Rangeland Ecological Site Policy for Montana

(a)(1) Definition

An Ecological Site is defined as a distinctive kind of land, with specific physical characteristics which differ from other kinds of land in its ability to produce a distinctive kind and amount of vegetation, and in its response to management.[1]

Ecological Sites are grouped into Land Resource Units (LRUs) within Montana. LRUs are grouped into Major Land Resource Areas (MLRAs) which cross state lines. MLRAs are grouped into Land Resource Regions (LRRs) of the United States. Refer to Agricultural Handbook 296 for further information: http://soils.usda.gov/survey/geography/mlra/ .

Brief descriptions of Montana's LRUs and MLRAs are included at the end of this document. Completed Ecological Site Descriptions can be found in the Field Office Technical Guide, Section II.

(a)(1)(i) Criteria for Differentiating Ecological Sites

Ecological Sites are differentiated based on chemical or physical environmental factors that have a direct effect on climax plant community composition and production.[1] The three primary factors which differentiate one ecological site from another are climate, topography, and soil.

The criteria for separating ecological sites are:[1]

- Soil factors that determine plant production and composition, the hydrology of the site, and the functioning of the mineral cycle, water cycle, and energy flow.
- Significant differences in species and the balance of species groups (trees, shrubs, half shrubs, grasses and forbs, including cool season and warm season composition.
- Significant differences in total annual production.

Rangeland Ecological Sites Descriptions (ESDs) will be used to describe ecological sites where the tree canopy cover in the potential native plant community is less than 25 percent. Forestland ESDs will be used to describe potential native plant communities which have greater than 25 percent tree canopy.[1]

(a)(1)(ii) Criteria for Documenting and Identifying New Ecological Sites

When proposing a new ecological site, conceptualize a model of it. Develop a model with a specific norm and range in characteristics for the proposed ecological site description, including the physiographic, climate, soil and plant community characteristics of the proposed ecological site. Some of the characteristics of the new ecological site will overlap the characteristics of an existing ecological site. Limits of the range in characteristics of the plant community (kinds, proportions, amount), soils, climate and other ecological site factors for the proposed ecological site should be as wide as those permitted within the LRU criteria to which it belongs. Generally keep the range in differentiating characteristics of the ecological site narrower than that for the span of the MLRA, unless the characteristics do not differ significantly among the LRUs within the MLRA (therefore the LRU designation for the ecological site is Y). Ranges cannot be too narrow for precise and consistent identification. They must be practical.

Select at least three (3) physical locations that are typical for the ecological site concept. These "type locations" for the ecological site are reference locations that illustrate the central concept for the ecological site description. They should be a minimum of 2,000 acres in size, and will have a completed soil profile description record (NRCS-232 or similar) that adequately describes the soil physical and chemical properties of each location. The minimal data set collected at each type location includes plant community composition and weight (by species and total for the site), ground cover, soil stability, landscape and plot photographs, and completed rangeland health evaluation for each of the 17 indicators.

The type locations, along with other very similar locations of the ecological site, form the model for the ESD. Thus, the selection of a type location is a very important process and is done with great care. Base it on the arrayed data on physiographic features, soil morphology, plant community composition, and geographic distribution. No ecological site type location is likely to be central for all ranges, but the representative type locations should lie reasonably near the center of the ranges for most physical, climatic and soil properties and for the geographic distribution.

After selecting the ecological site type locations, define the permissible ranges in site characteristics. Use the arrayed information on physiographic features, climate, soil properties, and plant community composition and production. Knowledge of the historic use and management of each type location is very helpful and will assist in the development of the state and transition model and management narratives for the ESD.

Only part of the set of observed properties define the classification of any ecological site, but consider all properties when defining the site. Not all observable properties are necessarily definitive for an ESD. The definitive properties that set an ecological site apart from similar ecological sites are essential. Emphasize these properties in the narratives describing the site's range in characteristics. Also describe the ranges in significant properties that do not differentiate between the ecological site being described and any similar ecological sites.

Next, test the ecological site concept. Check the norm and ranges in characteristics against the limits for the site and for the LRU to which the proposed ecological site belongs. Do not cross the limits of the site or LRU or MLRA with the ranges specified for the ecological site. Do not overlap ranges in differentiating characteristics such as plant community kinds, amounts or proportions, and soil physical or chemical characteristics. As the ecological site concept is tested, assign and correlate specific soil components to the proposed ecological site.

For guidance on correlating ecological sites to soils, refer to the National Range and Pasture Handbook (NRPH), Chapter 3, the National Forestry Manual, and the National Soil Survey Handbook, Part 622.07 (http://soils.usda.gov/technical/handbook/contents/part622.html#07).

(a)(2) Contents of Ecological Site Descriptions

(a)(2)(i) Ecological Site Name

The following criteria will be used to name rangeland ecological sites in Montana.

The basic site name will consist of two parts.

The first part will describe the physical attribute that most affects the plant community. This may be soil texture, depth, rock fragments, soil chemistry, parent material, or landscape position.
Soil textures names will be written according to the format shown in the soil descriptions section below. Soil textures usually identify the most common texture in a range of textures found on the site. For general use, and because it sounds better, a "y" or "ey" is added to indicate a range of textures around the one being named (e.g., Loamy indicates a texture range from fine sandy loam to silty clay loam). See the Soil Textural

Classes and Permeability Classes in the Soils Description section below for the general texture terms, and the range of textures they represent.

Soil chemistry terms used in ecological site names are Saline, Limy, and Sodic. Parent materials names include igneous, metamorphic or sedimentary rock types listed below in the Geology section under Physiographic Features.

The second part of the name will identify which LRU the site is being described within (e.g., LRU C).

Examples: Loamy LRU C
Loamy Steep LRU C

(a)(2)(ii) Numbering Ecological Sites

Ecological Sites are numbered based on a five-part system.

The letter “R” will be put in front of the number on Rangeland ESDs, and “F” on Forestland ESDs to help differentiate them.

Next, a three-digit number indicating the MLRA, and a one-digit letter indicating the MLRA subdivision.

Next, a single letter indicating the LRU (A, B, etc.).

Next, the three-digit site number, from 001 through 999 are assigned to each site regardless of the MLRA or LRU designation (e.g., Clayey is always 001, Loamy is always 032, etc).

And finally, the two-digit postal code for the state, MT.

Example Site Number: R044BC001MT (this rangeland site resides in MLRA 44B, LRU C. The 001 identifies it as the Clayey ecological site).

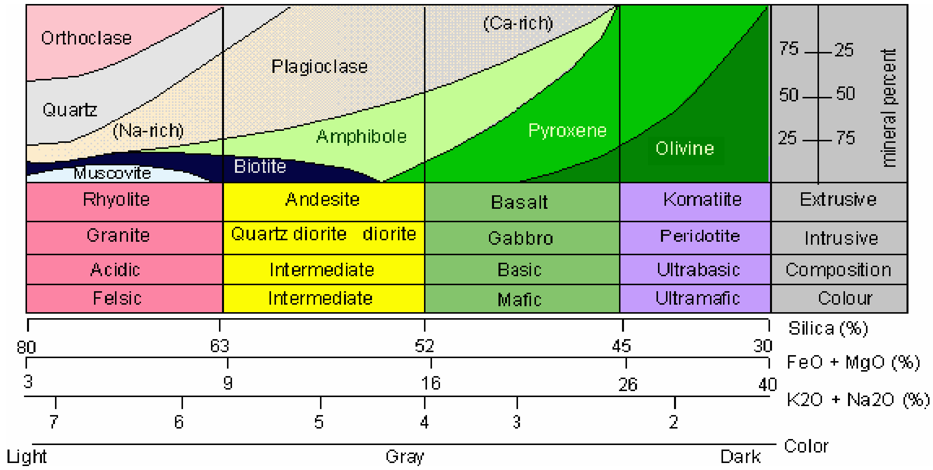
(a)(2)(iii) Physiographic Features

Physiographic features which affect the kinds and amounts of plants that grow on a site include elevation, slope, aspect, and depth to ground water.

(a)(2)(iv) Geology

Igneous Rocks

Igneous rocks form by direct crystallization of minerals from a magma melt; we see a surface expression of magmatic activity at sea-floor spreading ridges and other rift zones, volcanic arcs (subduction zones) and hot spots (intraplate volcanism). Intrusive (plutonic) rocks crystallize at depth, whereas extrusive (volcanic and pyroclastic rocks) rocks crystallize after the magma reaches the earth's surface. In general, extrusive rocks have a finer-grained texture than intrusive rocks.



Igneous rocks are often classified according to the percentage of silica (SiO_2). The figure above is a general guide to igneous rock classification, showing the rock names and the differences in mineralogy. As shown in this diagram and the table below, the basic chemical makeup of intrusive and extrusive rock types can be nearly identical. The resulting soils and plant communities in many cases are not significantly different on the intrusive and extrusive rocks within, for example, the acid igneous group.

Igneous Rock Names for Use in Ecological Site Description Names:

Igneous Rocks	**Extrusive**	**Intrusive**
Acid Igneous	rhyolite	granite
Intermediate Igneous	andesite	diorite
Basic Igneous	basalt	gabbro

Sedimentary Rocks [2, 3]

Sedimentary rocks are made of sediments transported as solid grains (clastic sedimentary rocks), or chemically precipitated out of water (chemical sedimentary rocks).

Clastic sedimentary rocks:

- Sandstone -- made of grains of sand deposited by wind, rivers, along coasts, in the sea
- Shale -- made of mud
- Conglomerate -- contains considerable gravel-sized sediments
- Mudstone.

Chemical sedimentary rocks:

- limestone -- ($CaCO_3$) made of calcite; forms from accumulation of shells in the sea or direct precipitation of calcite in water
- dolomite -- made of dolomite
- evaporite -- formed from minerals that precipitate as water evaporates
- gypsum ($CaSO_4$)
- Rock salt.

Metamorphic rocks [3 4]

Metamorphic rocks are formed by subjecting a pre-existing rock to very high pressures and/or temperatures below the surface of the earth. Metamorphic rocks develop interlocking crystalline texture. Some common metamorphic rocks include:

- slate -- barely metamorphosed shale
- schist -- metamorphosed shale and basalt
- gneiss -- highly metamorphosed shale and granite
- marble -- metamorphosed limestone
- quartzite -- metamorphosed sandstone.

Rock Type	**Increasing temperature and pressure →**			
Shale	Slate	Phyllite	Schist	Gneiss
Sandstone		Quartzite		
Limestone		Marble		
Basalt	Schist		Amphibolite	
Granite		Granite	Gneiss	
Coal	Peat	Lignite	Bituminous	Anthracite

(a)(2)(v) Land Forms

Land form descriptions are also an important part of physiographic features in ecological site descriptions. Ideally, the name and description of the topography should clearly identify the site to the user. The following definitions should help describe physiographic features.[4]

Alluvial Fan	A cone-shaped earth material deposit formed at the mouth of a tributary or high declivity in the valley or channel of a stream of less declivity which usually receives additional run-on moisture. They are usually steepest near the mouth of the tributary drainage and slope outward with ever decreasing gradient.
Alluvial Plain	A plain resulting from the deposition of alluvium by water. In the southwestern United States most alluvial plains are formed by streams having a considerable grade, and hence are generally referred to as alluvial slopes.
Alluvial Terrace	After filling its valley with waste for a time, a river may change its action and entrench its course in the built-up flood plain. The part of the plains then remaining above the new valley floor is commonly called an alluvial terrace, or simply a terrace.
Bench	The bench landform is somewhat heteromorphic. The area may be round or elongated. The surface configuration may be depressional or smooth, and may or may not have a reverse slopes.

Bolson	A closed basin; a depression or valley having no outlet.
Bottom	The first bottom land along streams.
Braided Streams	A stream flowing in several dividing and uniting channels, resembling the strands of a braid, the cause of the diversion being the obstruction by sediment deposited by the stream.
Butte	Detached hills and ridges which rise abruptly and reach too high to be called hills or ridges, and not high enough to be called mountains. If the broadening of valleys divides a mesa so that part of it stands as a separate hill, the hill is called a butte or mesa butte.
Canyon	A steep walled chasm, gorge, or ravine in a plateau of mountainous area.
Cienega (wet meadow)	An area where the water table is at or near the surface of the ground. Standing water occurs in the depressions and the area is covered with grass or sometimes with heavy vegetation.
Cinder Cone	A conical elevation formed by the accumulation of volcanic ash or clinker-like material around a vent.
Cirque	The semi-circular concave cove-like areas with steep faces and bowl-like appearance for most of their perimeter. In mountainous areas they are usually the result of glacial ice and snow abrasion reduction of former peaks and higher salient of the topography. These forms, however, could conceivably be the result of landslide, slump, or other geologic crust movements.
Cols	Alternating sags produced by intersection of opposed cirques and pointed peaks or horns representing unreduced portions of the original mountain range.
Colluvium	Loose and incoherent deposits usually at the foot of a slope or cliff and brought there chiefly by gravity. Because these materials were deposited chiefly by gravity, they are characterized by a lack of sorting.
Coulee	A steep walled, trench-like valley; a wash, gulch, or arroyo through which water flows intermittently.
Dune	A mound, ridge, or hill of wind blown material either bare or covered with vegetation.
Dune barchan	A crescentic shaped dune with tips extending to the leeward, making this side concave in plan, and the windward side convex. They tend to arrange themselves in chains extending in the direction of the most effective wind.
Dune seif	Instead of being transverse to the prevailing wind, is parallel to it. The width is roughly six times the height.
Dune whaleback	Flat topped sand ridges which extend parallel to the prevailing winds, but lack the collapsing fronts which mark seifs. They have much larger dimensions.
Escarpment	A cliff or slope separating level or gently sloping tracts.

Flood Plain	A strip of relatively smooth land bordering a stream, built of the sediment carried by the stream and dropped in the slack water beyond the influence of the channel. It is called a living flood plain if it is overflowed in time of high water, but a fossil flood plain if it is beyond the reach of the highest flood.
Headwall	A steep side slope immediately above a landslide, bench, or land flow.
Hill	A mass of material rising above the level of the surrounding country, and culminating in a well marked crest or summit. A mountain is simply a big hill.
Hogback	A ridge produced by highly tilted strata; a sharp crested ridge formed by a hard bed of rock that dips rather steeply downward.
Hung Valley	An elevated valley above the main drainage system which is separated by a sharp defile.
Hummock	A more or less elevated piece of ground rising out of a swamp, often densely wooded; a small elevation, a hillock.
Knoll	A rounded, convex knob-like area rising above adjacent land shapes. Knolls are most commonly associated with ridges and spurs.
Landflow	A mass of moisture-laden land moved down slopes by gravity flow. It is generally characterized by hummocky, irregular micro-relief, small marshy areas, indistinct and discontinuous small stream channels.
Land Slide	Slump or sag topography, which a hummocky rolling or other intricate micro-relief is formed by the accumulated mass of material moved gravitationally.
Loess Sheet	A deposit of loess (wind deposited silt size soil material) over the landscape.
Mesa	A flat-topped mountain or other elevation bounded on at least one side by a steep cliff; a plateau terminating on one or more sides in a steep cliff.
Mud Flow	Slow to very rapid movement of water saturated rock debris down definite channels.
Mountain	An elevation of the surface of the earth greater than a hill and rising high above the surrounding country. Any part of a land mass which projects conspicuously above its surroundings.
Peaks	Sharp, or rugged upward extensions of the ridge chain, usually at the branch junction of two or more ridges.
Pediment	Gently inclined planate erosion surfaces carved in bedrock and generally veneered with fluvial gravels. They occur between mountain and valley or basin bottoms, and commonly form extensive bedrock surfaces over which the erosion products from the retreating mountain fronts are transported to the basin.
Plain	A region of general uniform slope, comparatively level, of considerable extent, and not broken by marked elevations and depressions.

Plateau	A table land, or flat-topped region of considerable elevation and extent. A plateau is commonly higher than a mesa and usually more extensive. It may have an undulating surface and from it may raise mountains, or it may be dissected by the cutting off of canyon. If a large part of the original surface has been destroyed by streams, it is called a dissected plateau.
Playa	The shallow central part of a bolson, in which the water gathers after a rain and is evaporated.
Ravine	A gulch; a small gorge or canyon, the sides of which have comparatively uniform slopes. A depression worn out by running water, larger than a gully and smaller than a valley.
Ridge	The narrow, elongated crest of a hill or mountain; an elongated hill; a range of hills or mountains.
Rolling Upland Tableland	Massive, rolling topography with regular drainage patterns. Has a moderate total relief, with moderate expression of geologic erosion of folding.
Rubble Land	Areas with 90 percent or more of stones and boulders. It is the extreme of stony land, as rock outcrop is to rock land. Practically no soil is exposed.
Saddle	A low point on a ridge or crestline, generally a divide between the heads of streams flowing in opposite directions.
Sand Sheet or Drift	A sand area marked by an extremely flat surface and absence of any topographic relief other than small ripples.
Spur	These ridges are generally inverted “V”-shaped, plunging downward from the ridges or broad ridges, and generally lie considerably below the elevation of the associated ridge. A spur is a secondary divide between minor drainage systems of the area.
Steptoe	A granite hill projecting through the lava flows.
Swale	A low place; a slight depression in a region which is generally nearly level. These depressions are usually more moist than the adjacent higher land, and often the vegetation is more rank, due to the enrichment resulting from the washing down of the finer and richer part of the soils above.
Talus Slope	The sloping heap of loose fragments lying at the foot of a cliff or steep slope.
Terrace	A plain, natural or artificial, form which the surface descends on one side, and ascends on the other. The descent from river terraces toward the river may be very abrupt; the ascent on the other side may be only that of an extensive alluvial plain.
Toe Slope	An alluvial - colluvial deposit at the base of a steep slope.
Valley	Any hollow or low-lying land bounded by hills or mountain ranges and usually transverse by a stream or river which receives the drainage of the surrounding heights.
Valley Fill	Unconsolidated rock waste derived from erosion of the bordering mountains.

Vega	A broad bottom land adjacent to a stream bed.
Volcanic Sheet	A volcanic plateau with dome-like undulations.

(a)(2)(vi) Climatic Features

Climatic factors which affect the kinds and amounts of plants that grow on a site include temperature, frost free season, and the amount and distribution of rainfall.

(a)(2)(vii) Soil Moisture Regimes in Montana

Aquic

The aquic (L. aqua, water) moisture regime signifies a reducing regime in a soil that is virtually free of dissolved oxygen because it is saturated by ground water or by water of the capillary fringe. Some soils at times are saturated with water while dissolved oxygen is present, either because the water is moving or because the environment is unfavorable for micro-organisms (e.g., if the temperature is less than 1°C); such a regime is not considered aquic.

It is not known how long a soil must be saturated to have an aquic moisture regime, but the duration must be at least a few days, because it is implicit in the concept that dissolved oxygen is virtually absent. Because dissolved oxygen is removed from ground water by respiration of micro-organisms, roots, and soil fauna, it is also implicit in the concept that the soil temperature is above biologic zero (5°C) for some time while the soil is saturated.

Very commonly, the level of ground water fluctuates with the seasons; it is highest in the rainy season or in fall, winter, or spring if cold weather virtually stops evapo-transpiration. There are soils, however, in which the ground water is always at or very close to the surface. A tidal marsh and a closed, landlocked depression fed by perennial streams are examples. Such soils are considered to have a peraquic moisture regime.

The distinction between the aquic moisture regime and the peraquic moisture regime is not closely defined because neither regime is used as a criterion for taxa. These terms can, however, be used in descriptions of taxa. Some soils with an aquic moisture regime also have a xeric, ustic, or aridic (torric) moisture regime.

Aridic and torric (L. aridus, dry, and L. torridus, hot and dry)

These terms are used for the same moisture regime but in different categories of the taxonomy. In the aridic (torric) moisture regime, the moisture control section is, in six or more out of ten years,

1. Dry in all parts for more than half the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is above 5°C; and

2. Moist in some or all parts for less than 90 consecutive days when the soil temperature at a depth of 50 cm is above 8°C.

Soils that have an aridic or a torric moisture regime normally occur in arid climates. A few are in semi-arid climates and either have physical properties that keep them dry, such as a crusty surface that virtually precludes infiltration of water, or they are very shallow over bedrock. There is little or no leaching in these moisture regimes, and soluble salts accumulate in the soil if there is a source of them.

The limits set for soil temperature exclude from these moisture regimes the very cold and dry polar regions and high elevations. The data available on the soils of those regions are so fragmentary that no provision is made for their moisture regimes in this taxonomy.

Xeric

The xeric (Gr. *xeros*, dry) moisture regime is the typical moisture regime in areas of Mediterranean climates, where winters are moist and cool and summers are warm and dry. The moisture, which falls during the winter, when potential evapo-transpiration is at a minimum, is particularly effective for leaching. In areas of a xeric moisture regime, the soil moisture control section, in normal years, is dry in all parts for 45 or more consecutive days in the four months following the summer solstice and moist in all parts for 45 or more consecutive days in the four months following the winter solstice. Also, in normal years, the moisture control section is moist in some part for more than half of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is higher than 5^{o}C or for 90 or more consecutive days when the soil temperature at a depth of 50 cm is higher than 8^{o}C. The mean annual soil temperature is lower than 22^{o}C, and the mean summer and mean winter soil temperatures differ by 6^{o}C or more either at a depth of 50 cm from the soil surface or at a densic, lithic, or paralithic contact if shallower.

Ustic

The ustic (L. ustus, burnt, implying dryness) moisture regime is intermediate between the aridic and the udic regime. Its concept is one of moisture that is limited but is present at a time when conditions are suitable for plant growth. The concept of the ustic moisture regime is not applied to soils that have cryic or pergelic soil temperature regimes (defined below).

If the mean annual soil temperature is 22°C or higher or if the mean summer and winter soil temperatures differ by less than 5°C at a depth of 50 cm below the soil surface, the soil moisture control section in the ustic moisture regime, in six or more out of ten years, is dry in some or all parts for 90 or more cumulative days per year. But the moisture control section is moist in some part either for more than 180 cumulative days per year, or for 90 or more consecutive days.

If the mean annual soil temperature is lower than 22°C and if the mean summer and winter soil temperatures differ by 5°C or more at a depth of 50 cm from the soil surface, the soil moisture control section in the ustic regime is dry in some or all parts for 90 or more cumulative days per year in most years. But it is not dry in all parts for more than half the cumulative days when the soil temperature at a depth of 50 cm is higher than 5°C. If the moisture control section, is six or more out of ten years, is moist in all parts for 45 or more consecutive days in the four months following the winter solstice, the moisture control section is dry in all parts for less than 45 consecutive days in the four months following the summer solstice.

Udic

The udic (L. *udus*, humid) moisture regime is one in which the soil moisture control section is not dry in any part for as long as 90 cumulative days in normal years. If the mean annual soil temperature is lower than 22^{o}C and if the mean winter and mean summer soil temperatures at a depth of 50 cm from the soil surface differ by 6^{o}C or more, the soil moisture control section, in normal years, is dry in all parts for less than 45 consecutive days in the four months following the summer solstice. In addition, the udic moisture regime requires, except for short periods, a three-phase system, solid-liquid-gas, in part or all of the soil moisture control section when the soil temperature is above 5^{o}C.

The udic moisture regime is common to the soils of humid climates that have well distributed rainfall; have enough rain in summer so that the amount of stored moisture plus rainfall is approximately equal to, or exceeds, the amount of evapo-transpiration; or have adequate winter rains to recharge the soils and cool, foggy summers, as in coastal areas. Water moves downward through the soils at some time in normal years.

In climates where precipitation exceeds evapo-transpiration in all months of normal years, the moisture tension rarely reaches 100 kPa in the soil moisture control section, although there are occasional brief periods when some stored moisture is used. The water moves through the soil in all months when it is not frozen. Such an extremely wet moisture regime is called perudic (L. *per*, throughout in time, and L. *udus*, humid). In the names of most taxa, the formative element "ud" is used to indicate either a udic or a perudic regime; the formative element "per" is used in selected taxa.

(a)(2)(viii) Soil Temperature Regimes in Montana

Cryic (Gr. kryos, coldness; meaning very cold soils)

Soils in this temperature regime have a mean annual temperature lower than 8°C but do not have permafrost.

1. In mineral soils the mean summer soil temperature (June, July and August in Northern Hemisphere) either at a depth of 50 cm from the soil surface or at a densic, lithic, or paralithic contact, whichever is shallower, is as follows:
   a. If the soil is not saturated with water during some part of the summer and
      (1) If there is no O horizon: lower than 15°C; *or*
      (2) If there is an O horizon: lower than 8°C; *or*
   b. If the soil is saturated with water during some part of the summer and
      (1) There is no O horizon: lower than 13°C; *or*
      (2) If there is an O horizon or a histic epipedon: lower than 6°C.
2. In organic soils the mean annual soil temperature is lower than 6°C.

cryic soils that have an aquic moisture regime commonly are churned by frost. Iso-frigid soils could also have a cryic temperature regime. A few with organic materials in the upper part are exceptions.

Frigid

A soil with a frigid regime is warmer in summer than a soil with a cryic regime, but its mean annual temperature is lower than 8°C, and the difference between mean summer and mean winter soil temperatures (June-July-August and December-January-February) is more than 5°C either at a depth of 50 cm from the soil surface or at a densic, lithic, or paralithic contact, whichever is shallower.

(a)(2)(ix) Additional modifiers in the Soil Moisture and Temperature Regimes in Montana

Combining the terms "moist" and "dry" with the soil moisture regime, and the terms "warm", "cool" and "cold" with the soil temperature regimes was done colloquially in Montana to further differentiate the precipitation and/or temperature extremes found within a given MLRA. These modifiers are used to assist in the logical subdivisions of MLRAs into LRUs. Refer to the LRU tables below to see how these modifiers were used in each MLRA to determine the LRU breaks.

Examples: Ustic, moist and Frigid, cool (in the case of MLRA 43B, LRU E)
Udic, dry and Cryic, warm (in the case of MLRA 43B, LRU H).

(a)(2)(x) Associated Water Features

Describes stream and water body characteristics associated with the site. Use the Rosgen stream classification protocols where applicable. Use the Cowardin wetland classification protocols where applicable.

(a)(2)(xi) Soil Features

Soil properties significantly affect the plant-water-soil relationships that determine the kinds and amounts of plants that occur on a site. Soil properties can be divided into two main groups: physical properties and chemical properties.

Physical soil properties include parent material, soil texture, soil structure, soil depth, and amount of rock fragments on the soil surface and in the soil profile. These physical properties affect infiltration, available waterholding capacity, rooting depth, and fertility.

Physical soil properties that affect infiltration include soil surface texture and thickness, soil surface structure and thickness, shrink-swell capacity, surface soil crusting, and the amount and size of surface rock fragments. Physical properties that affect available waterholding capacity include soil texture, soil depth, shrink-swell capacity, and the amount and size of rock fragments in the soil profile. Physical properties that affect fertility include soil texture and parent material.

Chemical soil properties include salinity, sodicity and pH. The chemical properties affect infiltration, available waterholding capacity, nutrient availability and germination. Chemical soil properties that affect infiltration include soil surface salinity, soil surface sodicity, and surface soil hydro-phobicity. Chemical properties that affect available waterholding capacity include soil salinity, amount of volcanic ash, and the amount of gypsum or carbonates. Chemical properties that affect nutrient availability include soil pH. Chemical properties that affect germination include soil surface pH, soil surface salinity, and soil surface sodicity.

(a)(2)(xii) Physical Soil Properties and Terminology

Soil Textures and Abbreviations

Soil texture is determined by the percent of sand (.05 to 2.0 millimeters), silt (.05 to .002 millimeters), and clay (below .002 millimeters) after the particles larger than 2 millimeters have been removed.

COS	coarse sand	LVFS	loamy very fine sand	SI	silt
S	sand	COSL	coarse sandy loam	SCL	sandy clay loam
FS	fine sand	SL	sandy loam	CL	clay loam
VFS	very fine sand	FSL	fine sandy loam	SICL	silty clay loam
LCOS	loamy coarse sand	VFSL	very fine sandy loam	SC	sandy clay
LS	loam sand	L	loam	SIC	silty clay
LFS	loamy fine sand	SIL	silt loam	C	clay

Texture Modifiers and Abbreviations

BY	bouldery	CRV	very cherty	RB	rubbly
BYV	very bouldery	CRX	extremely cherty	SH	shaly
BYX	extremely bouldery	FL	flaggy	SHV	very shaly
CB	cobbly	FLV	very flaggy	SHX	extremely shaly
CBA	angular cobbly	FLX	extremely flaggy	SR	stratified
CBV	very cobbly	GR	gravelly	ST	stony
CBX	extremely cobbly	GRC	coarse gravelly	STV	very stony
CN	channery	GRF	fine gravelly	STX	extremely stony
CNV	very channery	GRV	very gravelly	SY	slaty
CNX	extremely channery	GRX	extremely gravelly	SYV	very slaty
CR	cherty	MK	mucky	SYX	extremely slaty
CRC	coarse cherty	PT	peaty		

Soil Textural Classes and Related Permeability Classes

Permeability is the rate at which saturated soil transmits water. Permeability classes shown in relation to texture below are only a general guide. Permeability varies with bulk densities, sodicity and weak cementation. Refer to the Montana Ksat Guide (dated 2/20/2006) for more information.

Texture	Textural Class	General	Permeability Class	Permeability (inches/hour)
coarse sand	coarse	sandy	very rapid	more than 20
sands, loamy sands	coarse	sandy	rapid	6.0 to 20
sandy loam, fine sandy loam	moderately coarse	loamy	moderately rapid	2.0 to 6.0
very fine sandy loam, loam, silt loam, silt	medium	loamy	moderate	0.6 to 2.0
clay loam, sandy clay loam, silty clay loam	moderately fine	loamy	moderately slow	0.2 to 0.6
sandy clay, silty clay, clay	fine	clayey	slow	0.06 to 0.2
clay pan - clay	fine	clayey	very slow	less than 0.06

Soil Drainage Classes

The following Drainage Classes are used on soils in Montana.

Drainage Class	Seasonal High Water Table Depth (feet)	Seasonal High Water Table Depth (inches)	Use and Management for Cropland	Land Capability Class	Notes
Very Poorly	+2.0-1.0	+24.0-12.0	Not suitable	5w	1
Poorly	1.0-2.0	12.0-24.0	Not suitable	5w	2
Somewhat Poorly	2.0-3.3	24.0-42.0	Suitable; some crops affected by wetness	3w 4w	3
Moderately well	3.3-5.9	42.0-72.0	Suitable; no wetness problem unless flooded	No limitation	3

Notes: (continued from Page MT3.1-19(13) table):
1. Wetness generally prohibits hay harvesting. Fair rangeland.
2. Excellent grass hay, pasture, and rangeland. Hay harvesting may be a problem in some years. Wetness prohibitive for alfalfa.
3. Wetness may be restrictive for alfalfa.
4. For NASIS data entry, enter water table observations to 183 cm.

Reference: Developed in cooperation with Soil Scientists from Montana, Nebraska, North Dakota, South Dakota, Iowa, and Minnesota (6-15-1995).

Soil Depth Classes

Deep	Moderately Deep	Shallow	Very Shallow
More than 40 inches	20 - 40 inches	10 - 20 inches	Less than 10 inches

Soil Loss Tolerance (T)

The soil loss tolerance represents the permissible tons of soil loss per acre per year that will permit a high level of productivity to be sustained economically and indefinitely. The following are used on rangeland and forestland.

Rooting Depth	Soil Loss Tolerance (T) Value
0 to 20 inches	1
20 to 40 inches	2
40 to 60 inches	3
greater than 60 inches	5

Shrink - Swell Behavior

Shrink – Swell behavior is that quality of the soil that determines its volume change with change in moisture content. The volume-change behavior of soils is influenced by the amount of moisture change, and the amount and kind of clay in the soil. Three degrees of limitation are recognized; low, moderate and high.

Low	Moderate	High
• 0-18 percent any clay mineral or 0-35 percent kaolinite clays • Coefficient of linear extensibility less than 0.03 • Linear extensibility less than 3	• 18-35 percent mixed or montmorillonitic clays, or more than 35 percent kaolinitic clays • Coefficient of linear extensibility 0.03 to 0.06 Linear extensibility 3 to 6	• Greater than 18 percent mixed or montmorillonitic clays • Coefficient of linear extensibility greater than 0.06 • Linear extensibility more than 6

Available Waterholding Capacity Classes

Available Waterholding Capacity (AWC) is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity (15 atmospheres), and the amount remaining in the soil at the wilting point of most crop plants (1/3 atmospheres for soils finer than loamy fine sand, and 1/10 atmospheres for loamy fine sands and coarser soils).

AWC Class	Inches of available water in a 60 inch soil profile or to a limiting layer
very low	less than 3.5 inches
low	3.5 to 5.0 inches
moderate	5.0 to 7.5 inches
high	greater than 7.5 inches

Available Waterholding Capacity by Texture and Percent Coarse Fragments

Numbers shown in the table below are inches of water available per inch of soil depth based on the soil texture and amount of coarse fragments in the soil.

	Percent Coarse Fragments by Volume														
Soil Texture	**0**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**
clay	.14-.16	.12-.14	.12-.14	.11-.13	.11-.12	.10-.11	.09-.10	.08-.10	.08-.09	.07-.08	.06-.07	.05-.06	.05-.06	.04-.05	.03-.04
silty clay	.15-.17	.13-.15	.13-.14	.12-.14	.11-.13	.10-.12	.10-.11	.09-.10	.08-.09	.07-.09	.07-.08	.06-.07	.05-.06	.04-.05	.04
sandy clay	.15-.17	.13-.15	.13-.14	.12-.14	.11-.13	.10-.12	.10-.11	.09-.10	.08-.09	.07-.09	.07-.08	.06-.07	.05-.06	.04-.05	.04
silty clay loam	.19-.21	.17-.19	.16-.18	.15-.17	.14-.16	.13-.15	.12-.14	.11-.13	.10-.12	.09-.11	.08-.09	.07-.08	.06-.07	.06	.05
clay loam	.19-.21	.17-.19	.16-.18	.15-.17	.14-.16	.13-.15	.12-.14	.11-.13	.10-.12	.09-.11	.08-.09	.07-.08	.06-.07	.06	.05
sandy clay loam	.14-.16	.12-.14	.12-.14	.11-.13	.11-.12	.10-.11	.09-.10	.08-.10	.08-.09	.07-.08	.06-.07	.05-.06	.05-.06	.04-.05	.03-.04
silt loam	.19-.21	.17-.19	.16-.18	.15-.17	.14-.16	.13-.15	.12-.14	.11-.13	.10-.12	.09-.11	.08-.09	.07-.08	.06-.07	.06	.05
loam	.16-.18	.14-.16	.14-.15	.13-.14	.12-.14	.11-.13	.10-.12	.10-.11	.09-.10	.08-.09	.07-.08	.05-.07	.05-.06	.05	.04-.05
very fine sandy loam	.15-.17	.13-.15	.13-.14	.12-.14	.11-.13	.10-.12	.10-.11	.09-.10	.08-.09	.07-.09	.07-.08	.06-.07	.05-.06	.04-.05	.04
fine sandy loam	.13-.15	.12-.14	.11-.13	.10-.12	.10-.11	.09-.11	.08-.10	.08-.09	.07-.08	.06-.08	.06-.07	.05-.06	.04-.05	.04-.05	.03-.04
sandy loam	.11-.13	.10-.12	.09-.11	.09-.10	.08-.10	.07-.09	.07-.08	.07-.08	.06-.07	.05-.07	.05-.06	.04-.05	.04-.05	.03-.04	.03
loamy very fine sand	.10-.12	.09-.11	.08-.10	.08-.10	.08-.09	.07-.08	.06-.08	.06-.07	.05-.07	.05-.06	.04-.05	.04-.05	.03-.04	.03-.04	.02-.03
loamy fine sand	.09-.11	.08-.10	.08-.09	.07-.09	.07-.08	.06-.07	.06-.07	.05-.07	.05-.06	.04-.06	.04-.05	.03-.04	.03-.04	.03	.02-.03
loamy sand	.06-.08	.05-.07	.05-.07	.05-.06	.05-.06	.04-.06	.04-.05	.04-.05	.03-.04	.03-.04	.03-.04	.02-.03	.02-.03	.02	.01-.02
fine sand	.05-.07	.04-.06	.04-.06	.04-.06	.04-.05	.03-.05	.03-.05	.03-.04	.03-.04	.03-.04	.02-.03	.02-.03	.02-.03	.01-.02	.01-.02

Plant Available Water Capacities for Soil Textural Classes in Montana

The following table was approved by Soils Committee, MSU, Plant and Soil Science Planning Conference, 01/31/1984.

	Texture	**Soil Textural Class**	**Estimated Average Plant AWC (in/ft)**[2]	**Range in Estimated Plant AWC (in/in)** (For use on Soil Interpretation Records)[3]
Sandy Soils	Coarse	Sands	0.5	0.02-0.06
		Loamy sands	1.0	0.06-0.10
		Loamy fine sands	1.25	0.08-0.12
		Loamy v. fine sands	1.25	0.08-0.12
		Fine sands	1.25	0.08-0.12
		Very fine sands	1.25	0.08-0.12
Loamy Soils	Moderate coarse	Sandy loam	1.5	0.11-0.15
		Fine sandy loam	1.5	0.11-0.15
	Medium	v. fine sandy loam	2.0	0.15-0.19
		Loam	2.0	0.15-0.19
		Silt loam	2.0	0.15-0.19
		Silt	2.0	0.15-0.19
	Moderately fine	Clay loam	2.2	0.16-0.20
		Sandy Clay Loam	2.2	0.16-0.20
		Silty clay loam	2.2	0.16-0.20
Clayey soils	Fine	Sandy clay	2.0	0.15-0.19
		Silty clay	2.0	0.15-0.19
		Clay	2.0	0.15-0.19

1. Soluble salts and gravel will decrease plant available water capacity; whereas, organic matter and good soil structure will increase it. The capacity increases about 0.1 in./ft. for each one percent organic matter. Soils with water-restricting layers like compact subsoil, shallow bedrock or stratification can increase PAWC of the overlying layers. Soils that are deep, medium-textured and uniform can have decreased PAW but allow for deeper rooting.

2. Soil depth measured to depth of crop rooting or depth to a root-limiting layer.

3. For the loamy and clayey soils, the range in plant AWC is 10 to 15 percent on each side of the median AWC figure. For sandy soils, (other than ‘sands’) the range is 20 to 25 percent. For ‘sands’ the PAWC is extremely variable and depends upon the size of the individual sand grains, i.e., medium sands hold more water than coarse sands.

Slope Classes

The use of discrete slope classes (e.g., 8-15 percent, 15-30 percent, etc.,) is no longer a strict requirement in soil survey procedures or development of ecological site concepts. For soil survey purposes in Montana, slopes are observed, ranges set and then classed into groups (e.g., A, B, C, etc.,) rather than utilizing pre-existing discrete slope classes. The slope group assignments portray the actual range of slopes for a given soil component within the context of its map unit design as they occur on the landscape. Rather than thinking of slopes merely in terms of a numerical range, a more appropriate use of slope is to consider the *surface morphometry* of the site.

Surface morphometry considers how elevation, slope aspect, slope gradient, slope complexity, slope shape, hillslope position, geomorphic position, micro-relief and drainage pattern influence a given site. Surface morphometry affects hydrology, soil formation factors, use and management, etc., of the site. As surface morphometry differs from location to location, ecological sites may be differentiated across the landscape. Refer back to the section on Criteria for Differentiating Ecological Sites for additional information.

Stoniness Classes

The size of coarse fragments on the soil surface, and the distance between those fragments, can greatly affect the kinds, amounts and/or proportions of plants on the site. The Stoniness Classes below were developed for use by Montana soil scientists. This chart, combined with pace-frequency transects to determine the percent of the ground covered by coarse fragments, should be used to help determine the ecological site.

Avg Rock Size	**Average Distance (feet)**																		
(Inch)	**2**	**3**	**4**	**5**	**7**	**10**	**15**	**20**	**30**	**40**	**50**	**70**	**100**	**150**	**200**	**300**	**500**	**700**	**1000**
10	17.36	7.72	4.34	2.78	1.42	0.69	0.31	0.17	0.08	0.04	0.03	0.01	0.007	0.003	0.002	0.001	0.000	***	***
12	25.00	11.11	6.25	4.00	2.04	1.00	0.44	0.25	0.11	0.06	0.04	0.02	0.010	0.004	0.003	0.001	0.000	***	***
15	39.06	17.36	9.77	6.25	3.19	1.56	0.69	0.39	0.17	0.10	0.06	0.03	0.016	0.007	0.004	0.002	0.001	0.000	***
18	56.25	25.00	14.06	9.00	4.59	2.25	1.00	0.56	0.25	0.14	0.09	0.05	0.023	0.010	0.006	0.003	0.001	0.000	***
24	100.00	44.44	25.00	16.00	8.16	4.00	1.78	1.00	0.44	0.25	0.16	0.08	0.040	0.018	0.010	0.004	0.002	0.001	0.000
30	***	69.44	39.06	25.00	12.76	6.25	2.78	1.56	0.69	0.39	0.25	0.13	0.063	0.028	0.016	0.007	0.003	0.001	0.000
36	***	100.00	56.25	36.00	18.37	9.00	4.00	2.25	1.00	0.56	0.36	0.18	0.090	0.040	0.023	0.010	0.004	0.002	0.000
48	***	***	100.00	64.00	32.65	16.00	7.11	4.00	1.78	1.00	0.64	0.33	0.160	0.071	0.040	0.018	0.006	0.003	0.000
60	***	***	***	100.00	51.02	25.00	11.11	6.25	2.78	1.56	1.00	0.51	0.250	0.111	0.063	0.028	0.010	0.005	0.000
72	***	***	***	***	73.47	36.00	16.00	9.00	4.00	2.25	1.44	0.73	0.360	0.160	0.090	0.040	0.014	0.007	0.000
84	***	***	***	***	100.00	49.00	21.78	12.25	5.44	3.06	1.96	1.00	0.490	0.218	0.123	0.054	0.020	0.010	0.000
96	***	***	***	***	***	64.00	28.44	16.00	7.11	4.00	2.56	1.31	0.640	0.284	0.160	0.071	0.026	0.013	0.000
120	***	***	***	***	***	100.00	44.44	25.00	11.11	6.25	4.00	2.04	1.000	0.444	0.250	0.111	0.040	0.020	0.000

Note:
Average rock size in this chart is based on an equivalent square dimension for the average size of surface stones and boulders at the site.
Average distance between surface stones or boulders is measured from center to center.

Extremely stony or extremely bouldery
Very stony or very bouldery
Stony or bouldery

(a)(2)(xiii) Chemical Soil Properties and Terminology

Soil Reaction

Soil reaction is the degree of acidity of alkalinity of a soil, expressed in pH values. The pH values and terms used to describe soil reaction are as follows.

Term	pH Value
extremely acid	less than 4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
moderately alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	more than 9.0

Salinity

Term	ECe x 10^3 mmhos/liter
non-saline	0 - 4
slightly saline	4 - 8
moderately saline	8 - 16
strongly saline	more than 16

Sodicity

The Sodium Adsorption Ratio (SAR) is the standard measure of the sodicity of a soil. The SAR is calculated from the concentrations (in milliequivalents per liter) of sodium, calcium, and magnesium in the saturation extract:

$$SAR = \frac{Na^{+}}{[(Ca^{++} + Mg^{++})/2]^{-2}}$$

Sodium is toxic to some crops, and sodium affects the soil's physical properties, mainly saturated hydraulic conductivity. A sodic condition has little effect on hydraulic conductivity in highly saline soils. A soil that is both saline and sodic may, when artificially drained, drain freely at first. After some of the salt has been removed, however, further leaching of salt becomes difficult or impossible. The SAR usually decreases as a soil is leached, but the amount of change depends in part on the composition of the water used for leaching and, therefore, cannot be predicted with certainty.

(a)(2)(ivx) Plant Community Descriptions and Dynamics

At a minimum, every ecological site description will qualitatively and quantitatively describe at least one of the plant communities that are represented in the Reference Plant Community identified for the ecological site. The community described may or may not be the historic climax plant community

(HCPC). The HCPC is the plant community believed to be in dynamic equilibrium on the site, and is thought to have occurred prior to European settlement. This community can rarely be found in meaningful quantities or geographic location/extent, and therefore becomes more of an interpretive community, rather than a quantifiable community.

State and Transition Models (STMs)

Every ESD will include a State and Transition Model (STM). Refer to NRCS policy on development of these models, found in the National Range and Pasture Handbook and in the following published articles: ftp://ftp-fc.sc.egov.usda.gov/GLTI/technical/publications/spec-report-1024.pdf and ftp://ftp-fc.sc.egov.usda.gov/MT/www/technical/range/publications/JRM-State_Transition_Stringham.pdf. Additional ESD development guidance can be obtained at the USDA-ARS Jornada experimental range web site http://usda-ars.nmsu.edu/esd.html

Guidance in the development of the STM for an ecological site was also developed by Dr. Brandon Bestelmeyer, USDA-ARS (modified by Loretta Metz, USDA-NRCS), and is as follows:

Catalog of States and Transitions for STMs

States and communities within states are described in detail, as well as easily-reversible changes among communities due to climate or land use (i.e., retrogression). Note that within states, ecological condition/health scores and similarity indices may be used. Distinction of states must be based on 1) large differences in ecosystem functioning involving both plant functional groups and biotic or abiotic processes, and 2) differences that are relevant to land management.

Provide descriptive name for each state and discuss the following items for each plant community phase within each state:

- Historic communit(ies) and soil series basis of variation within state.
- Typical vegetation (detailed), vegetation structure (e.g., bare patch/grass patch size, grass stature) and soil properties (soil fertility, soil permeability, soil stability, erosion rates, etc.).
- Changes in vegetation, cover and structure, and soil properties due to retrogression, how this might vary on different soils within ecological sites.
- In some cases (e.g., shrub-invaded states), states can only be maintained through accelerating practices (e.g., shrub removal).
- Diagnosis: Describe typical range of quantitative indicators (Herrick, et al. 2002) to identify a state. Continuous variables must be complementary; one should be able to write a dichotomous key based on the presentation (e.g., blue grama basal cover is > 25 percent; there is evidence of sideoats grama reproduction by seed production; the proportion of canopy gaps greater than 100 cm does not exceed 0.05; mean soil stability values range from 4-6; clubmoss is absent). Some indicators (i.e., grass reproduction) will be difficult to assess but nonetheless describe important distinctions.
- Transitions from state: Describes one or several presumed or possible causes for one or more transitions, referring to theoretical frameworks developed in detail in *Information sources and theoretical background*.
  a) Identify transition (e.g., *Transition to Shrub-invaded state*). There may be several.

b) What are possible causes of transitions (e.g., climate change or drought periods, changes to hydrology by roads or dams, soil degradation due to loss of soil fertility, compaction, or erosional soil loss, shrub/tree encroachment due to reduction of fire frequency and disturbance to grasses, extinction of seed pools). Note that this list of causes tends to repeat in many ecological sites. Discuss chains of causation using multiple causes (overgrazing leads to increased bare patch size and reduced fuel loads both of which favor shrub establishment) and multiple pathways to the same transition (e.g., interrupted surface flow of water and drought have similar effects). Note that transitions indicate changes in site characteristics (erosion rates, loss of key species) and/or changes in management needs (shrub invasion even when erosion rates do not change much initially). See Bestelmeyer, et al (in review).

c) Key indicators of threshold: Identifies qualitative, and eventually quantitative, indicators that can be monitored and should be emphasized in rangeland health assessment (with reference to an ecological reference area or “ideal”) to warn of an impending transition once the state has been identified, ranked in order of importance (e.g., increases in bare ground, decreases in litter amount, increased frequency of green needlegrass decadence, etc.).

d) Preventative and reversing practices: Preventative practices are used within the reference state to prevent the transition (e.g., grazing management) and reversing practices are used after the transition has occurred (e.g., shrub removal, restoration of soil fertility). In many cases, reversing practices are not possible. In other cases (e.g., shrub removal), intensive management does not take you back into the previous state (even though it may look identical), it simply causes retrogression from a new, shrub-dominated climax. As long as shrubs are in the system, a lack of shrub removal may eventually lead to a transition to a soil-degraded state where shrub removal cannot even temporarily restore grass.

Information Sources and Theoretical Background for STMs

Primary references and sources on the dynamics of an ecological site. Most sites have not received scientific attention, so the source of authoritative observations and speculations should be noted. Area Rangeland Management Specialists, Area Resource Soil Scientists and other experienced professionals are reliable reference sources.

Develop a theoretical framework for understanding dynamics, framed as propositions that can be tested. This is usually based on published ideas, whether or not they directly involve consideration of the ecological site in question. This summarizes what we know and do not know about the causes and patterns of vegetation and soil dynamics within a site or related sites. The hypotheses implicitly suggest ways of testing these ideas, and management prescriptions should be considered tests of these hypotheses. Understanding the causes of transitions is crucial to applying appropriate management, efficiently utilizing the scarce financial resources of agencies, and fairly attributing unfavorable changes in rangelands to people or nature, or both.

(a)(3) Site Data Collection, Documentation and Correlation Requirements

Every ecological site description in Montana will be supported by field data collected from the ecological site type locations. Each type location will be located using UTM coordinates within the NAD 83 datum. Data collected will be entered into the Rangeland Database (http://usda-ars.nmsu.edu/JER/Monit_Assess/rangedb_main.php). *To obtain the most current Montana copy of this database, contact the Montana NRCS State Rangeland Management Specialist.*

Select at least three (3) field locations that are typical for the ecological site concept. These "type locations" for the ecological site are reference locations that illustrate the central concept for the ecological site being described. Type locations for each ecological site should be well distributed geographically throughout the LRU in which the specific ecological site is being proposed and described.

The ecological site proposed should be a minimum of 2,000 acres in size. The reference plant community being described at the type location will be at least five acres in size. Each ecological site type location will have a completed soil profile description record (NRCS-232 or similar) that adequately describes the soil physical and chemical properties of each location. The minimal data set collected at each type location includes landscape and plot photographs, plant community composition and weight (by species and total for the site), ground cover, soil stability, and completed rangeland health evaluation for each of the 17 indicators. Additional data collected can include gap-intercept, vertical structure, multiple canopy layers, etc. For the additional data collection parameters, follow the instructions found in *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems.* Volume I and II, 2005. USDA ARS, Jornada Experimental Range.

(a)(3)(i) Protocols to follow for data collection include:

1) Production and Species Composition by Dry Weight
   a) **double sampling**, described in Chapter 4, NRPH), ***OR***
   b) **dry weight rank**, described in Ruyle, G.B. *Some Methods for Monitoring Rangelands and other Natural Area Vegetation.* 1997. University of Arizona Cooperative Extension Report 9043, and; *Sampling Vegetation Attribute.* 1999. Interagency Technical Reference BLM 1734-4;

2) Soil stability – Using the soil stability test kit methodology, described in *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems.* Volume I and II, 2005. USDA ARS, Jornada Experimental Range;

3) Ground cover – using the **line-intercept method**, described in *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems.* Volume I and II, 2005. USDA ARS, Jornada Experimental Range;

4) Digital photos – landscape and ground (plot) photos will be taken. They will be high resolution (at least two mega-pixels), and the camera will be at the normal settings (no zoom, no flash). Landscape photos should be taken at a five-foot height above the ground. All photos taken will include a "photo board" in the picture. Follow the procedures in the *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems.* Volume I and II, 2005. USDA ARS, Jornada Experimental Range. Photos for multiple plant communities or states should be taken, where available, to document the STM and ESD;

5) Rangeland health – All indicators should be described quantitatively and qualitatively, using information collected at each type location. This site-specific data will be aggregated to develop the final Rangeland Health Reference Area Worksheet for the proposed ecological site.

6) Field data entry – All field data collected will be entered into Rangeland Monitoring Database (http://usda-ars.nmsu.edu/JER/Monit_Assess/rangedb_main.php). *To obtain the most current Montana copy of this database, contact the Montana NRCS State Rangeland Management Specialist.*

Each soil map unit component will be correlated to one ecological site. One ecological site may be correlated to multiple soil components. For guidance on correlating ecological sites to soils, refer to the National Range and Pasture Handbook, Chapter 3, the National Forestry Handbook, and the National Soil Survey Handbook, Part 622.07 (http://soils.usda.gov/technical/handbook/contents/part622.html#07).

As soil scientists conduct field work, it is recommended that they complete the Soil Survey Vegetative Field Worksheet, MT-ECS-6 (see Chapter 3, Section 1, *Exhibits*) at each location where they fully describe a soil profile. The original forms will be filed with the soil survey data, and copies given to the State Rangeland Management Specialist and the Rangeland Management Specialist assigned to the soil survey. The form will also be entered into the rangeland database and sent to the state office. When using the form, the soil scientist will key the site to the appropriate ecological site, regardless if the site is currently developed for the MLRA-LRU.

(a)(4) MLRAs and LRUs in Montana

MLRAs and the associated LRUs are the basic units for delineating statewide patterns of soils, climate, water resources, and land use.[5] Elevation, topography, and rainfall (effective amount, timing, kind and distribution) have been the primary factors used to delineate these LRUs in Montana, because of their affect on potential native plant communities, land uses, and water resources.

It is important to note that LRU determinations cannot and should not be made by solely evaluating the plant community present on the site at the time of inventory. The LRU determination must be made only after evaluating the soil moisture and soil temperature regimes, the amount of effective precipitation the site receives on a climatological basis (not annual weather fluctuations), the timing of precipitation (ratio and distribution of spring, summer, fall and winter precipitation), the kind of precipitation (rainfall or snow), and the length of the active plant growing season. All of these factors are evaluated apart from the plant community on the site to determine the LRU that the ecological site is within. *The plant community is an expression of these soil and climate influences (at the LRU level), in addition to other factors that are considered at either the MLRA level (e.g., geology) or at the site level (e.g., soil chemistry, depth, landscape position, etc).*

For additional information and descriptions, refer to Montana Field Office Technical Guide, Section II, the Agricultural Handbook 296 (http://soils.usda.gov/survey/geography/mlra/), and the National Soil Survey Handbook, Part 649.05 (http://soils.usda.gov/technical/handbook/contents/part649.html#ex1).

The following MLRAs and LRUs have been delineated for use in Montana. Note that LRU Y accounts for all the ecological sites that occur anywhere throughout the entire MLRA, only if the plant communities at climax (or in the reference plant community) do not change significantly across the latitude, longitude, elevation and climate variations within the MLRA. So LRU Y is the catch-all LRU for sites that don't change significantly from one LRU to another within the same MLRA. **These LRU designations replace all previously existing references to "rangeland resource units" that were used in Montana prior to the year 2005.** For MLRAs that are administered by other states (MLRAs 32, 54, 58B, 58C, 58D and 60A), refer to the ecological site descriptions developed by the lead state.

MLRA 32 – Northern Intermountain Desertic Basins

(The State of Wyoming develops these criteria and ESDs in conjunction with Montana)

*Refer to the Wyoming NRCS eFOTG, Section II, Ecological Site Descriptions, **5-9 Big Horn**.*

Soil Moisture Regimes	Aridic
Soil Temperature Regimes	Mesic
Typical Annual Rainfall Range	5 to 9 inches
Winter:Summer Rainfall Ratio	50:50. Winter precipitation is in the form of snow. Spring, summer and fall precipitation is rain. The normal precipitation pattern shows a peak in May and June, and a secondary peak in September.
Elevation Range	3,700 to 6,000 feet
Major Vegetation	Big sagebrush, Gardner saltbush, rhizomatous wheatgrasses, Indian ricegrass, needleandthread, bluebunch wheatgrass, black sage.

MLRA 43A – Northern Rocky Mountains

Soil Moisture Regimes	Xeric, Ustic, Udic
Soil Temperature Regimes	Frigid (50 percent), Cryic (50 percent)
Dominant Geological Resources	Argillite, quartzite with alpine and Cordilleran (coalescence of valley and mountain) glaciation; volcanic ash influence (Mazama ash). Below 4,200 feet, Glacial Lake Missoula influences (deposits, with over-steepened landscapes due to slumping).
Typical Annual Rainfall Range	13 – 100+ inches. In the Frigid temperature regime, the RV (representative value) of mean annual precipitation is 25 inches. In the Cryic temperature regime, the RV of mean annual precipitation is 40 inches.
Precipitation Timing	25 to 40 percent of the total precipitation falls during the growing season. There is a strong maritime climate influence.
Frost-free Days	10 to 110 days per year are above 32^{o} F.
Elevation Range	1,800 to 10,100 feet. Typically, NRCS works on elevations below 4,000 feet in this MLRA.
Major Vegetation	Approximately 95 percent of the lands in this MLRA are forested, leaving 5 percent as grasslands. Typical over-story vegetation includes grand fir, Douglas-fir, western red cedar, western hemlock, western larch, lodgepole pine, subalpine fir, ponderosa pine, whitebark pine.

LRUs within MLRA 43A:

Notes: RV PPT for LRU designations refers to the Representative Value for the range of effective precipitation (inches).
RV FFD for the LRU designations refers to the Representative Value for the range of Frost-free Days (>32^{o}F) annually.

LRUs - 43A	MLRA	Moisture phase	Temperature Phase	Cover	RV PPT (inches)	RV FFD (days)
A	43A	Xeric	frigid	rangeland	13-17	90-110
A	43A	Ustic	frigid	rangeland	13-17	90-110
B	43A	Xeric	frigid, cool	rangeland	17-20	70-90
C	43A	Ustic	frigid	forest	16-20	90-105
C	43A	Xeric, moist	frigid	forest	16-20	90-105
D	43A	Ustic, moist	frigid	forest	19-24	70-100
E	43A	Udic dry	frigid	forest	24-30	70-90
F	43A	Udic	frigid	forest	30-45	70-90
G	43A	Udic	cryic	forest	30-45	30-50
H	43A	Udic dry	cryic, warm	forest	24-30	50-70
I	43A	Udic, Moist	cryic,warm	forest	45-100	50-70
J	43A	Udic, Moist	cryic, cool	forest	45-100	15-30
K	43A	Udic, Moist	cryic, cold (above tree line)	alpine	45-100	<15
Y	43A	any	any	any	13-100	<15-110

MLRA 43B – Central Rocky Mountains

Soil Moisture Regimes	Ustic, Udic
Soil Temperature Regimes	Frigid (40 percent), Cryic (60 percent)
Dominant Geological Resources	Limestone, granitics, argillite, quartzite, volcanics, tuffs, sedimentary rocks, alpine glaciation.
Typical Annual Rainfall Range	12 – 80 inches. Core concept is 26 inches (may not be very meaningful due to high variability).
Precipitation Timing	Approximately 45 percent of the total precipitation falls during the growing season (May, June, and July). The climate influence is continental, not maritime.
Frost-free Days	15 to 105 days per year are above 32^{o} F.
Elevation Range	3,800 to 10,000 feet.
Major Vegetation	Many of the lands in this MLRA are forested, but there is also a significant extent of grasslands and grassland/shrubland mixes. Typical vegetation includes ponderosa pine, Douglas-fir, subalpine fir, bluebunch wheatgrass, needlegrasses, Idaho and rough fescues, several sagebrush species, rabbitbrush, other shrubs and forbs.

LRUs within MLRA 43B:

<u>Notes</u>: RV PPT for LRU designations refers to the Representative Value for the range of effective precipitation (inches).
RV FFD for the LRU designations refers to the Representative Value for the range of Frost-free Days (>32^{o}F) annually.

LRUs - 43B	**MLRA**	**Moisture phase**	**Temperature Phase**	**Cover**	**RV PPT** (inches)	**RV FFD** (days)
A	43B	Ustic, dry	frigid, cool	rangeland	9-14	70-100
B	43B	Ustic	frigid	forest	14-19	90-110
C	43B	Ustic	frigid, cool	rangeland	14-19	70-90
C	43B	Ustic	frigid,cool	forest	14-19	70-90
D	43B	Ustic	cryic, warm	rangeland	14-19	50-70
D	43B	Ustic	cryic, warm	forest	14-19	50-70
E	43B	Ustic, moist	frigid, cool	rangeland	19-22	70-90
E	43B	Ustic, moist	cryic, warm	rangeland	19-22	50-70
E	43B	Ustic, moist	frigid,cool	forest	19-24	70-90
E	43B	Ustic, moist	cryic, warm	forest	19-24	50-70
F	43B	Ustic, moist	cryic	rangeland	19-22	30-50
G	43B	Udic dry	frigid,cool	forest	24-30	70-90
H	43B	Udic dry	cryic, warm	forest	24-30	50-70
H	43B	Udic,dry	cryic	forest	24-30	30-50
I	43B	Udic	cryic	forest	30-40	30-50
J	43B	Udic, Moist	cryic, cool	forest	40-60	15-30
K	43B	Udic, Moist	cryic, cold (above tree line)	alpine	40-80	<15
Y	43B	any	any	any	12-80	<15-110

MLRA 44A – Northern Rocky Mountain Valleys

Soil Moisture Regimes	Xeric, Ustic
Soil Temperature Regimes	Frigid
Dominant Geological Resources	Glacial Lake Missoula sediments over Tertiary valley fill and other sediments (glacial outwash, recent alluvium) parent materials.
Typical Annual Rainfall Range	12 to 16 inches is the average annual precipitation amount. Total precipitation can range from 9 to 44 inches.
Precipitation Timing	Less than 33 percent comes in growing season. Maritime climate.
Frost-free Days	90-120 days per year (average) are above 32^{o} F. It ranges from 50 to 185 days in much of the area.
Elevation Range	1,750 to 4,200 feet.
Major Vegetation	Bluebunch wheatgrass, rough fescue, Idaho fescue, Douglas-fir, ponderosa pine, grand fir, western red cedar, western hemlock, pinegrass, common snowberry, mallow ninebark, and white spirea.

LRUs within MLRA 44A:

<u>Notes</u>: *RV PPT for LRU designations refers to the Representative Value for the range of effective precipitation (inches).*
RV FFD for the LRU designations refers to the Representative Value for the range of Frost-free Days (>32^{o}F) annually.

LRUs - 44A	**MLRA**	**Moisture phase**	**Temperature Phase**	**Cover**	**RV PPT** (inches)	**RV FFD** (days)
A	44A	Ustic, dry	frigid, warm	rangeland	10-14	105-120
A	44A	Xeric, dry	frigid, warm	rangeland	10-14	105-120
B	44A	Ustic	frigid	rangeland	14-19	70-120
B	44A	Xeric	frigid	rangeland	14-19	70-120
C	44A	Ustic	frigid	forest	16-20	90-105
C	44A	Xeric, moist	frigid	forest	16-20	90-105
D	44A	Ustic, moist	frigid	forest	19-24	90-105
E	44A	Udic dry	frigid	forest	24-30	90-105
F	44A	Udic	frigid	forest	30-45	90-105
Y	44A	any	any	any	10-45	70-120

MLRA 44B – Central Rocky Mountain Valleys

Soil Moisture Regimes	Ustic
Soil Temperature Regimes	Frigid (70 percent) and Cryic (30 percent)
Dominant Geological Resources	Tertiary valley fill and recent alluvium (+ miscellaneous glacial outwash) parent material. Park county has consolidated Tertiary deposits (sedimentary rock versus sedimentary fill materials).
Typical Annual Rainfall Range	12 to 16 inches is the average annual precipitation amount. Total precipitation can range from 9 to 44 inches.
Precipitation Timing	50-60 percent comes in growing season.
Frost-free Days	16-120 days per year are above 32^{o} F. More typical range is 70-120 days. Wisdom, Montana is the coldest at 16 days.
Elevation Range	3,800 to 6,800 feet. Core concept is 5,400 feet.
Major Vegetation	Bluebunch wheatgrass, rough fescue, Idaho fescue, and scattered ponderosa pine in isolated areas.

LRUs within MLRA 44B:

Notes: RV PPT for LRU designations refers to the Representative Value for the range of effective precipitation (inches).
RV FFD for the LRU designations refers to the Representative Value for the range of Frost-free Days (>32^{o}F) annually.

LRU-44B	**MLRA**	**Moisture phase**	**Temperature Phase**	**Cover**	**RV PPT** (inches)	**RV FFD** (days)
A	44B	Ustic, dry	frigid, cool	rangeland	9-14	70-90
A	44B	Ustic, dry	frigid	rangeland	9-14	90-105
A	44B	Ustic, dry	frigid	rangeland	10-14	90-110
A	44B	Ustic, dry	frigid, cool	rangeland	10-14	70-90
B	44B	Ustic	frigid	rangeland	14-19	80-110
C	44B	Ustic	frigid, cool	rangeland	14-19	70-105
D	44B	Ustic	cryic, warm	rangeland	14-19	50-70
D	44B	Ustic	cryic	rangeland	14-19	<50
E	44B	Ustic, moist	frigid	rangeland	19-22	80-100
Y	44B	any	any	any	10-22	<50-110

MLRA 46 – Northern Rocky Mountain Foothills

Soil Moisture Regimes	Ustic
Soil Temperature Regimes	Frigid (95 percent) and Cryic (5 percent).
Dominant Geological Resources	Materials that have eroded from the mountains toward the prairies (till plain; sedimentary plains). Parent materials include outwash, piedmont till (formed in alpine setting and moves outside of the mountain ranges and spreads into large fan), old alluvial pediments, sedimentary hills, associated local alluvium (along drainage/river channels). MLRA 46 starts along continental terminal moraines. Ice-marginal lakes are not part of MLRA 46. Metamorphic, limestone, and igneous deposits are common.
Typical Annual Rainfall Range	11-22 inches. Core concept is 16 inches. Wind is a dominating natural occurrence in MLRA 46 and needs to be accounted for in the LRU concepts. The Precipitation RV ranges in the LRUs account for the wind factors (higher potential evapo-transpiration (PET)).
Precipitation Timing	40-60 percent comes in the growing season.
Frost-free Days	70-130 days per year are above 32^{o} F.
Elevation Range	3,200 to 6,000 feet.
Major Vegetation	Bluebunch wheatgrass, Idaho fescue, rough fescue, needlegrasses, prairie junegrass, shrubby cinquefoil, big sagebrush, milkvetches, snowberry, silver buffaloberry, ponderosa pine, western juniper.

LRUs within MLRA 46:

<u>Notes</u>: RV PPT for LRU designations refers to the Representative Value for the range of effective precipitation (inches)
RV FFD for the LRU designations refers to the Representative Value for the range of Frost-free Days (>32^{o}F) annually.

LRUs - 46	**MLRA**	**Moisture phase**	**Temperature Phase**	**Cover**	**RV PPT** (inches)	**RV FFD** (days)
A	46	Ustic, Dry	frigid, warm	rangeland	10-15	110-130
A	46	Ustic, Dry	frigid	rangeland	10-15	90-110
A	46	Ustic, Dry	frigid	rangeland	10-15	90-110
B	46	Ustic	frigid, warm	rangeland	15-19	110-130
C	46	Ustic	frigid, warm	rangeland	15-19	110-130
D	46	Ustic	frigid	rangeland	15-19	90-110
E	46	Ustic	frigid, cool	forest	15-19	70-90
E	46	Ustic	frigid, cool	rangeland	15-19	70-90
F	46	Ustic	frigid, cool	rangeland	15-19	70-90
G	46	Ustic	frigid, cool	rangeland	15-19	70-90
H	46	Ustic	cryic, warm	forest	15-19	50-70
H	46	Ustic	cryic, warm	rangeland	15-19	50-70
I	46	Ustic, Moist	frigid, cool	forest	19-24	70-90
I	46	Ustic, Moist	frigid, cool	rangeland	19-24	70-90
J	46	Ustic, Moist	frigid, cool	rangeland	19-24	70-90
K	46	Ustic, Moist	cryic, warm	forest	19-24	50-70
K	46	Ustic, Moist	cryic, warm	rangeland	19-24	50-70
Y	46	any	any	any	10-24	50-130

MLRA 52 – Brown Glaciated Plains

Soil Moisture Regimes	Ustic
Soil Temperature Regimes	Frigid
Dominant Geological Resources	Parent materials include continental till, outwash, lacustrine deposits, associated local alluvium (along drainage/river channels) and eolian deposits. Ice-marginal lakes are part of MLRA 52. Topography is more level and rolling. Very little aspect and slope effects throughout.
Typical Annual Rainfall Range	10 to 16 inches. Core concepts = 12 inches. The west side of MLRA 52 receives higher precipitation, where the glacial till intergrades with MLRA 46 foothills. The south side of MLRA 52 is also higher precipitation where it intergrades with MLRA 43B.
Precipitation Timing	40-60 percent comes in the growing season. This MLRA has a continental climate. Chinook winds are more prevalent in the west versus the east parts of this MLRA. Chinook period is November-April.
Frost-free Days	90-140 days per year are above 32^{o} F.
Elevation Range	2,200 to 4,200 feet.
Major Vegetation	The predominance of lands in this MLRA is grasslands. Hardwood draws comprise the only sites that are defined as forestlands in this MLRA. Typical vegetation includes bluebunch wheatgrass, western and thickspike wheatgrasses, needleandthread, green needlegrass, basin wildrye, scurfpeas, winterfat, silver sagebrush, blue grama, prairie sandreed, prairie coneflower.

LRUs within MLRA 52:

<u>Notes</u>: *RV PPT for LRU designations refers to the Representative Value for the range of effective precipitation (inches).*
RV FFD for the LRU designations refers to the Representative Value for the range of Frost-free Days (>32^{o}F) annually.

LRUs - 52	**MLRA**	**Moisture phase**	**Temperature Phase**	**Cover**	**RV PPT** (inches)	**RV FFD** (days)
A	52	Ustic, Dry	Frigid, warm	Rangeland	10-12	100-140
B	52	Ustic, Dry	Frigid, warm	Rangeland	12-14	100-140
C	52	Ustic	Frigid	Rangeland	14-16	90-130
D	52	Ustic	Frigid	Rangeland	14-16	90-130
Y	52	any	any	any	10-16	90-140

MLRA 53A – Northern Dark Brown Glaciated Plains

Soil Moisture Regimes	Ustic
Soil Temperature Regimes	Frigid
Dominant Geological Resources	Parent materials include continental till, outwash, lacustrine deposits, associated local alluvium (along drainage/river channels) and eolian deposits. Ice-marginal lakes are part of MLRA 53A. There is a Driftless area (unglaciated) consisting of Flaxville gravels and Fort Union formation. This area occurred because the Cypress Hills in Canada deflected the continental glacier around central Daniels county. By the time it hit the Roosevelt county line, the glacier closed, so those soils are glaciated. The topography has more terraces and is dissected (more of a MLRA 58A-type landscape).
Typical Annual Rainfall Range	12 to 14 inches. Core concept = 13 inches.
Precipitation Timing	60-70 percent comes in the growing season. This MLRA has a continental climate. Chinook winds are rare/uncommon.
Frost-free Days	105-130 days per year are above 32^{o} F.
Elevation Range	1,900 to 3,000 feet.
Major Vegetation	The predominance of lands in this MLRA is grasslands. Typical vegetation includes little bluestem, green needlegrass, western and thickspike wheatgrasses, needleandthread, blue grama, prairie sandreed, bluebunch wheatgrass, fringed sagewort, silver sagebrush, winterfat, snowberry, chokecherry.

LRUs within MLRA 53A:

<u>Notes</u>: RV PPT for LRU designations refers to the Representative Value for the range of effective precipitation (inches).
RV FFD for the LRU designations refers to the Representative Value for the range of Frost-free Days (>32^{o}F) annually.

LRUs - 53A	**MLRA**	**Moisture phase**	**Temperature Phase**	**Cover**	**RV PPT** (inches)	**RV FFD** (days)
Y	53A	Ustic	Frigid, warm	Rangeland	12-14	105-130
Y	53A	Ustic	Frigid, warm	Forested	12-14	105-130

MLRA 54 – Soft Shale Plains

(The State of North Dakota develops these criteria and ESDs in conjunction with Montana)

Refer to the North Dakota NRCS eFOTG, Section II, Ecological Site Descriptions, ***MLRA 54.***

Soil Moisture Regimes	Ustic
Soil Temperature Regimes	Frigid
Typical Annual Rainfall Range	12 to 18 inches
Precipitation Timing	Most of the precipitation falls during the growing season.
Frost-free Days	110 – 135 days per year are above 32^{o} F.
Elevation Range	1,640 to 3,600 ft.
Major Vegetation	Little bluestem, prairie sandreed, western wheatgrass, blue grama, needleandthread, green needlegrass, chokecherry, buffaloberry, prairie rose.

MLRA 58A – Northern Rolling Plains, Northern Part

Soil Moisture Regimes	Ustic
Soil Temperature Regimes	Frigid
Dominant Geological Resources	Tertiary continental shale, siltstone, and sandstone underlie the eastern one-third to one-half of this area. These stream deposits are part of the Fort Union Formation. This formation also contains coalbeds. Marine and continental sediments of the Cretaceous Montana Group underlie the rest of the MLRA, generally at the higher elevations. The Montana Group includes the Bearpaw shale; the Judith River sandstone, siltstone, and shale; the Claggett shale; the Eagle sandstone; and the Telegraph Creek sandy shale.
Typical Annual Rainfall Range	10 to 19 inches. Core concept = 14 inches.
Precipitation Timing	There are roughly three dominant precipitation patterns in MLRA 58A. In the first pattern, most annual precipitation comes before June 15. This results in ecological sites dominated by cool season plants. In the second pattern, the annual precipitation is bimodal, coming mostly in April and May (the cool season), then in June and July (the warm season). This results in ecological sites represented by a mix of both cool and warm season plants. In the third pattern, the precipitation events extend beyond June 15 through the month of July. This results in ecological sites dominated by warm season plants.
Frost-free Days	90 to >120 days per year are above 32^{o} F.
Elevation Range	2,950 to 3,280 feet.
Major Vegetation	Approximately 95 percent of the lands in this MLRA are grasslands, leaving five percent as forested. Typical vegetation includes western and thickspike wheatgrasses, green needlegrass, needleandthread, bluebunch wheatgrass, little bluestem, winterfat, big sagebrush, horizontal juniper, and isolated areas of ponderosa pine.

LRUs within MLRA 58A:

<u>Notes</u>: All Temperature Regimes in 58A are Frigid. RV PPT is 10-14 inches for all LRU designations. It refers to the Representative Value for the range of precipitation received (inches). RV FFD is 90 to >120 days for all the LRU designations. It refers to the Representative Value for the range of Frost-free Days (>32°F) annually. The overriding factor in this MLRA is the timing of the precipitation, which results in different expressions of cool or warm season plants on the sites, and overall annual production amounts.

LRUs – 58A	MLRA	Moisture phase	Precipitation Pattern/Timing	Cover	Key Species	General Location within MLRA 58A
A	58A	Ustic, aridic	bimodal precip; April-May and June-July	rangeland	mix of cool and warm season plants on all sites.	NE part of MLRA.
B	58A	Ustic, aridic	most precip comes before June 15 annually	rangeland	cool season plants dominate on all sites.	Central part of MLRA.
C	58A	Ustic, typic	precip extends beyond June 15 and into July annually	rangeland	warm season plants dominate on all sites.	Very small extent in far east part of MLRA.
D	58A	Ustic, typic	bimodal precip; April-May and June-July	rangeland	mix of cool and warm season plants on all sites.	Eastern and northwestern edges of MLRA where it contacts with adjacent MLRAs.
E	58A	Ustic, typic	most precip comes before June 15 annually	rangeland	cool season plants dominate on all sites.	S and SW part of MLRA.
F	58A	Ustic, moist	precip extends beyond June 15 and into July annually	forest	warm season plants dominate the understory on all sites.	Forested sites in this MLRA.
G	58A	Ustic, moist	bimodal precip; April-May and June-July	forest	mix of cool and warm season understory plants on all sites.	Forested sites in this MLRA.
H	58A	Ustic, moist	most precip comes before June 15 annually	forest	cool season plants dominate the understory on all sites.	Forested sites in this MLRA.
Y	58A	any	not applicable	any	All aquic and ubiquitous sites.	Randomly throughout MLRA.

MLRA 58B – Northern Rolling Plains, Southern Part

(The State of Wyoming develops these criteria and ESDs in conjunction with Montana)
Refer to the Wyoming NRCS eFOTG, Section II, Ecological Site Descriptions, ***10-14 Northern Plains.***

Soil Moisture Regimes	Aridic, Ustic
Soil Temperature Regimes	Mesic
Typical Annual Rainfall Range	10 to 17 inches
Precipitation Timing	Bimodal, coming during both the cool and warm season. Chinook winds may occur in winter and bring rapid temperature rises.
Elevation Range	2,950 to 5,900 feet
Major Vegetation	Thickspike and western wheatgrasses, green needlegrass, needleandthread, big bluestem, blue grama, bluebunch wheatgrass, Indian ricegrass, little bluestem, prairie coneflower, big sagebrush, winterfat.

MLRA 58C – Northern Rolling Plains, Northeastern Part

(The State of South Dakota develops these criteria and ESDs in conjunction with Montana)
Refer to the South Dakota NRCS eFOTG, Section II, Range Site Descriptions, ***Western Technical Guide Area.***

Soil Moisture Regimes	Ustic, Aridic
Soil Temperature Regimes	Frigid
Typical Annual Rainfall Range	14 to 17 inches
Precipitation Timing	More than one-half of the precipitation falls during the growing season.
Elevation Range	1,980 to 3,280 feet
Major Vegetation	Thickspike and western wheatgrasses, needleandthread, green needlegrass, blue grama, threadleaf sedge, little bluestem, sideoats grama, scattered green ash, chokecherry, western snowberry, Rocky Mountain juniper.

MLRA 58D – Northern Rolling Plains, Eastern Part

(The State of South Dakota develops these criteria and ESDs in conjunction with Montana)
Refer to the South Dakota NRCS eFOTG, Section II, Range Site Descriptions, ***Western Technical Guide Area.***

Soil Moisture Regimes	Ustic, Aridic
Soil Temperature Regimes	Frigid
Typical Annual Rainfall Range	14 to 17 inches
Precipitation Timing	Most precipitation comes early in the growing season (May-June).
Elevation Range	2,300 to 4,000 feet
Major Vegetation	Thickspike and western wheatgrasses, green needlegrass, blue grama, buffalograss, little bluestem, prairie sandreed, big bluestem, coneflower, scurfpea, buffaloberry, silver sagebrush, western snowberry, chokecherry.

MLRA 60A – Pierre Shale Plains and Badlands

(The State of South Dakota develops these criteria and ESDs in conjunction with Montana and Wyoming)
*Refer to the South Dakota NRCS eFOTG, Section II, Ecological Site Descriptions, **MLRA 60A.***

Soil Moisture Regimes	Ustic
Soil Temperature Regimes	Mesic
Typical Annual Rainfall Range	13 to 19 inches
Precipitation Timing	Most precipitation comes early in the growing season (May-June).
Elevation Range	2,620 to 3,610 feet
Major Vegetation	Western wheatgrass, green needlegrass, blue grama, buffalograss, little bluestem, sideoats grama, big bluestem, coneflower, scurfpeas, scarlet globemallow, sand sagebrush, silver sagebrush, western snowberry.

MLRA 60B – Pierre Shale Plains and Badlands, Northern Part

Soil Moisture Regimes	Ustic
Soil Temperature Regimes	Frigid
Dominant Geological Resources	Marine and continental sediments of the Cretaceous Montana Group underlie most of this MLRA, generally at the higher elevations. The Montana Group in this part of Montana includes Fox Hills Sandstone and Pierre Shale. A group of younger Cretaceous sediments occurs at the lower elevations at the north and west ends of the area.
Typical Annual Rainfall Range	11 to 15 inches.
Precipitation Timing	Most of the annual precipitation occurs as high-intensity, convective thunderstorms during the growing season.
Frost-free Days	90 to 110 days per year are above 32^o F.
Elevation Range	2,950 to 3,300 feet
Major Vegetation	Most of the lands in this MLRA are grasslands, but there are forested areas in drainages and on some uplands. Typical vegetation includes: western wheatgrass, green needlegrass, blue grama, little bluestem, sideoats grama, ponderosa pine, scattered oak species.

LRUs within MLRA 60B:

Notes: RV PPT for LRU designations refers to the Representative Value for the range of effective precipitation (inches).
RV FFD for the LRU designations refers to the Representative Value for the range of Frost-free Days (>32^{o}F) annually.

LRUs – 60B	**MLRA**	**Moisture phase**	**Temperature Phase**	**Cover**	**RV PPT** (inches)	**RV FFD** (days)
A	60B	Ustic	Frigid	All	11-15	85-110
B	60B	Ustic	Frigid	All	11-15	85-110
Y	60B	All	All	All	11-15	85-110

(a)(5) Ecological Site Key for Montana

A descriptive dichotomous key has been developed for use in the field. This key assists the user in correctly determining the ecological site(s) encountered.

It is important to remember that the Key *must* be used in conjunction with the MLRA and LRU criteria described above. This is because an ecological site is an expression of the kinds, amounts, and proportions of vegetation, and its response to management. A Loamy site in MLRA 58A, LRU B will look and respond differently from a Loamy site in MLRA 58A, LRU C.

The Key also contains a list of ecological site abbreviations, a brief summary that describes *general* characteristics of the site, and a glossary. The Key can be found in the Field Office Technical Guide, Section II, or the eFOTG, or at: http://www.mt.nrcs.usda.gov/technical/ecs/range/handbook/.

(a)(6) Soil Survey Vegetative Field Form for Montana

See Chapter 3, Section 1, *Exhibits*, for a blank Soil Survey Vegetative Field Worksheet, MT-ECS-6. Soil Scientists are to use this form in the field to assist in verification and documentation of the ecological site encountered. Retain this form with the corresponding NRCS-232 form (or similar soil documentation form). Provide copies of this form to the Montana State Rangeland Management Specialist and the Rangeland Management Specialist assigned to that soil survey.

References:

[1] NRCS **National Range and Pasture Handbook**, December 2003, Chapter 3
[2] http://www.oswego.edu/~gabel/govrx.html, **Dr. Gabel's Introductory Geology (GEO 100) Notes**
[3] Sorrell, Charles A., **Minerals of the World,** Western Publishing Company, New York, 1973
[4] SCS Technical Note - Range NV32, **Landform Definitions**, February 1973
[5] USDA Natural Resources Conservation Service, Agricultural Handbook 296, **Land Resource Regions and Major Land Resource Areas of the United States**. http://soils.usda.gov/survey/geography/mlra/

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