Upland Ecosite:

- Soil map shows saline soils
- White salt crust on surface
- Upland locations
- No mottling or gleying in soil profile
- Mixture of salt-tolerant and normal upland plants
- Plant indicators
  - salt grass occurring with normal upland grasses

Saline Subirrigated (SUBSA)

The Saline Subirrigated Ecosite consists of low-lying land that is moist but rarely flooded, with saline soils. The potential vegetation includes varying proportions of salt-tolerant plants.

Somewhat saline areas are dominated by less salt-tolerant species such as slender wheat-grass, western wheat-grass or sedges, but have a secondary component of more salt-tolerant species, especially salt grass. Moderately saline areas tend to be dominated by salt grass.

Saline Subirrigated Ecosites occurs on saline and gleyed series of a variety of Chernozemic or Solonetzic associations (e.g. Alluvium Saline Gleyed).

Things to look for in identifying the Saline Subirrigated Ecosite:

- Soil map shows saline and gleyed soils.
- White salt crust on surface
- Low-lying, moist land, but not usually flooded
- Usually bordering wetter ecosites (Saline Wet Meadow, Saline Marsh)
- Soil profile shows faint to distinct mottles
- Plant indicators
    - salt grass
    - western wheat-grass
    - slender wheat-grass
    - greasewood

Saline Wet Meadow (WMDSA)

The Saline Wet Meadow Ecosite consists of wet low-lying wetlands that are normally flooded for three to four weeks in spring, with saline soils and water. Somewhat saline areas are dominated by less salt-tolerant species such as northern reed-grass, but have a secondary component of more salt-tolerant species such as salt grass. Moderately saline areas tend to be dominated by salt grass, while saline areas may be dominated by Nuttall's alkali-grass.

Soils corresponding to Saline Wet Meadow ecosites may include Alluvium Saline Gleysols, Meadow Saline Gleysols, Saline Complex, or saline and gleysolic series of a variety of other soil associations.

Things to look for in identifying the Saline Wet Meadow Ecosite:

- Soil map shows saline gleysols
- Low-lying wetlands that are usually flooded in spring
- White salt crust on surface
- Soil profile shows Gleysol profile with dull colours and/or prominent mottles
- Plant indicators
    - northern reed-grass
    - alkali cord-grass
    - Baltic rush
    - foxtail barley
    - salt grass
    - Nuttall's alkali-grass
    - sea milkwort
    - silverweed
    - common arrow-grass

Saline Shallow Marsh (SMHSA)

The Saline Shallow Marsh Ecosite consists of wetlands that are normally flooded until July or early August, with saline soils and water. Somewhat saline areas are dominated by less salt-tolerant species also found in fresh-water marshes, such as awned sedge, creeping spike-rush, and spangletop. Moderately saline areas are dominated by more salt-tolerant species such as three-square bulrush, while saline areas have the most salt-tolerant species such as Nevada bulrush and red samphire.

Things to look for in identifying the Saline Shallow Marsh Ecosite:

- Soil map shows saline gleysolic soils (e.g. Marsh Saline Gleysolic)
- Wetlands that are flooded for extended periods
- White salt crust on drying soil surfaces
- Soil profile shows Gleysol profile with dull colours and/or prominent mottles
- Plant indicators
  - three-square bulrush
  - Nevada bulrush
  - Nuttall's alkali-grass
  - narrow-leaf water-plantain
  - red samphire
  - sea-blite

Saline Deep Marsh (DMHSA)

The Saline Deep Marsh Ecosite consists of wetlands that are normally flooded throughout the growing season (non-use areas), with saline soils and water. Somewhat saline areas are dominated by less salt-tolerant species also found in freshwater marshes, such as hardstem bulrush and common reed. Moderately saline to saline areas are dominated by more salt-tolerant species such as prairie bulrush.

Things to look for in identifying the Saline Deep Marsh Ecosite:

- Wetlands that are almost always flooded
- White salt-crust on drying soil surfaces
- Vegetation consists of tall emergent plants
- Plant indicators
  - prairie bulrush

4. COMMUNITIES

4.1 Introduction

Sections 2 and 3 show how the rangelands of southern Saskatchewan are divided into ecoregions (which depend on climate) and ecosites (which depend on landform and soil). Within a given ecoregion and ecosite, a number of different plant communities may be found. The main reason for this is differences in disturbance history. Some areas may be heavily grazed over several years, causing the taller or more palatable species to decrease, while other areas are only lightly grazed. Repeated fires may eliminate the shrubs from some areas, while prolonged absence of fire may allow shrubs to expand. Some communities are altered by invasion of exotic plant species. The result is a range of possible plant communities on a given ecosite.

4.2 Methods

Classification of plant community types was based on analysis of existing data. PCAP partners contributed grassland composition data from a wide range of locations across southern Saskatchewan (Table 6). The range condition database collected by AAFC in community pasture surveys accounted for about half of the data.

Table 7 Data sources used for classification of plant community types.

data	source
AAFC range condition surveys	AAFC staff - personal communication
Saskatchewan Watershed Authority / Water Security Agency surveys	SWA/WSA staff - personal communication
Ducks Unlimited surveys	DU staff - personal communication
Saskatchewan range benchmarks	AAFC staff - personal communication
Original grassland data collected by R.T. Coupland and his students	R.T. Coupland, personal communication
Matador IBP site	Coupland 1973
U. of S research in the Coteau Hills	J. Romo, U of S, personal communication
M.Sc. Thesis on the Dundurn Sand Hills	Houston 1999 and personal communication
Other U of S theses	Brayshaw 1951, Heard 1953, Hird 1957, Hulett 1962, Baines 1964, Martens 1979
Prairie Biodiversity Survey	A. Riemer, Sask. Environment, personal communication
Saskatchewan Environment survey in the Great Sand Hills	A. Riemer, Sask. Environment, personal communication
Saskatchewan Forest Ecosite Classification	M. McLaughlan, Sask. Environment, personal communication.
Saskatchewan forest benchmark sites	Thorpe and Godwin 2008
Alberta forest benchmark sites	AB Sustainable Resource Development staff, personal communication
Grasslands National Park monitoring plots	GNP staff, personal communication
Grasslands National Park grazing experiment	GNP staff, personal communication
SRC range condition survey of Cypress Hills Provincial Park	Godwin and Thorpe 1994a

data	source
SRC range condition survey of Danielson Provincial Park	Thorpe and Godwin 1994
SRC research on farm biodiversity	Godwin et al. 1998
SRC research on range monitoring methods	Thorpe and Godwin 1998a
SRC research on sage grouse habitat	Thorpe and Godwin 2003
SRC research on WDF lands	Thorpe and Godwin 2001, 2002
SRC survey of Batoche National Historic Site	Godwin and Thorpe 2002a
SRC survey of Battle Creek valley	B. Godwin, SRC, unpublished data
SRC survey of Cowessess I.R.	Godwin and Thorpe 2004a
SRC survey of Moose Mountain Provincial Park	Thorpe 1994
SRC survey of Old Man on his Back	Thorpe and Godwin 1998b, 1999a
SRC survey of Saskatchewan Landing Provincial Park	Godwin and Thorpe 1994b, 2002b
SRC survey of Silverwood area	Godwin and Thorpe 1992
SRC survey of the Manito Sand Hills	Thorpe and Godwin 1993a
SRC surveys in Douglas Provincial Park and Elbow PFRA Pasture	Thorpe and Godwin 1992, Godwin and Thorpe 1994c, 1999
SRC surveys in Old Wives area	Thorpe and Godwin 1999b
SRC surveys in the Great Sand Hills	Thorpe and Godwin 1997
SRC surveys of Saskatoon Natural Grassland	Thorpe and Godwin 1993b, Godwin and Thorpe 2004b

A standard data format was developed, and data from the various sources were edited to fit the standard format. This allowed data from different sources to be pooled for analysis. The basic unit of data was considered to be the vegetation plot. This could be a sample area (e.g. a 5 m by 5 m square plot), or it could be a transect (e.g. a 100 m line laid out across the landscape). In the case of plots or transects sampled by a series of small quadrats (e.g. ten placements of a 50 cm by 50 cm frame), the averages of the quadrat values were considered to be the plot values. Each plot can be visualized as a column in the dataset, while the rows include location information, environmental attributes (e.g. slope, aspect, soil type), production measurements, vegetation structure, and abundance values for individual plant species. Plot locations were used with GIS data to assign values for ecoregion, climate variables, and mapped soil information. Plots were assigned to ecoregions based on the Ecoregions of Saskatchewan map (Padbury and Acton 1994) and the mapped climatic data. Plots were assigned to ecosites based on environmental data (e.g. observed topography, soil texture, or range site identification) and the soil survey map.

Species names used in the original data sources were converted to standardized names. In the second phase of the project (2013-2014), the species names used in the 2007 publication have been updated to more current names (Harms 2006). For example, northern wheat-grass was called *Agropyron dasystachyum* in the 2007 publication, but this has been updated to the more current name *Elymus lanceolatus* in the 2014 revision.

The data included a variety of species abundance measures, with most using either percent cover (i.e. the percent of the ground area covered by the species) or percent biomass (i.e. the percent contributed by each species on a weight basis). One of the fields in the database recorded the type of abundance measure, so that plots with the same measure could be grouped. However, for some analyses, species abundance values were transformed to ranks within growth-forms (e.g. the rank of each herbaceous species in relation to all herbaceous species). Rank-transformed data were considered to be comparable between plots using different abundance measures.

Plots were separated by ecoregion and ecosite. In some cases, particular combinations of ecoregion and ecosite had insufficient numbers of plots for analysis, so were combined with other similar combinations. For example, Mixed Grassland and Dry Mixed Grassland were separated for the Loam Ecosite, but were combined for some other ecosites with lower plot numbers.

Classification of communities within an ecoregion/ecosite combination followed a supervised approach. Each plot was represented by a few variables, including percent exotics, percent shrubs, dominant herbaceous species, and a successional index based on proportions of decreasers and increasers. These variables were used in a manual sorting process aimed at grouping similar plots. In either approach, types represented by small numbers of plots were either eliminated or combined with other types, as appropriate. Most types were represented by at least 10 plots. Smaller sample sizes were occasionally allowed, for example to ensure that a distinctive or important type is represented in the classification.

Knowledge of successional relationships was used to interpret a potential or reference community for each ecoregion/ecosite combination, defined as the community that would be expected under ungrazed or lightly grazed conditions. Percent similarity of other community types to the reference community was determined by Sorensen's index (Mueller-Dombois and Ellenberg 1974). Communities were arranged in a state-and-transition diagram showing the interpreted relationships among them.

Data for community types were summarized by calculating the mean and the 10^{th} and 90^{th} percentiles of vegetation structure and composition variables. Plant species were separated by growth-forms:

- graminoids – grass-like plants, including grasses, sedges, and rushes
- forbs – herbaceous plants that are not grass-like
- half-shrubs – plants that are woody at the base, but with mostly herbaceous growth (i.e. most of the above-ground growth dies back each year)
- shrubs – woody plants (i.e. above-ground growth persists from year to year)
- cactus – succulent plants with spines

Minor species within each growth-form were grouped, and only the total abundance for the grouped species was shown. The results were shown in standardized community descriptions.

In the second phase of the project (2013-2014), which extended the classification to riparian sites, the same methods were used for most communities. However, for some community types which are known to be important, insufficient field data was available for development of a description. In these cases, community descriptions were based on the publications of Thompson and Hansen (2001, 2003). These publications provide descriptions for a large number of riparian communities found in southern Saskatchewan, but do not relate them to an ecosystem framework. For the current work, these communities were assigned to ecosites, by inference from the trends shown in the wetland classification literature (Stewart and Kantrud 1971, Millar 1976).

Species abundances in the Thompson and Hansen reports are shown as percent constancy (i.e. the percentage of plots in the type in which the species occurred), and average cover where present (i.e. the average percent cover over the plots in which the species was present). These were converted to a more standard form by multiplying percent constancy by average cover where present. The result is the average percent cover over all plots in the type. Thompson and Hansen also give the ranges of percent values. These ranges extend from the lowest to the highest value recorded, so are somewhat wider than the ranges given in other community descriptions, which were based on the 10th and 90th percentiles of abundance values.

It should be noted that the percent cover values given by Thompson and Hansen are based on the "canopy cover" concept, in which the entire area of the crown of a plant is considered its cover. Most of the cover data provided in other community descriptions is based on the "foliar cover" concept, in which only the actual cover of leaves and other plant parts is considered (i.e. the gaps between leaves are subtracted). As a result, the cover values given by Thompson and Hansen are somewhat higher than the cover values in other descriptions.

The numbers of communities that have been described to date are summarized in Table 8. The total is roughly double what it was at the end of the first phase of the project. Most of the increase has been in moist to wet ecosites, as well as in shrublands and woodlands of upland ecosites.

Table 8 Numbers of described communities

	as of 2008				as of 2014			
ECOSITE	grassld.	shrubld.	woodld.	**total**	grassld.	shrubld.	woodld.	**total**
Badlands	3			**3**	3			**3**
Thin	5	1		**6**	7	2		**9**
Gravelly	5			**5**	5			**5**
Dunes	9	5		**14**	9	7	2	**18**
Sand & Sandy Loam	11		4	**15**	11	2	5	**18**
Loam	20		3	**23**	20	2	3	**25**
Clay	3			**3**	3			**3**
Solonetzic	7			**7**	7			**7**
Overflow & Subirrigated			3	**3**	4	16	14	**34**
Wet Meadow				**0**	6	4		**10**
Marsh				**0**	11			**11**
Saline Upland				**0**	3			**3**
Saline Overflow & Subirrigated				**0**	8	1		**9**
Saline Wet Meadow				**0**	5			**5**
Saline Marsh				**0**	4			**4**
total	**63**	**6**	**10**	**79**	**106**	**34**	**24**	**164**

4.3 Using the community descriptions

Descriptions of the communities for each ecosite are presented in a series of separate publications. For example, Publication 4 shows the communities for the Loam Ecosite, Publication 5 for the Sand and Sandy Loam Ecosites, and so on.

Each description shows:

- a code for the community type (e.g. MG-LM-A, meaning Mixed Grassland Ecoregion, Loam Ecosite, community type A)
- the name of the community type based on the dominant species
- a general description of the community type, including its interpreted successional relationships with other types
- the structure of the vegetation, represented by the percent cover of each vegetation layer, as well as litter cover and exposure of bare soil
- the species composition, represented by major species in each vegetation layer with abundance values (either percent biomass or percent cover, depending on available data); note that mosses, lichens, and clubmoss (*Selaginella densa*) are shown under Vegetation Structure, and are not included in the composition data.
- percent similarity of the community to the reference community for that ecoregion/ecosite
- average forage production, if sufficient data were available
- recommended stocking rates (see Section 5)

The publication also includes a state-and-transition diagram representing the successional relationships among the various community types.

In using the community descriptions, it is important to understand that they do not represent every possible variation in species composition. Rather, they represent the major trends. A sample plot examined in the field may not exactly match any of the described community types. The user should examine the composition trends shown by described types, then interpret the composition of the sample plot in relation to these trends.

As an aid to this interpretation, the user can calculate the percent similarity (Mueller-Dombois and Ellenberg 1974) between the sample plot and the reference community for that ecosite. Table 9 shows an example on Loam Ecosite in the Mixed Grassland Ecoregion. The description for the reference community (MG-LM-A in Publication 4) gives average values of percent biomass for each major species, as well as totals for minor species. Values determined for the sample plot are entered beside those for the reference community. In this example, the sample plot had data for one graminoid (crested wheat-grass) and four forbs (prairie sage, scarlet mallow, cinquefoil, and goat's-beard) that were not listed as major species in the reference community. Such species must be grouped as "minor" species, even though they may be of major importance in the sample plot. Percent similarity is then calculated by taking the lesser of the two values for each species, and summing these lesser values.

Table 9 Example of calculating percent similarity to the reference community using percent biomass data, for a sample plot on Loam Ecosite in the Mixed Grassland.

	PERCENT BIOMASS		
	ref. community	**sample plot**	**lesser value**
Major graminoids			
western porcupine-grass	31	15	15
northern wheat-grass	24	15	15
June grass	5	0	0
western wheat-grass	4	5	4
blue grama	4	20	4
needle-and-thread	4	14	4
sedges	3	20	3
plains rough fescue	3	0	0
green needle grass	2	1	1
plains reed-grass	1	0	0
Hooker's oat grass	1	0	0
Major forbs and half-shrubs			
pasture sage	7	1	1
crested wheat-grass		3	
Total of minor graminoids	3	3	3
prairie sage		1	
scarlet mallow		2	
cinquefoil		1	
goat's-beard		5	
Total of minor forbs and half-shrubs	6	8	6
PERCENT SIMILARITY			55

This example used percent biomass data, which should add up to 100 in each plot, allowing the use of the simplified calculation of percent similarity shown in Table 9. Some community descriptions show percent cover data, which do not usually add up to 100. In this case, the full formula for percent similarity must be used (Mueller-Dombois and Ellenberg 1974). The sum of the lesser values is multiplied by 200, then divided by the sum of the reference values plus the sum of the sample values. An example of the calculation for percent cover is given in Table 10.

Percent similarity values can be used directly to judge the extent to which the sample plot has been altered from the reference community. However, the Saskatchewan Range Health Assessment method refers to classes of alteration in assigning points for ecological status. The following ranges of similarity can be used as a rough guide for assigning these classes:

- more than 65% - reference community
- 50-65% - minor alteration
- 30-50% - moderate alteration
- 15-30% - significant alteration
- less than 15% - severe alteration

Table 10 Example of calculating percent similarity to the reference community using percent cover data, for a sample plot on Loam Ecosite in the Aspen Parkland.

	PERCENT COVER		
	reference community	**sample plot**	**lesser of the two values**
Major graminoids			
plains rough fescue	23	2	2
northern wheat-grass	5	0	0
western porcupine-grass	2	5	2
sedge	2	0.2	0.2
bearded wheat-grass	1	2	1
Kentucky blue grass	1	0	0
June grass	0	0.1	0
Hooker's oat grass	0	0.1	0
Major forbs and half-shrubs			
three-flowered avens	0	0.1	0
everlasting	5	0.1	0.1
timber oat grass		0.1	
rough hair grass		0.01	
sheep fescue		0.01	
Total of minor graminoids	0	0.12	0
crocus anemone		0.1	
cut-leaved anemone		0.1	
early blue violet		0.1	
field chickweed		0.1	
gaillardia		0.1	
golden bean		0.1	
hedysarum		0.1	
long-fruited anemone		0.1	
low goldenrod		0.1	
many-flowered aster		0.1	
northern bedstraw		0.1	
prairie sage		0.1	
woolly yarrow		0.1	
pasture sage		0.1	
Total of minor forbs and half-shrubs	2	1.4	1.4
rose		0.1	
Total of minor shrubs	0	0.1	0
TOTAL	41	11.22	6.7
PERCENT SIMILARITY	=(200*6.7)/(41+11.22)		25.7

While the similarity index provides a good general measure of departure from the reference composition, it occasionally leads to inappropriate results when used as a measure of grazing impact. For example, if a reference community contained equal percentages of two dominant decreaser species, the highest similarity would be obtained with a sample plot that also had equal percentages of these species. In a sample plot in which one of these decreasers was dominant and the other was low in abundance, the similarity to the reference community would be lower. This conflicts with the usual idea that abundance of any major decreaser species is a sign of high condition or low grazing impact. Because of this problem, similarity index values should be interpreted cautiously, taking into account which species are causing the departure from the reference community. In future work, modification of the similarity index to improve its performance as a measure of grazing impact would be desirable.

5. PRODUCTION AND STOCKING RATES

The community descriptions show average production values, for communities with sufficient data. The descriptions also show recommended stocking rates. These are intended to be initial estimates of sustainable stocking rates for each community. In actual use, they should be fine-tuned on the basis of pasture characteristics and monitoring of range trend.

Recommended stocking rates were based on analysis of historic stocking rates from AAFC community pastures. Actual stocking of individual fields was recorded for years from 1988-2002, in pastures in Saskatchewan and Manitoba. Data were restricted to fields that have been maintained in good to excellent range condition, so they should represent sustainable stocking rates. In order to reduce the effect of site variation, only fields with predominantly Loamy Sites were used in the analysis. The effect of climatic variation was captured by determining the climatic moisture index (CMI) (see Figure 1 in Section 2) for each field. The pattern of stocking rates in relation to CMI is shown in Figure 3. Stocking rates increase from the driest regions (CMI = -400) to the moistest (CMI close to zero), and the graph shows a slight upward curve.

In a separate analysis, measured grassland production values from benchmark sites and research plots (mostly ungrazed) were plotted against CMI. The results (Figure 4) show almost exactly the same pattern as the stocking rate analysis, providing independent confirmation of the climatic trend in productivity.

The trend shown in Figure 3 is considered to be the best evidence available for determining recommended stocking rates for the Loam Ecosite. This trend can be used to estimate recommended stocking rates in two ways:

- as a continuous response to the climatic moisture gradient (Figure 5)
- as average values for the ecoregions (Table 11)

For example, in estimating stocking rates for a community pasture or ranch, one could determine which region it falls into, and use the average value for that region (Table 11). This is similar to the method used by Abouguendia et al. (1990) based on soil zones. On the other hand, a more exact estimate might be obtained by finding the location on the map (Figure 5) and reading the recommended stocking rate at that location.

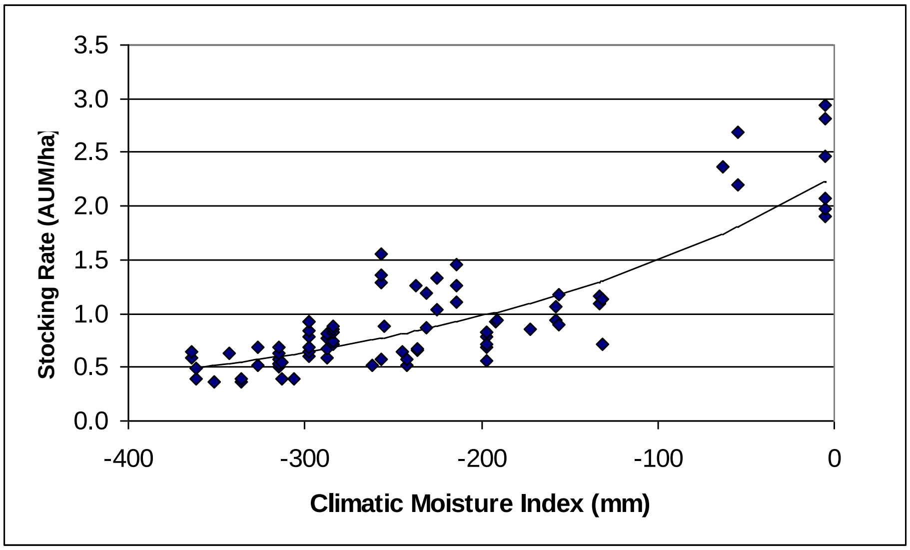


Figure 3 Stocking rates of fields in good to excellent range condition on loamy sites in AAFC pastures in Manitoba and Saskatchewan, in relation to the Climatic Moisture Index.

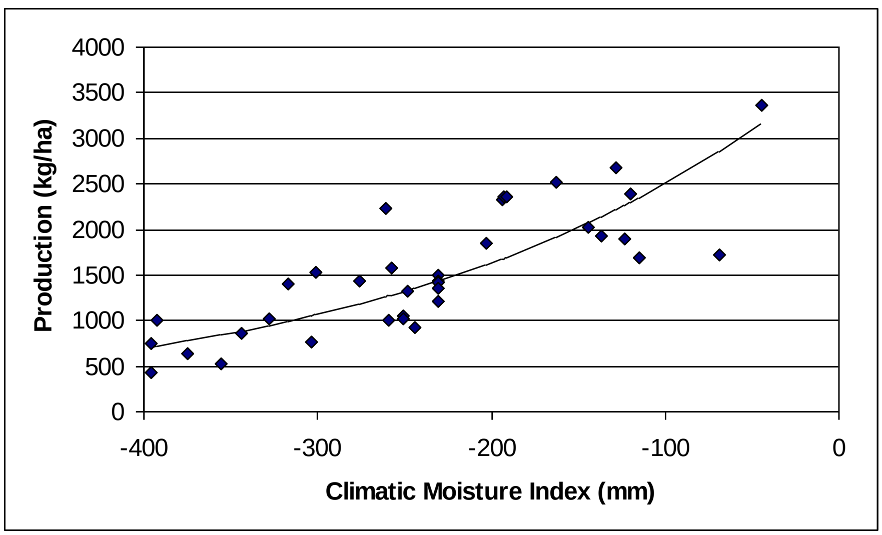


Figure 4 Annual grassland production from reference areas on loamy sites in the Canadian prairies, in relation to the Climatic Moisture Index.

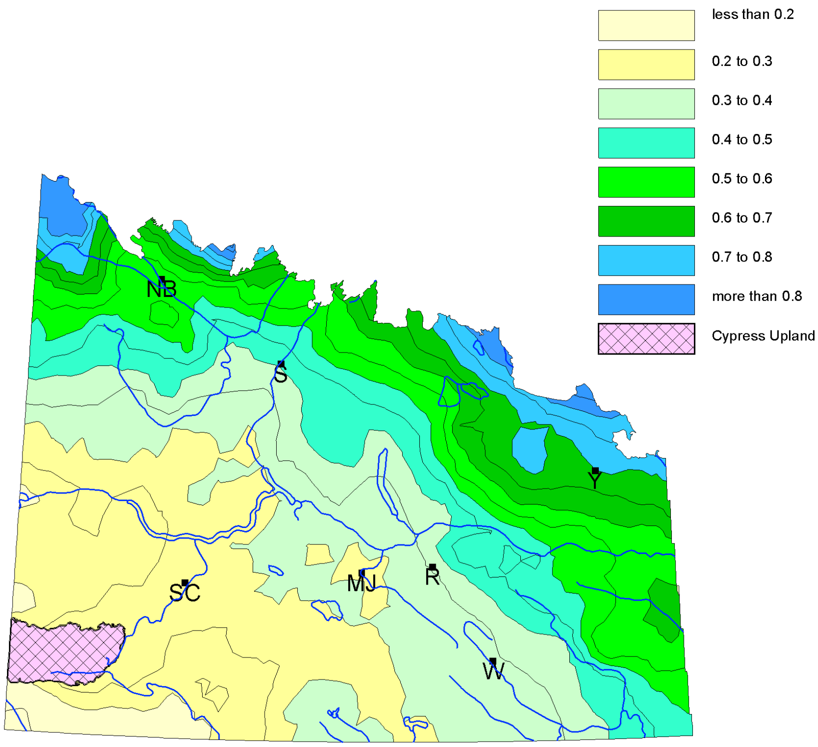


Figure 5 Recommended stocking rates (AUM/ac) for the Loam Ecosite, as a continuous surface predicted from the climatic moisture index.

Table 11 Average recommended stocking rate for the Loam Ecosite in each ecoregion, predicted from the climatic moisture index.
The Aspen Parkland has been arbitrarily divided at a CMI value of -125 mm.

		stocking rate	
Ecoregion	**climatic moisture index (mm)**	**AUM/ha**	**AUM/ac**
Dry Mixed Grassland	below -325 mm	0.49	0.20
Mixed Grassland	-325 to -225 mm	0.72	0.29
Aspen Parkland, drier portion	-225 to -125 mm	1.10	0.44
Aspen Parkland, moister portion	above -125 mm	1.67	0.68

The Cypress Upland Ecoregion required special treatment. As discussed in Section 2, the regional mapping of the climatic moisture index was not precise enough to capture the small-scale elevational pattern in the Cypress Hills. Therefore, elevations were used to map the boundaries between regions. Henderson et al. (2002) estimated that CMI increases 58 mm for each 100 m rise in elevation in the Cypress Hills. By adding this increase to the assumed value of -325 mm at the boundary between Dry Mixed Grassland and Mixed Grassland, one can predict the CMI values at higher elevations, and use these values to estimate stocking rates. The results can again be shown either as average stocking rates for elevational zones (Table 10), or as a continuous increase in recommended stocking rate with elevation (Figure 6).

Table 12 Average recommended stocking rates for the Loam Ecosite in the Cypress Upland Ecoregion, predicted from the relationship between elevation and climatic moisture index.

Ecological Region	elevation	climatic moisture index	stocking rate	
			AUM/ha	AUM/ac
Mixed Grassland at lower elevations	below 1050 m	below -209 mm	0.74	0.30
Fescue Grassland at higher elevations	above 1050 m	above -209 mm	1.39	0.56

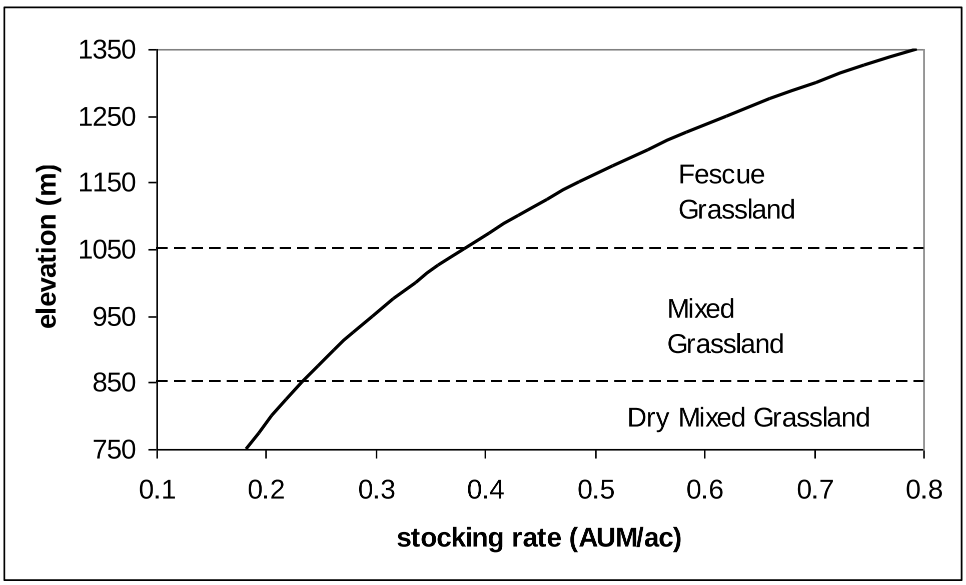


Figure 6 Recommended stocking rates for the Loam Ecosite in the Cypress Upland Ecoregion, as a continuous response to elevation.

The values shown in Figure 6 and Table 10 are intended for the Loam Ecosite in the Cypress Upland. However, they could also be applied to other areas within the Mixed Grassland where there are strong elevational gradients, such as the Wood Mountain Upland. These areas do not reach elevations high enough to support extensive fescue grassland as found in the Cypress Hills, but the Mixed Grassland becomes moister and more productive with increasing elevation.

The analysis of recommended stocking rates shown above was for the Loam Ecosite. In Saskatchewan, this ecosite accounts for more rangeland than any other, and can be considered to be the modal site, neither excessively wet nor excessively dry. Therefore, the analysis should be a good representation of the regional trends in productivity. Ideally, a similar analysis would be done for each ecosite, but unfortunately the data were insufficient for ecosites other than Loam.

Therefore, the approach that was taken was to modify the regional trend determined for the Loam Ecosite, based on published data showing the relative productivities of different ecosites. Recommended stocking rates and/or production values were taken from existing publications (Wroe et al.1988, Abouguendia 1990, Adams et al. 2003, 2004, 2005, NRCS ecological site descriptions for MLRAs 58a and 60b in Montana and 64 and 65 in Nebraska [http://esis.sc.egov.usda.gov/]). For each publication, the ratio of the production or stocking rate on a given ecosite to that on loam was calculated. These ratios were fairly consistent among publications, so they were averaged (Table 13). In the current Version 2 of the publication, these ratios have been modified from those used in the original version in two respects:

1. For the Solonetzic Ecosite, the relatively low ratio based on the stocking rate guides (0.66) was found to be appropriate only for soils with the most pronounced solonetzic characteristics, including dense B-horizon and frequent eroded patches (burnouts). Many Solonetzic soils are less extreme in these characteristics, and approach the productivity of the Clay or Loam Ecosite. A ratio of 0.90 was estimated for the less extreme Solonetzic soils.
2. For moist ecosites, recent analysis of data from the Manitoba rangeland benchmark system (Thorpe 2014), which includes many plots on these sites, showed that the ratios based on the stocking rate guides were too high. Therefore, the ratios for Overflow and Subirrigated Ecosites (and their saline variants) have been adjusted downward from those shown previously. For the saline ecosites, the ratios shown here were assumed to apply to "somewhat saline" areas. Stocking rates for "moderately saline" areas were reduced to one half, and for "saline" areas to one quarter, of these rates.
3. For wetlands (wet meadow and marsh ecosites), the data did not support classification of different communities by ecoregion, so they are shown as occurring over the entire Prairie Ecozone. Trends in the productivity of these communities across the ecozone are not well understood. The best information available is from the Manitoba rangeland benchmark system, so recommended stocking rates developed on that basis (Thorpe 2014) are shown here. However, it should be recognized that these rates are only appropriate as long as water tables are high enough for development of the characteristic communities of these ecosites. Particularly in the Mixed Grassland and Dry Mixed Grassland Ecoregions, intermittent drought years may cause these ecosites to dry out, reducing productivity to near zero. Therefore, the recommended stocking rates should be discounted for the occurrence of drought years.

The stocking rates used in the regional analysis are based on AAFC-PFRA pasture fields in good to excellent range condition. Therefore, they should be applicable to the reference plant communities as well as to those showing minor alteration from the reference community. To examine trends in more altered communities, the available production data for communities on the Loam Ecosite were analyzed. These included production data based on clipping of quadrats to measure peak standing crop, as well as data in which graminoid production was estimated from basal area of individual graminoid species using the method of Lodge and Campbell (1965). Because most plots in the database did not have production data, there was little information for some communities. Only averages based on at least five plots within a community type were used (Table 14).

Table 13 Average ratio of the recommended stocking rate on a given ecosite to that on the Loam Ecosite.

Ecosite	Ratio
Badlands	0.29
Gravelly	0.60
Dunes	0.73
Sand	0.94
Sandy Loam	0.97
Loam	1.00
Clay	1.00
Solonetzic (with burnouts)	0.66
Solonetzic (without burnouts)	0.90
Overflow	1.20
Subirrigated	1.30
Saline Upland	0.70
Saline Overflow	1.00
Saline Subirrigated	1.10

Table 14 Production data for communities on the Loam Ecosite.
Values are averages of at least five plots within a given community type.

		annual production (kg/ha)				
community	alteration from reference community	estimated graminoids	clipped graminoids	clipped forbs	clipped browse	clipped total
Mixed Grassland						
MG-LM-A	reference	1209				
MG-LM-B	minor	897	1275	182	11	1440
MG-LM-D	minor	725	914	184	29	1107
MG-LM-E	moderate	488				
MG-LM-F	moderate	582				
Aspen Parkland						
AP-LM-A	reference		1419	199	0	1619
AP-LM-B	moderate	931				

While the data in Table 14 are incomplete, they do show a trend of declining productivity from the reference community to those with increasing alteration from the reference. Based on this trend, communities showing moderate alteration were set at 80% of the regional stocking rates, and communities showing significant alteration at 60% of the regional stocking rates. This is similar to the approach followed by Wroe et al. (1988) and Abouguendia et al. (1990) in assigning rates to lower range condition classes. For communities dominated by exotic invaders, no information was available for estimating stocking rates.

To summarize, the recommended stocking rates for reference communities on the Loam Ecosite were based on the regional value determined from analysis of PFRA stocking records (Table 11 and Table 12). Recommended stocking rates for reference communities on ecosites other than Loam were determined by multiplying the regional value by the ecosite ratio shown in Table 13.

Recommended stocking rates for altered communities were determined by multiplying the rate for the reference community by 0.8 (moderate alteration) or 0.6 (significant alteration). The overall calculation is shown in Table 15.

Table 15 Example of determination of recommended stocking rates, for a location where the regional trend shows a rate of 1.00.

		Ecosite			
		Loam	**Sand**	**Solonetzic**	**other ecosites**
		ratio to Loam			
		1.00	0.94	0.66	…
	ratio to reference				
reference community	1.00	1.00	0.94	0.66	…
minor alteration	1.00	1.00	0.94	0.66	…
moderate alteration	0.80	0.80	0.75	0.53	…
significant alteration	0.60	0.60	0.56	0.40	…

The above methods were used for grassland communities. For open shrublands with a mix of woody and herbaceous cover, rates were set at half of those in the corresponding grassland community. For woodlands, recommended stocking rates were developed by Thorpe and Godwin (2008), based on monitoring of forage production in those communities. Rates for woodland types not covered by Thorpe and Godwin (2008) were estimated by extrapolation from the represented types.

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PHOTO CREDIT: Cover photo – Mixed grassland in Coalfields Community Pasture (Bob Godwin).

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