Youth/Adult Workbook

Index:

Montana Range Days Plant List (2021)

GRASSES

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102	blue grama	*Bouteloua gracilis*	PNWI
103	**bluebunch wheatgrass**	***Pseudoroegneria spicata***	PNCD
104	bottlebrush squirreltail	*Elymus elymoides*	PNCI
105	**cheatgrass**	***Bromus tectorum***	AICV
106	crested wheatgrass	*Agropyron cristatum*	PICV
107	foxtail barley	*Hordeum jubatum*	PNCI
108	green needlegrass	*Nassella viridula*	PNCD
109	Idaho fescue	*Festuca idahoensis*	PNCI
110	Indian ricegrass	*Achnatherum hymenoides*	PNCD
111	inland saltgrass	*Distichlis spicata*	PNWI
112	Japanese brome	*Bromus japonicus*	AICV
113	Kentucky bluegrass	*Poa pratensis*	PICV
114	**needle-and-thread**	***Hesperostipa comata***	PNCI
115	oatgrass	*Danthonia spp.*	PNCI
116	plains muhly	*Muhlenbergia cuspidata*	PNWD
117	plains reedgrass	*Calamagrostis montanensis*	PNCI
118	**prairie junegrass**	***Koeleria macrantha***	PNCI
119	prairie sandreed	*Calamovilfa longifolia*	PNWD
120	red threeawn	*Aristida purpurea*	PNWI
121	sand dropseed	*Sporobolus cryptandrus*	PNWI
122	**Sandberg bluegrass**	***Poa secunda***	PNCI
123	slender wheatgrass	*Elymus trachycaulus*	PNCD
124	smooth brome	*Bromus inermis*	PICV
125	thickspike wheatgrass	*Elymus lanceolatus*	PNCI
126	timothy	*Phleum pratense*	PICV
127	tufted hairgrass	*Deschampsia cespitosa*	PNCD
128	**western wheatgrass**	***Pascopyrum smithii***	PNCI

GRASSLIKES

129	baltic rush	*Juncus balticus*	PNCI
130	needleleaf sedge	*Carex duriuscula*	PNCI
131	**threadleaf sedge**	***Carex filifolia***	PNCI

FORBS

132	**American vetch**	***Vicia americana***	PNCD
133	annual sunflower	*Helianthus annuus*	ANWV
134	arrowleaf balsamroot	*Balsamorhiza sagittata*	PNCI
135	bastard toadflax	*Commandra umbellata*	PNCI
136	biscuitroot	*Lomatium spp.*	PNCI
137	blanketflower	*Gaillardia aristata*	PNWI
138	blue flax	*Linum lewisii*	PNCI
139	buckwheat	*Eriogonum spp.*	PNCI
140	**Canada thistle**	***Cirsium arvense***	PICV N

FORBS

141	cinquefoil	*Potentilla spp.*	PNCI
142	**cudweed sagewort**	***Artemisia ludoviciana***	PNWI
143	curlycup gumweed	*Grindelia squarrosa*	BNWV
144	dense clubmoss	*Selaginella densa*	PNXI
145	dotted gayfeather	*Liatris punctata*	PNWD
146	evening primrose	*Oenothera spp.*	BNCV
147	field chickweed	*Cerastium arvense*	PNCI
148	fleabane	*Erigeron spp.*	PNCI
149	hairy goldenaster	*Heterotheca villosa*	PNWI
150	harebell	*Campanula spp.*	PNCI
151	Hood phlox	*Phlox hoodii*	PNCI
152	**houndstongue**	***Cynoglossum officinale***	BICV N
153	leafy spurge	*Euphorbia esula*	PICV N
154	loco weed	*Oxytropis spp.*	PNCI P
155	low larkspur	*Delphinium bicolor*	PNCI P
156	**lupine**	***Lupinus sp.***	PNCI P
157	manyflowered aster	*Symphyotrichum ericoides*	PNWI
158	meadow deathcamas	*Zygadenus venenosus*	PNCI P
159	milkvetch	*Astragalus spp.*	PNCI
160	miner's candle	*Cryptantha celosioides*	BNCV
161	Missouri goldenrod	*Solidago missouriensis*	PNWI
162	penstemon	*Penstemon spp.*	PNCI
163	prairie coneflower	*Ratibida columnifera*	PNWI
164	prairie onion	*Allium spp.*	PNCI
165	prairiesmoke	*Geum triflorum*	PNCI
166	purple prairieclover	*Dalea purpurea*	PNWD
167	pussytoes	*Antennaria spp.*	PNCI
168	**salsify**	***Tragopogon dubius***	BICV
169	scarlet gaura	*Gaura coccinea*	PNWI
170	scarlet globemallow	*Sphaeralcea coccinea*	PNCI
171	segolily mariposa	*Calochortus nuttallii*	PNCD
172	spotted knapweed	*Centaurea maculosa*	P/BIWV N
173	sticky geranium	*Geranium viscosissimum*	PNCD
174	wavyleaf thistle	*Cirsium undulatum*	P/BNWV
175	**western yarrow**	***Achillea millefolium***	PNWI
176	yampah	*Perideridia gairdneri*	PNWI
177	yellow owl's clover	*Orthocarpus luteus*	ANCV
178	Yellow sweetclover	*Melilotus offiicinalis*	BICV

CACTI

179	pincushion cactus	*Escobaria spp.*	PNCI
180	**plains pricklypear**	***Opuntia polyacantha***	PNCI

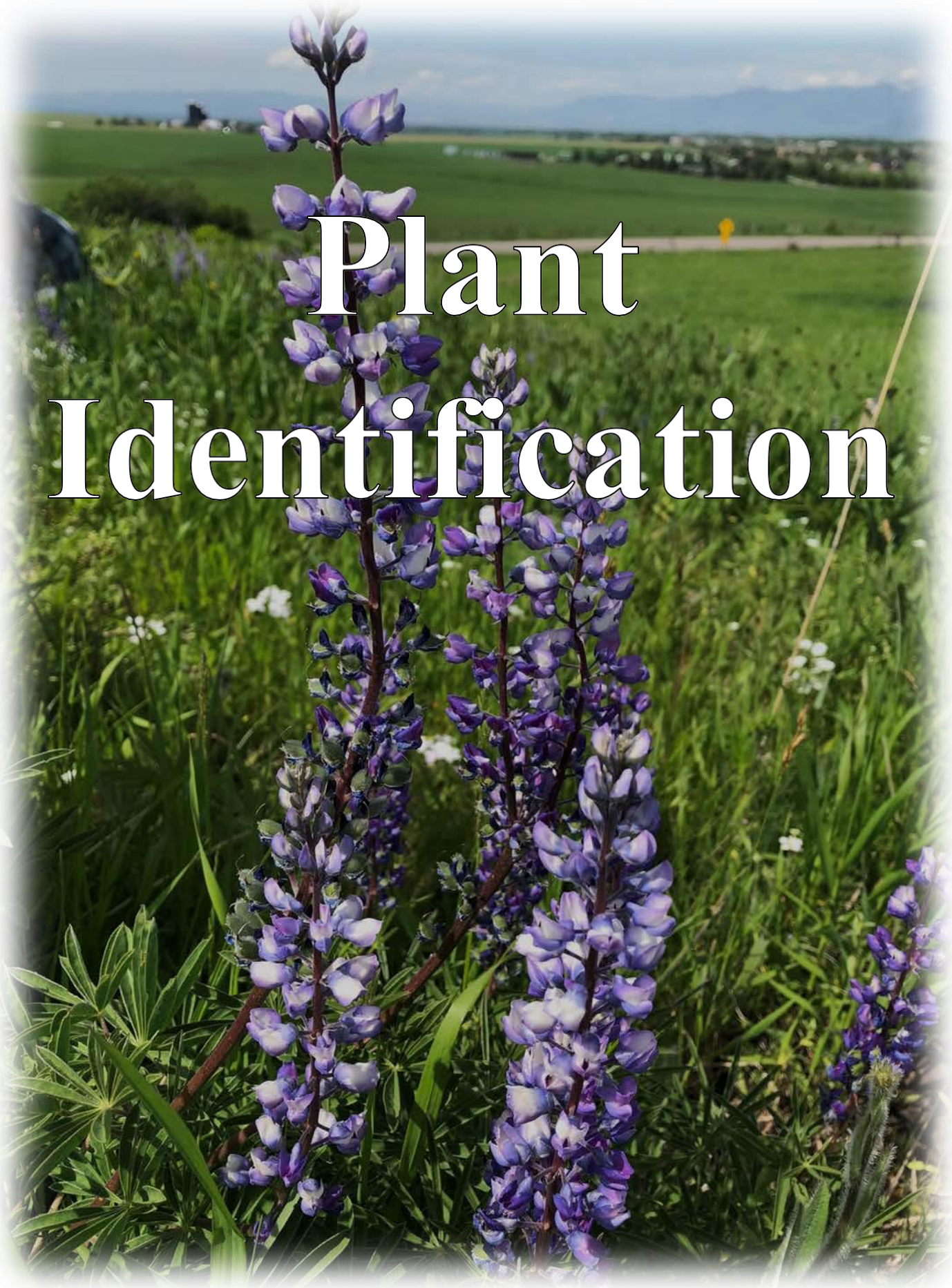
HALF-SHRUBS, SHRUBS, TREES

181	**big sagebrush**	***Artemisia tridentata***	PNWI
182	broom snakeweed	*Gutierrezia sarothrae*	PNWI
183	chokecherry	*Prunus virginiana*	PNCD P
184	Creeping juniper	*Juniperus horizontalis*	PNXX
185	**fringed sagewort**	***Artemisia frigida***	PNWI
186	Gardner's saltbush	*Atriplex gardneri*	PNWD
187	gray horsebrush	*Tetradymia canescens*	PNWI P
188	green rabbitbrush	*Chrysothamnus viscidiflorus*	PNWI
189	**ponderosa pine**	***Pinus ponderosa***	PNXX P
190	quaking aspen	*Populus tremuloides*	PNCD
191	**Rocky Mountain juniper**	***Juniperus scopulorum***	PNXX
192	rubber rabbitbrush	*Ericameria nauseosa*	PNWI
193	serviceberry	*Amelanchier alnifolia*	PNCD
194	shrubby cinquefoil	*Dasiphora fruticosa*	PNCI
195	silver sagebrush	*Artemisia cana*	PNWI
196	skunkbush sumac	*Rhus trilobata*	PNCD
197	soapweed	*Yucca glauca*	PNCI
198	western snowberry	*Symphoricarpos occidentalis*	PNCI
199	**wild rose**	***Rosa spp.***	PNCI
200	winterfat	*Krascheninnikovia lanata*	PNWD

Key

Lifespan	Origin	Other
(A) Annual	(N) Native	(P) Poisonous
(B) Biennial	(I) Introduced	(N) Noxious
(P) Perennial		
Season	**Grazing Response**	**Bolded**
(W) Warm Season	(D) Decreaser	Key Plants*
(C) Cool Season	(I) Increaser	
(X) Inappropriate	(V) Invader	
	(X) Inappropriate	

*Key plants will not change from year to year.

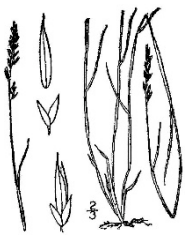
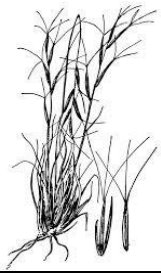


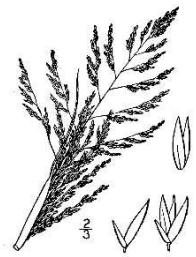
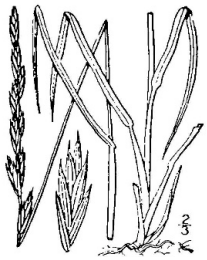
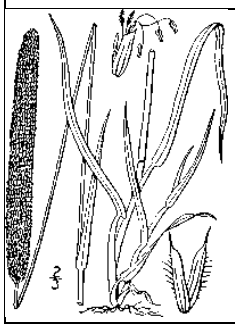
Plant Identification

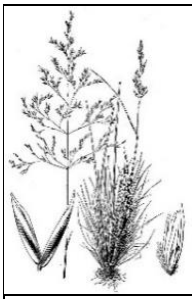
Grasses

	**101 – basin wildrye - *Leymus cinereus* - PNCD** Bunchgrass with short, thick rhizomes. This grass is very tall (3-7ft.). There is more than one spikelet at each node on the seedhead. Glumes are bristle-like. Leaf blades are wide and flat. Auricles and ligules are prominent. Grown in deep soils, saline overflow and saline subirrigated sites. Growing points are elevated, so heavy grazing hurts this plant.
	**102 – blue grama – *Bouteloua gracilis* - PNWI** Sod-forming grass with short rhizomes. Has short, green leaves that curl and turn brown in the fall. Has hair at the collar. Note that unlike buffalo grass, blue grama does not have hair on the surface of the leaves. Has eyebrow-shaped seedheads. Grows on dry hills and plains and often forms dense mats.
	*** 103 – bluebunch wheatgrass – *Pseudoroegneria spicata* - PNCD** State grass of Montana. Bunchgrass habit. It has fine, narrow, in-rolled leaves that grow from the base of the plant. There are small auricles at the collar. The spike seedhead is slender with spikelets barely overlapping along the rachis (1/8 inch overlap). There are 4-8 florets per spikelet. Lemmas are awned with the awns bending at 45-90 degree angles when mature.
	**104 - bottlebrush squirreltail - *Elymus elymoides* - PNCI** Bunchgrass. Leaf blades 1-5 mm wide flat to folded. The erect rachis readily disarticulating at maturity. Spikelets usually 2 per node, 11-14mm long. Glumes gradually tapering from the base to a narrow acute tip, often bifid. Found on open, dry shrub steppe as well as in moderately disturbed sides such as along gravel back roads. This species often hybridizes readily with other species of Elymus or Agropyron.
	*** 105 - cheatgrass - *Bromus tectorum* - AICV** A small, bunchgrass that is a winter annual, also known as "downy brome". It germinates in the fall, over-winters as a rosette, and resumes growth in the spring. Roots pull easily. It has a closed, hairy leaf sheath and a small jagged, ligule. (Note: All bromes have a closed leaf sheath.) The panicle seedhead is open and drooping. The plant turns reddish-purple with maturity. Lemmas are narrow, and conspicuously awned. Cheatgrass grows on disturbed upland sites and is easily confused with Japanese brome, which has inflated spikelets.
	**106 – crested wheatgrass – *Agropyron cristatum* - PICV** A bunchgrass introduced from Russia for hay and pasture. It is very drought resistant. Leaves bend away from the stems at 45 degree angles. Leaves are a deep green color. Small, clasping auricles are present. Spikelets lay flat to the rachis of the spike seedhead and overlap, appearing crowded. There are 3-8 florets/spikelet.

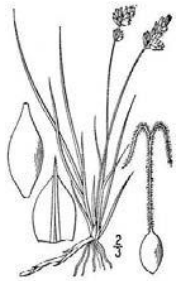
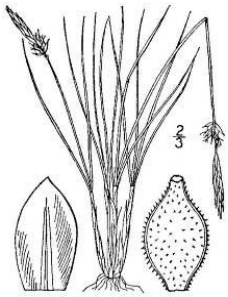
	**107 – foxtail barley – *Hordeum jubatum* - PNCI** A tufted bunchgrass that is sometimes considered a weed. It likes to grow in saline seeps and on disturbed sites. Young leaf sheaths are split and hairy. The leaves are deeply veined. Auricles are absent or very small and the ligules are short (1mm) and membranous. Spike seedheads have three spikelets per node or joint. There are 7 long, barbed awns at each node. The awns can injure grazing animals.
	**108 – green needlegrass – *Nassella viridula* - PNCD** A perennial bunchgrass that grazing animals prefer. It has large leaves that grow from the base of the plant. The backs of the leaves are very shiny. The throat of the leaf collar is hairy. There are not very many seedheads per plant (1-3) and the seedheads are taller than the leaves. The panicle seedhead has one floret per spikelet with a 1 to 1 ½ inch awn. Prefers deep, clay-textured soils and overflow sites.
	**109 - Idaho fescue - *Festuca idahoensis* - PNCI** This is a shorter plant with stems 10-80 cm tall. Inflorescence is an open panicle 2-20 cm long, with 2-5 mm long awns. Plant matures by midsummer, reproduces from seeds and tillers. Excellent forage that can withstand some excessive grazing.
	**110 – Indian ricegrass – *Achnatherum hymenoides* - PNCD** A tufted bunchgrass that prefers sandy soils. It has long, in-rolled leaf blades. The ligules are long and split at the tips. The panicle inflorescence is white and unique because it branches in pairs of two (dichotomous). Each spikelet has one awned floret, surrounded by white hair. The awn falls off at maturity (deciduous). The floret is round and black colored. Indians ground the seeds into flour. This grass is a useful forage species for livestock and wildlife.
	**111 - inland saltgrass - PNWI - *Distichlis spicata* - PNWI** Strongly rhizomatous dioecious (male and female reproductive parts on different plants) perennial. Leaf blades wide, flat and ascending stiff and pungent-tipped. Inflorescence a contracted panicle or raceme. Glumes faintly veined. Lemmas 4-6 mm long, many veined, and awnless. Disartivulation above glumes. Found in Alkali flats and less commonly in shrub steppe at lower elevations.
	**112 - Japanese brome - *Bromus japonicus* - AICV** Shallow-rooted, winter annual, cool-season bunchgrass. Inflorescence is an open, nodding panicle. Awns are attached to the back of the blunt lemmas. This grass can be confused with cheatgrass, but the seedheads of Japanese brome are heavier, broader and have shorter awns.
	**113 – Kentucky bluegrass – *Poa pratensis* - PICV** A sod-forming grass commonly planted in lawns. It likes moist sites, has a shallow root system and is very palatable. Leaf tips are boat-shaped/keeled. The two veins down the midrib of the leaf are sunken and look like railroad tracks. Seedheads are triangular-shaped panicles. The spikelets are compressed (flattened). The glumes are nearly equal and membranous. There are generally 3 florets per spikelet. If you pull the florets away from the glumes, you can see cobwebby hairs. Ligules are short, flat-topped and membranous. Compare to the ligules of Sandberg bluegrass which are pointed.

	*** 114 – needle-and-thread – *Hesperostipa comate* - PNCI** Medium-stature bunchgrass. Leaves are blue/green, narrow and rolled. Leaf sheaths are open. Ligules are split (bunny ears). Seedheads are loose panicles. Glumes are large, almost equal and membranous. There is one floret per spikelet. The floret is sharp like a needle and awned (thread). The awn is long and twice bent. This grass grows on a wide variety of range sites, but does not prefer clay-textured soils. It is palatable and used by grazing animals early in the growing season and late in the fall, when the "needles" are not formed or have dropped to the ground.
	**115 – oatgrass – *Danthonia spp.* - PNCI** Bunchgrass, with inflorescense a contracted to open but sparsely flowered panicle. The ligule is hairy. Lemma tapering to a bifid tip and bearing a flattened, twisted awn from between the two teeth. Reproduces from seeds and tillers. Excellent forage for livestock and wildlife.
	**116 – plains muhly – *Muhlenbergia cuspidate* – PNWD** Stems are 20-40 cm long, the area below the stem node is smooth and without bumps, the stem bases is hard, scaly and bulb-like. Inflorescense is a narrow panicle. Lemmas slightly hairy often more towards the base only. Mostly in short grass prairie and occasionally sagebrush steppe on moderately disturbed settings including road cuts.
	**117 – plains reedgrass – *Calamagrostis montanensis* - PNCI** A rhizomatous grass. The stems are stiff and erect. There are no auricles, but ligules are prominent and pointed. The seedhead is similar to prairie junegrass. However, plains reedgrass has only one floret per spikelet. The lemma is hairy and has bent awns. It is palatable and prefers clayey range sites.
	*** 118 – prairie junegrass – *Koeleria macrantha* - PNCI** A small, perennial bunchgrass. Leaves are basal and 2-4 inches tall. The leaf veins are prominent. Some varieties of junegrass have hairy leaves. This grass has no auricles and just a tiny ligule. It is called the "Plain Jane" grass. The compact panicle seedheads stand upright. If you bend the panicle, it will split into a hand and thumb. During flowering, the panicle spreads out and looks much larger. This often confuses people. Spikelets are small with 2+ florets. The glumes are membranous and unequal.
	**119 - prairie sandreed - *Calamovilfa longifolia* - PNWD** Tall, coarse, stout, open sod forming grass found on sandy soil in dry areas. The rhizomes are scaly. Leaf blades are rigid, hairless, and tapered to a drawn out tip. Ligule is short and hairy. the collar is hairy inside. Inflorescence is a panicle.
	**120 - red threeawn - *Aristida longiseta* - PNWI** This is a medium-sized, densely tufted bunchgrass that acts as an invader on some range sites. Leaves are fine and in-rolled. There is long hair at the collar region. Glumes are unequal. There is one floret per spikelet. The lemma tips split to form three awns, which turn red as the plant matures. Red threeawn grows on plains, foothills and dry mountain slopes throughout Montana. Livestock or wildlife do not usually graze this grass. It reportedly contains silica, which is irritating to grazing animals.

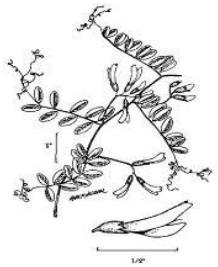
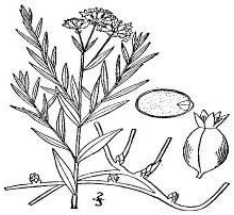
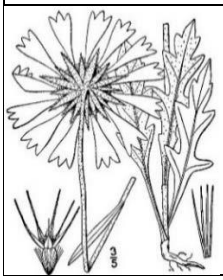
	**121 - sand dropseed - *Sporobolus cryptandrus* – PNWI** Stems are 20-80 cm. Leaf blade has conspicuous tuft of white hairs at throat. Inflorescence a contracted to open panicle 8-20 cm long, partially enclosed in leaf sheath. Occurs in disturbed settings, and rarely in sagebrush steppe. Common along roadsides and there conspicuous because of inflorescences each in an arcuate leaf sheath. Provides fair to good forage for livestock and poor forage for wildlife.
	*** 122 – Sandberg bluegrass – *Poa secunda* - PNCI** A small-stature bunchgrass that flowers early in the spring. It has very short basal leaves. Seedhead culms are taller than the leaves. Like other bluegrasses, it has 2 sunken veins in the middle of each leaf (railroad tracks), and keeled leaves. The ligule is sharp-pointed. Seedhead is a panicle. The spikelets are long and pointed, with unequal glumes and 3-5 florets. There are no cobwebs at the base of the florets as in Kentucky bluegrass.
	**123 – slender wheatgrass – *Agropyron trachycaulum* - PNCD** Cool season perennial bunchgrass. One spikelet per node, spikelets are 3 -7 flowered. The glumes are strongly nerved. Grows in two strongly marked forms bearded and beardless (subspecies) beardless with awns up to 4 mm long, bearded with awns 4 to 30 mm long. The combination of (1) no rhizomes, (2) the spikelets overlapping about half their length in the spike, (3) the prominent glumes with bodies strongly nerved and two thirds to fully as long as the spikelet's distinguishes it from other similar species.
	**124 – smooth brome – *Bromus inermis* - PICV** Smooth brome is an introduced, rhizomatous grass commonly planted for hay or pasture forage. Leaf sheaths are closed. Leaf blades are long, wide and taper to a point. There is a crimp on the leaf blade where it exits the collar. There is also an M/W crimp about mid-way up the leaf. The ligules are small and membranous. There are no auricles. Seedheads are panicles, which open and turn light brown as the seedhead matures. Glumes are membranous, shorter than the florets and unequal. Florets number 5-13.
	**125 - thickspike wheatgrass – *Elymus lanceolatus* - PNCI** This species is *v*ery similar to western wheatgrass. Thickspike occurs as single stems from rhizomes but can appear to have a bunch habit. Spike inflorescences are compact, with the lemmas sometimes bearing a short awn. The lemmas are hairy, which distinguished it from western wheatgrass. Leaf sheaths may also be pubescent.
	**126 - timothy – *Phleum pratense* - PICV** Timothy is an introduced bunchgrass. Seed head is a tight cylindrical panicle and may be as much as six inches long. The glumes are equal, bristly on back and awned. Stems are swollen or bulblike at the base. Leaf blades fairly wide and light green and often crimped at the collar. A membranous ligule is present. Timothy is found in moist sites.

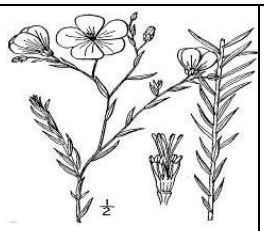
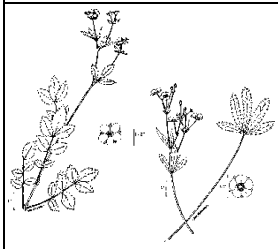
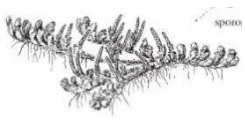
	**127 – tufted hairgrass - *Deschampsia cespitosa* - PNCD** Bunchgrass, mostly basal in a dense tuft. standing 30-100 cm tall. Inflorescence an open panicle 8-25 cm long. Glumes gradually tapering to a sharp-pointed tip. Used for revegetating disturbed sites. mostly found in seasonally flooded/moist areas Excellent forage palability for all livestock.
	*** 128 – western wheatgrass – *Pascopyrum smithii* - PNCI** A common rhizomatous grass of Montana rangelands. This grass has prominent, clasping auricles that are often colored purple. Leaves are rigid and very rough textured because of the prominent nerves. The seedhead is a spike. The spikelets have unequal glumes and approximately 5 florets. Grows on a variety of range sites, but prefers clay-textures soils. It is palatable to grazing animals.

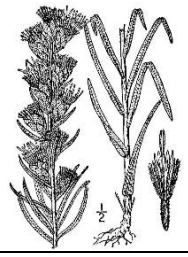
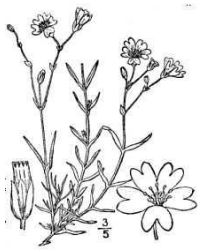
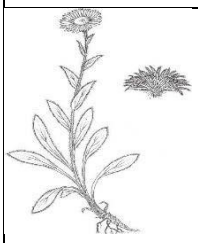
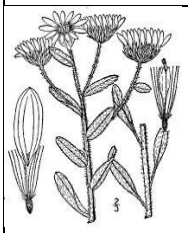
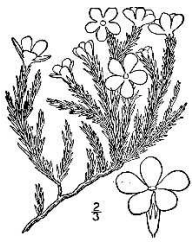
Grasslike

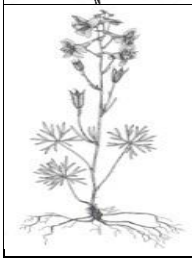
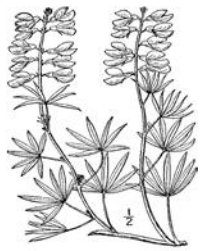
	**129 – baltic rush – *Juncus balticus* - PNCI** A rhizomatous rush that grows up 8-32 inches tall. You might need a hand lens to study the seedhead. The inflorescence is a panicle, about 2 ½ inches long. The flowers are very small. Flower parts are bract-like and in series of three. The perianth (sepals and petals) is purplish/brown in color with green midribs. The edges of the perianth are white and papery. The 3-celled seed pods/capsules are brown and egg-shaped. The tips of the capsules are sharp-pointed. The capsules break open when ripe, and contain many tiny, tiny seeds. There is also a long, green bract that grows straight up and extends beyond the seedhead. This makes the inflorescence appear to grow in the middle of the stem. The dark green stems are smooth, round and pithy. Leaves are basal and reduced to sheaths. Rhizomes are strong, extensive and dark-colored. The nickname for this plant is "wire rush', because the stems are so tough. It is palatable early in the growing season and fairly resistant to grazing because of its rhizomatous nature.
	**130 – needleleaf sedge – *Carex duriuscula* - PNCI** A sod-forming sedge with slender, brown rhizomes. This sedge is low growing and rather inconspicuous. It seems to prefer better soils and wetter sites than its relative, threadleaf sedge. On many needleleaf sedge plants you will notice that there are only three prominent leaves. This is a fairly reliable characteristic. There are 4-8 spikes that form a head on the seed culm. The spikes are arranged so close together that they look like just one spike. Each spike has male and female flowers with the male flowers are above the female flowers. The female flowers have two stigma and produce lens-shaped achenes.
	*** 131 –threadleaf sedge - *Carex filifolia* - PNCI** Threadleaf sedge grows in a tufted, bunch habit. Like plains muhly, it often forms a circular pattern as the middle of the plant gets old and dies. The roots are black and wiry. Narrow, threadlike leaves grow from the base of the plant. The leaf sheaths are filamentose (shredded) and rust-colored. Seed culms are narrow and triangle-shaped. It is hard to feel or see the triangle because the stems are so narrow. There is only one spike per seed culm. The upper part of the spike is male, the lower part is female. The flowers have 3 stigmas and so the seeds (achenes) are triangle shapes. The perigynia is obovoid and inflated. The beak of the perigynia is very short.

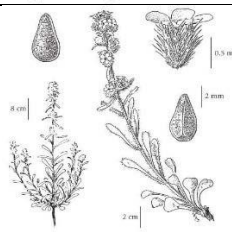
Forbs

	*** 132 – American vetch – *Vicia americana* (Pea Family) - PNCD** This forb spreads and climbs by clinging to other vegetation using tendrils (modified leaflets). It is also rhizomatous. Leaves are even-pinnate with the tendril being terminal. There are 8-18 leaflets. Raceme inflorescences develop from the leaf axils. There are 3-10 flowers, with color ranging from white, blue and purple. The fruit is in a bean-like pod, approximately 1 inch long. The pod splits lengthwise to drop its seeds. American vetch is good forage for livestock and decreases with overgrazing.
	**133 - annual sunflower - *Helianthus annuus* (Aster family) - ANWV** Erect, coarse, tap-rooted annual with rough-hairy stems. The leaves are mostly alternate, egg-shaped to triangular and entire or toothed. The flower heads are 3-6 inches wide and at the ends of the branches. Ray flowers are yellow and the disk flowers are reddish-brown.
	**134 - arrowleaf balsamroot - *Balsamorhiza sagittata* (Aster Family) - PNCI** Leaves originate at the base of the plant. Leaves and bracts appear silvery due to dense white, felt-like hair that covers the plant surface. Leaves are large (up to 12 inches long and 6 inches wide) and are shaped like giant arrowheads. Yellow flower heads are solitary on the long stems and resemble sunflowers.
	**135 – bastard toadflax – *Comandra umbellata* (Sandalwood Family) - PNCI** Low growing, rhizomatous forb. Has a taproot. Leaves are numerous and arranged alternately. Leaves spiral up and around the stem and give a 3-D appearance. Leaves are gray-green, glabrous and rather thick. Flowers are arranged on cymes with five erect white to pink petal-like sepals. There are no petals. Bastard toadflax is a parasitic plant and gets some of its nutrients and water from other plants' root.
	**136 – biscuitroot – *Lomatium spp.* (Parsley Family) - PNCI** Biscuitroot grows on dry, open, sometimes rocky places. It has a short, thick, tuberous root. The leaves are compound and dissected. Inflorescences are compound umbels. The flowers are yellow. The fruit is often obovate-shaped and flattened with wings.
	**137 - blanketflower - *Gaillardia aristata* (Aster Family) - PNWI** Blanketflower grows from slender taproots. Its stems grow erect and unbranched. Stems are leafy and hairy. Leaves are basal and alternately arranged. They are lance-shaped, 5-20 cm long and hairy. Upper leaves are toothed to deeply lobed. Flower heads are unusual. Ray flowers are yellow around a domed, purple-colored cluster of disc flowers. The tips of the ray petals are deeply divided into three lobes.

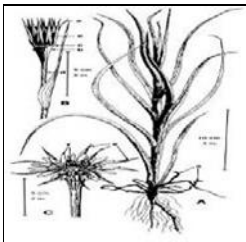
	**138 – blue flax *Linum lewisii* (Flax Family) - PNCI** Tap-rooted forb, with few to many stems arising from a woody crown. Stems are simple below, but branch at the tips. Linear leaves are numerous, alternate and crowded on the lower parts of the stems. The inflorescence is a branched raceme. There are five sepals and petals on each flower. Petals are blue. Flowers open in the morning and the petals are generally shed by mid-day. This plant is often used to reclaim disturbed sites, such as those created by road construction.
	**139 – buckwheat –*Eriogonum spp*. (Buckwheat Family) - PNCI–** Wild buckwheat species tend to form mats from branched crowns. Hairy basal leaves grow in tufts. The stems are scapes (leafless), usually erect, and topped by a whorl of bracts. The flowers are arranged in umbels or compound umbels, and are white, yellow or pink.
	*** 140 – Canada thistle – *Cirsium arvense* (Aster Family) – PICV N** A rhizomatous, weed that forms large colonies. It is categorized as a noxious weed in nearly 40 states. Plants are usually 1-3 FT tall. Leaves are dark green, toothed and almost always spiny. Canada thistle is dioecious, with male and female flowers occurring on different plants. The inflorescence is a head with many pink, lavender or purple flowers. The heads are small and there are many heads per seedstem. This thistle favors disturbed sites and flourishes in burned areas.
	**141 – cinquefoil – *Potentilla spp.* (Rose Family) - PNCI** Most species are rhizomatous. Leaves are primarily basal and either pinnately or palmately compound. Flowers have five petals that are cream to bright yellow in color.
	*** 142 – cudweed sagewort – *Artemisia ludoviciana* (Aster Family) - PNWI** Alternate leaves, simple mostly cauline, blades linear to lanceolate or elliptic. Reduced above, margins entire or apically toothed or lobed. Top of the leaves pilose and green to white tomentose, bottom of the leaves white tomentose. Sessile leaves. Erect rhizomatous forb.
	**143 – curlycup gumweed – *Grindelia squarrosa* (Aster Family) - BNWV** Forb with a taproot. Reproduces by seeds. It is a biennial. Leaves are alternate, simple and thick. The leaves are also dotted with characteristic glands. The inflorescence can be a solitary head or a loose corymb. The flowers are perfect and yellow. The heads have green bracts that are curved down. The plant produces a sticky resin that makes it worthless to livestock.
	**144 - dense clubmoss - *Selaginella densa* (Selaginella family) - PNXI** Dense clubmoss is from the spike moss family. It is a pteridophyte that reproduces by spores. It greens up whenever there is moisture, so it doesn't officially have a season. Clubmoss is usually less than 1" in height and forms dense mats. the root system is shallow, which allows the plant to absorb water from light rain showers. Mechanical treatment is often recommended for clubmoss infestations.

	**145 – dotted gayfeather – PNWD – *Liatris punctata* (Aster Family*)* - PNWD** Has a corm (bulb-like rootstalk). Reproduces by seed and by the corm. The stem is erect and generally un-branched. Leaves are alternate, simple and linear-shaped. The leaf surface is dotted with pits. The inflorescence is a spike-like head. Flowers are pinkish-purple and number 4-8 per head. The pappus consists of white, feathery bristles.
	**146 - evening primrose - *Oenothera spp.* (Evening primrose family) - BNCV** Biennial to perennial herbs. Inflorescence a leafy-bracteate spike or sessil in axils of basal rosette leaves.
	**147 - field chickweed - *Cerastium arvense* (Pinks Family) - PNCI** Opposite leaves that are mostly oblanceolate or apatulate. Leaves of flowering stems spaced wider and much larger. Stiff-hairy and glandular stems and leaves. Flowers are in a 2 forked branched cluster, are terminal and white.
	**148 - fleabane - *Erigeron spp.* (Aster Family) - PNCI** There are many types of *Erigeron spp.* Infloresence mostly open, coymbiform or paniculate or solitary heads. Heads usually radiate, sometimes apparently discoid.
	**149 - hairy goldenaster - *Heterotheca villosa* (Aster Family) - PNWI** Has a woody taproot. Stems are erect, clustered and arise from a woody crown. Leaves are alternate, simple and are shaped linear to oblanceolate. Leaves are rough with short hairs and leaf margins are ciliate. Inflorescence is a head arranged in a corymb or cyme. There are 3-30 heads per branch. Ray and disk flowers are yellow-colored.
	**150 - harebell - *Campanula spp.* (Bellflower Family) - PNCI** These plants are perennial herbs with a milky sap. Leaves are basal and cauline with flowers being blue, corolla campanulate or funnelform.
	**151 – Hood's phlox - *Phlox hoodii* (Polemoniaceae family) - PNCI** A low, mat forming forb that grows only 2-8 cm high. Leaves are opposite and clustered. They are linear shaped, stiff and sharp-tipped. Leaves often have cobwebby hairs at the axils. Flower is a solitary white to purple flower at the stem tip. Flower petals are lobed.

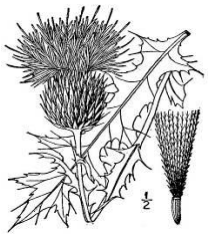
	*** 152 - houndstongue - *Cynoglossum officinale* (Borage Family) – BICV N** A robust, woody biennial. Has a thick, carrot-like taproot. The stem is solitary and only branched at the inflorescence. The stem has soft hairs, but is nearly smooth at the base. The lower leaves have petioles nearly as long as the leaf. The blades are slightly rough with soft hairs. The inflorescence is a raceme. Flowers are reddish-purple. Each flower has five sepals joined together at the base to form a star. The petals are fused in a funnel-shape. Seeds are covered with short, barbed prickles. This is a noxious weed in Montana.
	**153 - leafy spurge - *Euphorbia esula* (Spurge Family) – PICV N** Has aggressive, extensive rhizomes. Stems are filled with milk-like latex. Leaves are alternate and linear, with one prominent vein. Stems are thickly clustered. Stems and leaves are hairless. Flowers are yellowish-green, and arranged in an umbel. The flowers have paired heart-shaped yellow-green bracts. Flowers lack petals. Several male flowers surround one female. Each seed capsule produces three seeds. The deep roots make this plant difficult to manage and/or eradicate.
	**154 - loco weed - *Oxytropis spp.* (Pea Family) – PNCI P** Perennials often very short plant with persisten leaf bases. Infolorescnece is terminal. This plan is poisonous to livestock and can cause loco disease.
	**F24 – low larkspur – *Delphinium bicolor* (Buttercup Family) – PNCI P** A poisonous plant that can cause livestock loss. Larkspur has a tap-root. Leaves are simple, but palmately divided. The flowers are purple and arranged in a raceme. There is a spur on the flower that is formed by one of the sepals. Three pods eventually develop at the site of each flower.
	*** 156 - lupine - *Lupinus argenteus* (Pea family) – PNCI P** Lupine has a tap-root. Leaves are palmate, compound and divided into 5 to 7 finger-like leaflets. It has blue or dark purple flowers; occasionally white, pink or yellow. The flowers are arranged in racemes. Lupine can be poisonous. Hairy pods develop at each flower.
	**157 – manyflowered aster – *Symphyotrichum ericoides* (Aster Family) – PNWI** Stems are usually unbranched below, leaves basal.
	**158 – meadow deathcamas – *Zygadenus venenosus* (Lily Family) PNCI P** An erect perennial forb with a bulbous root. Leaves are mostly basal and linear. The leaves are strongly folded at the base. Inflorescence is a raceme. Their flowers are smaller and stem denser than showy deathcamas. White to yellowish-white are the primary colors of the flowers. Their stamens are longer than the petals. This plant is one of the more poisonous plants of the region.

	**159 - milkvetch – *Astragalus spp.* (Pea Family) - PNCI** Low growing taprooted perennials with compactly branched crowns. Stems are generally short and spreading to prostrate, much overtopped by leaves and peduncles. Herbage varies from bright green to gray-green to whitish. Most astragalus species will have hair, some are covered with dense pubescence. The hair is often an identification feature. Leaves are odd-pinnate. Flowers bloom in racemes on axillary peduncles. Flower color ranges from white to yellow to rose purple. Flowers are tubular with the typical wing and keel petals.
	**160 - miner's candle (butte candle) - *Cryptantha celosioides* (Borage Family) – BNCV** A tall cluster of white blossoms with five petals and yellow throats. They are in the Borage family, sometimes called the forget-me-not family. You can find them on dry soils in fields, mesas, and mountain foothills.
	**161 – Missouri goldenrod – *Solidago missouriensis* (Aster Family) – PNWI** Has well-developed rhizomes and often grows in patches. Sometimes the rhizomes produce leafy rosettes without seedheads. This can be confusing. Stems are single and colored brown towards the base. The lower leaves grow the largest. The upper leaves are much smaller. Leaf blades are lanceolate-shaped. There are 3 main veins/nerves per leaf. Most leaf margins are entire. However, the larger, older leaves may be toothed. There are many heads in a panicle inflorescence. The branches of the inflorescence lean/arch to one side. The heads bear golden ray and disk flowers.
	**162 – penstemon – *Penstemon spp.* (Figwort Family) - PNCI** There are many different species in the Genus Penstemon. Penstemons generally have fibrous roots and opposite leaves. Leaf shapes may vary greatly between species. Flowers grow in narrow panicles. The petals are tubular with 5 lobes. 2 lobes point upwards, while three face down. Seeds form in capsules. You will often notice the old capsules the following year. Penstemons are utilized primarily by sheep and wildlife.
	**163 - prairie coneflower - *Ratibida columnifera* (Aster family) - PNWI** Has a taproot and grows form a woody, branched crown. Stems turn brown with maturity and are deeply veined (ribbed). Leaves are simple, pinnately divided and arranged alternately. Leaves have hirsute hair on the surfaces. The inflorescence is an unusual-shaped head. The number of heads varies with each plant. The disk flowers are arranged on a receptacle that looks like a cylinder. Ray flowers are long, yellow and turn downward. Sometimes petals are colored maroon. Prairie coneflower is considered fair forage for livestock.
	**164 - prairie onion – *Allium spp.* (Lily Family) -PNCI** Prairie onion has a bulb for a storage structure. The bulb tastes and smells like an onion you would buy in a store. This plant has historically been utilized as a seasoning for foods. Prairie onion has linear, green leaves that arise from the base. The leaves are flat or channeled on the upper surfaces. The flowering stem has an umbel inflorescence. Flowers are initially enclosed in a white membrane, which is easy to observe. Be careful when picking wild onions to eat. The plant is often confused with death camas, which is very poisonous.
	**165- prairie smoke - *Geum triflorum* (Rose Family) - PNCI** Also known as "old man whiskers". The leaves are fern like, mainly basal and pinnately divided into many toothed or lobed leaflets. The flowers are purple to dusty pink in color, hairy and are usually found in loose clusters of 3. The fruits have 3 mm long achenes tipped with 2-4 cm long feathery bristles forming fluffy tufts., similar to "troll's hair".

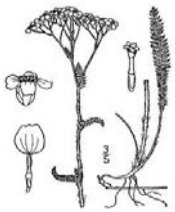
	**166 - purple prairie clover - *Dalea purpurea* - (Pea family) - PNWD** Warm season legume which can grow up to 1' tall. Several stems may grow from a single base. The flowers are pinkish-purple on elongated spikes. The flower head at the end of a wiry stem is cylindrical, with a fringe of rosy petals on a partly bare core. Leaves are divided into 3-5 narrow leaflets with may be sparingly hairy. May cause bloat in cattle, but it is seldom abundant enough to be a problem.
	**167 – pussytoes – *Antennaria spp.* (Aster Family) - PNCI** Very robust. The bract tips are bright white or seldom dull white or pinkish, dry corollas of female florets usually 5-8 mm long.

	*** 168 – salsify – *Tragopogon dubius* (Aster family) *BICV*** Because of its linear leaves, salsify often looks like grass early in the spring. However, its milky stem gives it away. It has a tap-root and a long hollow stem that is tipped with a head inflorescence. The ray flowers are yellow and gradually mature into a puffball. The seeds are attached to bristly parachutes that float in the wind.
	**169 - scarlet gaura - *Gaura coccinea* (Primrose family) - PNWI** Small perennial forb with small, narrow, alternate leaves crowded on stems from 4 to 20 inches long that tend to lean with upright side branches. Flowers are in terminal spikes in which flowering progresses from the base toward the tip. Sepals project backward, and 4 slender, spreading petals range in color from scarlet to pink to white. Forage value is considered poor.
	**170 – scarlet globemallow – *Sphaeralcea coccinea* (Mallow Family) - PNCI** A rhizomatous, low-growing forb. The entire plant is covered with star-shaped, stellate hairs. Leaves are simple and arranged alternately. The leaves are deeply divided. Orange flowers appear about this time of year. The flowers have five petals and are arranged in racemes. This plant is very drought resistant, because it can shed its leaves. It increases with overgrazing, and has fair forage value to livestock. Native Americans used this plant as medicine to treat burns.
	**171 - segolily mariposa - *Calochortus nuttallii* (Lily Family) - PNCD** This plant grows 6-18" tall, arising from an odorless, onion-like bulb. It blooms early, producing a tulip-like flower with 3 large cream-colored petals. Before flowering, the plant might be confused with death camas, but the leaf cross-section is U-shaped, unlike death camas which has a V-shaped leaf cross section.
	**172 - spotted knapweed – *Centaurea stoebe* (Aster Family) – P/BIWV** Spotted knapweed aggressively invades rangelands. It does not have rhizomes, so it relies on seeds for reproduction. It is a biennial, so the first year of growth it forms a rosette. The leaves are pinnately divided. The pink/purple flowers are in heads. There are only disk flowers in the heads. The bracts on the flower head are tipped/"spotted" with black.

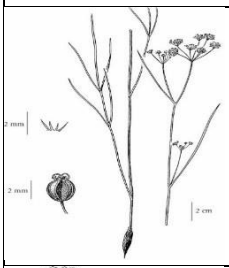
173 - sticky geranium - *Geranium viscosissimum* – (Geranium Family) - PNCD
Perennial. Stems erect, 15-90cm. Herbace strigose to villous, glandular, especially in the inflorescence. Leaf blades cordate, orbicular, 5-14cm wide, deeply cleft into 5- or 7 lobed segments. Flowers: sepals 8-12mm long, bristle-tipped; petals 12-20mm long, rose to purple; 10 fertile stamens. Casule 25-40mm long including the style column.



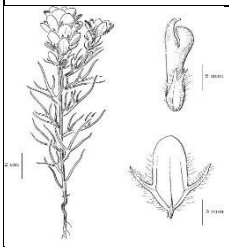
174 - wavyleaf thistle –*Cirsium undulatum* (Aster Family) – P/BNWV
Has a taproot. Grows a rosette the first year and then bolts during the second. It has stout stems with a single head inflorescence at the tops. The pink/purple flowers are all disk. The leaves have wavy, toothed margins. There are spines at the tips of the teeth. The leaves appear gray because they are covered with woolly hair. Leaves are largest at the base of the plant. Horses and wildlife may eat the seedheads.



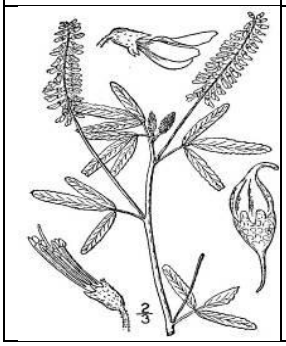
*** 175 - western yarrow – *Achillea millefolium* (Aster Family) - PNWI**
A rhizomatous forb. The entire plant is covered with hair. There can be one to several stems per plant. Leaves are simple, pinnately dissected and alternately arranged. The leaves are fern-like. The inflorescence is a corymb. This forb was used in a poultice to treat various injuries and ailments. It has a unique odor. Some kids think it smells like Noxzema. Cattle, sheep and wildlife utilize this forb a little bit during the growing season



176 - yampah – *Perideridia gairdneri* (Apiaceae) - PNWI
Perennial up to 100cm tall with erect, wiry, smooth stem. Flowers are tiny with white, scoop shaped petals and green hemispherical calyx; compound umbel: flowers are in small stalked umbels that make up the primary umbel. Leaves are split into threadlike leaflets to 15cm long.

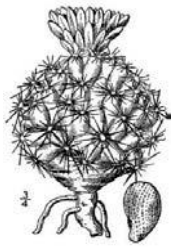
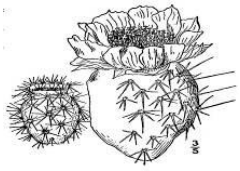


177 – yellow owl's clover – *Orthocarpus spp.* (Broomrape Family) - ANCV
Taprooted annual herbs. Leaves all cauline, alternate, sessile. Inflorescense dense, terminal, bracteate spikes, becoming expanded in fruit; bracts often wider than leaves. Flowers: calyx divided above into 4 acute lobes, the median clefts deeper than the lateral; corolla tubular, bilabiate, the upper lip (galea) beak-like, lower lip obscurely 3-lobed, pouch-like, nearly as long as the galea; stamens usually capitate. Capsule obovoid to globose.

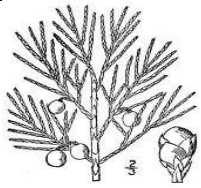


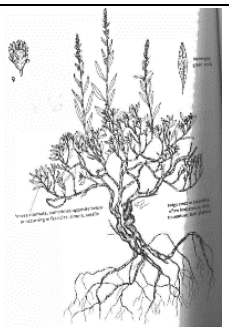
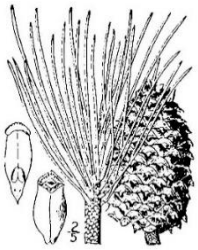
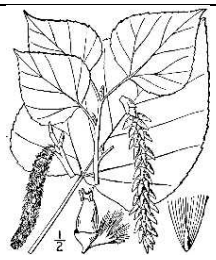
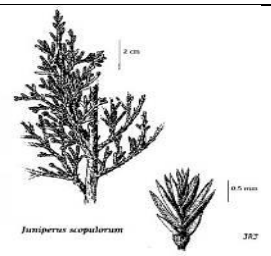
178 – yellow sweetclover – *Melilotus officinalis* (Pea Family) - BICV-
A tap-rooted biennial that is much-branched. It produces a rosette the first year. The second year it flowers. The leaves are palmately compound. The leaflets are toothed all around the edge. Yellow flowers develop in racemes. Sweetclover grows whenever conditions are favorable. Moldy sweetclover hay can be very toxic to livestock.

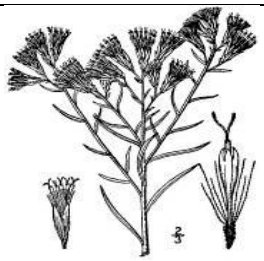
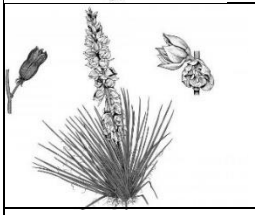
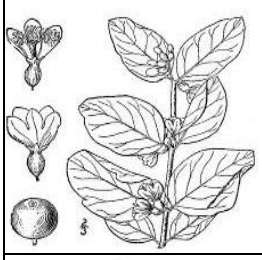
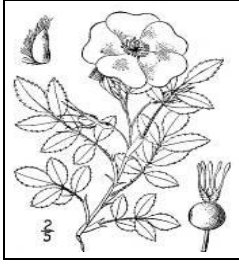
Cacti

	**179 - pincushion cactus - *Mammillaria spp.* - PNCI** **S**tems buried in soil. Spines white, weathering to brown, 11 to 55 per areole (small bumps out of which grows clusters of spines). Central spines 3-6, reddish. Flowers 2-3 cm long, tepals 21 to 56 yellow or magenta. Fruit green to brown.
	*** 180 – plains pricklypear – *Opuntia polyacantha* - PNCI** This cactus has flatten, jointed, succulent stem segments with spines over the entire surface. They have short lived fleshy, conical leaves. The flowers appear May-June and are yellow to pink to red. Fruits are greenish, fleshy, and spiny.

Half-shrubs, Shrubs & Trees

	*** 181 - big sagebrush - *Artemisia tridentata* - PNWI** Stems are woody with growth rings. Leaves are covered with hair and appear silver-gray. Leaves are also three-tipped or "three-toed." Flowers are heads. Deep tap root, no rhizomes. Evergreen shrub. Important winter browse species for a variety of rangeland animals.
	**182 – broom snakeweed – *Gutierrezia sarothrae* -PNWI** Low compact sub shrub with single to several stemmed base, erect fine branches arise and re-branch to from a dense crown, twigs green to brown. Leaves simple alternate, linear 1.5 to 4 cm. Flower heads tiny, numerous, in flat topped clusters yellow when in full bloom.
	**183 – chokecherry – *Prunus virginiana* -PNCD P** Large shrub or small tree often forming thickets. The bark is dark, red- brown. Twigs are red- brown with many white lenticels. Leaves are alternate and simple with serrulate margins. Flowers are in rather dense drooping racemes. Fruit is like a miniature cherry, round dark purple to nearly black when ripe.
	**S4 – Creeping juniper – *Juniper horizontalis* - PNXX** Is an evergreen, mat forming shrub that roots along the branches. Leaf color is highly variable from blue to dark green. Leaves are small, opposite, imbricate (overlapping) and scale like. This juniper produces cones that are powdery blue and berry-like.
	*** 185 – fringed sagewort – *Artemisia frigida* - PNWI** Is a warm season shrub with a tap root. It reproduces by seeds. Stems grow above the leaves and often persist from the previous year. The simple, alternate leaves look fringy because they are divided. Seedheads can be in panicles or racemes that bear yellow disk flowers. The flowers "bow" their heads late in the season. Fringed sagewort is aromatic and is a staple of many wildlife species.

	**186 - Gardner's saltbush - *Atriplex gardneri* - PNWD** Low, mostly dioecious subshrub to 50 cm high. Stems prostrate to usually decumbent with gray-scurfy foliage. Leaves short-petiolate; the blades linear to spatulate, 5-40 mm long with entire margins, the lowest sometimes opposite. Inflorescense glomerules in terminal spikes or dense panicles. Male flowers yellow or brown, 5-parted. Female flowers lacking a calyx; pisillate bracts united above the middle. Mature pistillate bracts lanceolate to orbicular, 2-5 mm long with toothed or winged margins and facial tubercles. Fine-tectures, saline soils of stream terraces, badlands, steppe, grasslands; plains, valleys, montane.
	**187 - gray horsebrush - *Tetradymia canescens* – PNWI P** Shrubs up to 80 cm tall. Leaves alternate, simple, entire, often in secondary fascicles. Stems unarmed; twigs tomentose. Heads discoid; involucre cylindric to obconic; phyllaries few in 1 series; receptacle flat, naked. Disk flowers 4 to 6, perfect, yellow; tube longer than the throat; style branches flattened. Pappus white, capillary bristles. Achenes 3-5 mm long, glabrous or sericeous. Grassland, sagebrush steppe; valley, montane.
	**188 - green rabbitbrush - *Chrysothamnus viscidiflorus* - PNWI** Shrubs. Stems spreading to erect, 10-50 cm, glabrous to puberulent; twigs brittle, white; bark gray. Leaves alternate, entire, linear, usually somewhat twisted, glabrous to puberulent, resinous, 1-4 cm long with 3 to 5 veins. Inflorescence tight-corymbiform with several heads on short peduncles. Heads discoid; involucres obconic, 4-9 mm high; phyllaries imbricate in 3 to 5 series, narrowly lanceolate, white to greenish; receptacle convex, glabrous. Disk flowers 4 to 8, perfect, yellow; corolla 4-7 mm long, tube shorter than throat; style branches linear. Pappus barellate, capillary bristles. Achenes obconic, 2-4 mm long, 5-angled, pubescent. Sagebrush steppe, grasslands; valleys, montane.
	*** 189 - ponderosa pine - *Pinus ponderosa* – PNXX P** Height of mature trees can range from 55' to 90'. Needles are 3-5" long with 3 needles in a cluster. The needles usually remain on the stem 3-4 years with the major needle drop in September and October. The cones are pineapple shaped, 3-6" long and take 2 years to mature. Bark is dark brown to nearly black when young and can be cinnamon brown to orange yellow. Deep tap root except on shallow soils where roots often follow cracks. Well adapted to grow on bare rock.
	**190 - quaking aspen - *Populus tremuloides* - PNCD** A rapidly growing tree, 10-20 meters tall. Grows from basal and root sprouts, and form colonies. Seedheads are catkins that droop. Capsules are borne as fruit in the catkins. Leaves are simple, oval to round, alternate and have serrated margins, with a long petiole, allowing them to "quake" in the wind.
	*** 191 – Rocky Mountain juniper – *Juniperus scopulorum* - PNXX** Dioecious shrub or small tree crown getting a pyramidal shape. Leaves are opposite or in whorls of 3, scale like, closely appressed, fleshy, thickened and rounded. Margins entire and smooth, gland on the back (abaxial) of the leaf. Twigs slender, flattened at first then becoming round, bark shreds easily.

	**192 – rubber rabbitbrush – *Ericameria nauseosa* - PNWI** Is a warm season shrub. The twigs of this plant are erect, flexible, and covered with tangled hair (tomentose). This shrub reproduces by seeds and root sprouts. The inflorescence is a cyme. The flowers are yellowish green. The plant has a unique odor when crushed and is used for browse by wildlife.
	**193 – serviceberry - *Amelanchier alnifolia* - PNCD** Forms dense thickets. The bark is smooth, and dark grey when mature. The leaves are alternate, oval shaped, with a rounded tip, and has a coarsely toothed margin on the upper half of the leaf. The flowers are white and star-shaped with 5 petals. The berries are like tiny apples.
	**194 - shrubby cinquefoil - *Dasiphora fruticosa* - PNCI** Erect shrub, new stems have silky bark, changing to shreddy reddish-brown bark when mature. Leaves are alternate, odd-pinnately compound, with 3-7 leaflets. The leaf margins are sometimes curled under. The leaf surfaces with appressed silky gray hairs. Flowers are yellow, buttercup like and regular with 5 petals, 5 sepals and arranged singly in leaf axils, or in clusters of 3 to 7.
	**195 - silver sagebrush - *Artemisia cana* - PNWI** Densely branched shrub with a rounded crown often forming colonies from extensive rhizomes. Flower heads in perfect terminal leafy panicles, subtended by leaf-like bracts that surpass the head. Leaves are alternate simple, with linear blades and entire margins. Twigs are green to straw colored, with the older stems brown to gray. Very aromatic.
	**196 - skunkbush sumac - *Rhus trilobata* - PNCD** Mid sized shrub, excellent for wildlife. Compound leaves are alternate and arranged ternate. Very distinct smell. Red berries and foliage appear in the fall.
	**197 – soapweed – *Yucca glauca* – PNCI** Perennial shrub of the Agavaceae family. Woody stems or woody bases, often tall with long and narrow leaves crowded in rosettes at end of stems or branches. A stout rapidly growing flower stalk arising from the rosette.
	**198 – western snowberry – *Symphoricarpos occidentalis* - PNCI** A rhizomatous shrub that forms dense thickets. Leaves are opposite and oval or ovate. Leaf margins are mostly entire or irregularly lobed. Petioles are glabrous to pubescent. The flowers are clustered in groups of 6-14 at tips of stems. Flowers are greenish white to purple. The fruits start as white and turn blue to black.
	*** 199 – wild rose – *Rosa spp.* - PNCI** Shrubs. Stems spiny, branched above. Leaves cauline, petiolate, stipulate, pinnately divided into 7 to 11 dentate leaflets; stipules green, leaf-like, adherent to the petiole base. Inflorescence a small cyme or flowers solitary. Flowers perfect, perigynous; hypanthium almost completely enclosing the ovary; selpals5; petals pink to rose, shallowly lobed at the tip; stamens numerous; pistils 10. Fruit a swollen, pulpy hypanthium (hip) enclosing the hairy achenes.

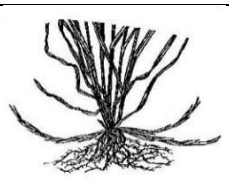
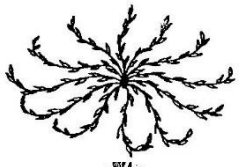
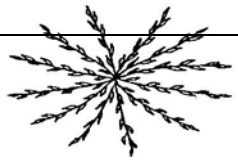
200 – winterfat – *Krascheninnikovia lana* – PNWD

This subshrub has also been known as *Eurotia lanata* and *Ceratoides lananta.*
Monoecious or dioecious subshrub with stellate-pubescent, long-hairy foliage. Stems erect, to 40 cm, woody only at the base. Primary leaves short-petiolate, linear, narrowly oblanceolate, 1-2 cm long with entire margins; tomentose; fascicled leaves smaller. Inflorescence heads terminating branches in a corymbiform. Flowers unisexual, apetalous. Male flowers a 4-parted calyx with 4 stamens. Female flowers enclosed in 2 partly united bracts; calyx absent.
Achenes Fruit enclosed by densely long-hairy bracts, 4-6 mm long with divergent horn-like tips. Grasslands, steppe; plains, valleys, often with sagebrush.


Plant
Anatomy

PLANT GROWTH HABIT / FORM

The "style" of a plant is called the growth habit or growth form.

GROWTH HABIT/FORM	DESCRIPTION	VISUAL	EXAMPLE
STATURE	Describes size of plants in relation to other plants in the community.		**Tall –** prairie sandreed, basin wildrye, pubescent wheatgrass **Mid –** needle and thread, crested wheatgrass, little bluestem **Short –** blue grama, plains muhly
BUNCH	Grows in a tuft or bunch.		Idaho fescue, prairie junegrass, threadleaf sedge
SOD-FORMING	Grows as a single plant.		plains reedgrass, prairie sandreed, smooth bromegrass, needleleaf sedge
ASCENDING	Multiple stems grow upward from the base of the plant.		purple point loco
DECUMBANT	The base of stems are prostrate, but stem tips curve up		hairy goldenaster
ERECT	Stems grow up and branch at approximately 45 degree angles		rush skeletonplant
PROSTRATE	Stems grow nearly flat to the ground		groundplum milkvetch

THE FACTS ABOUT PLANT PARTS

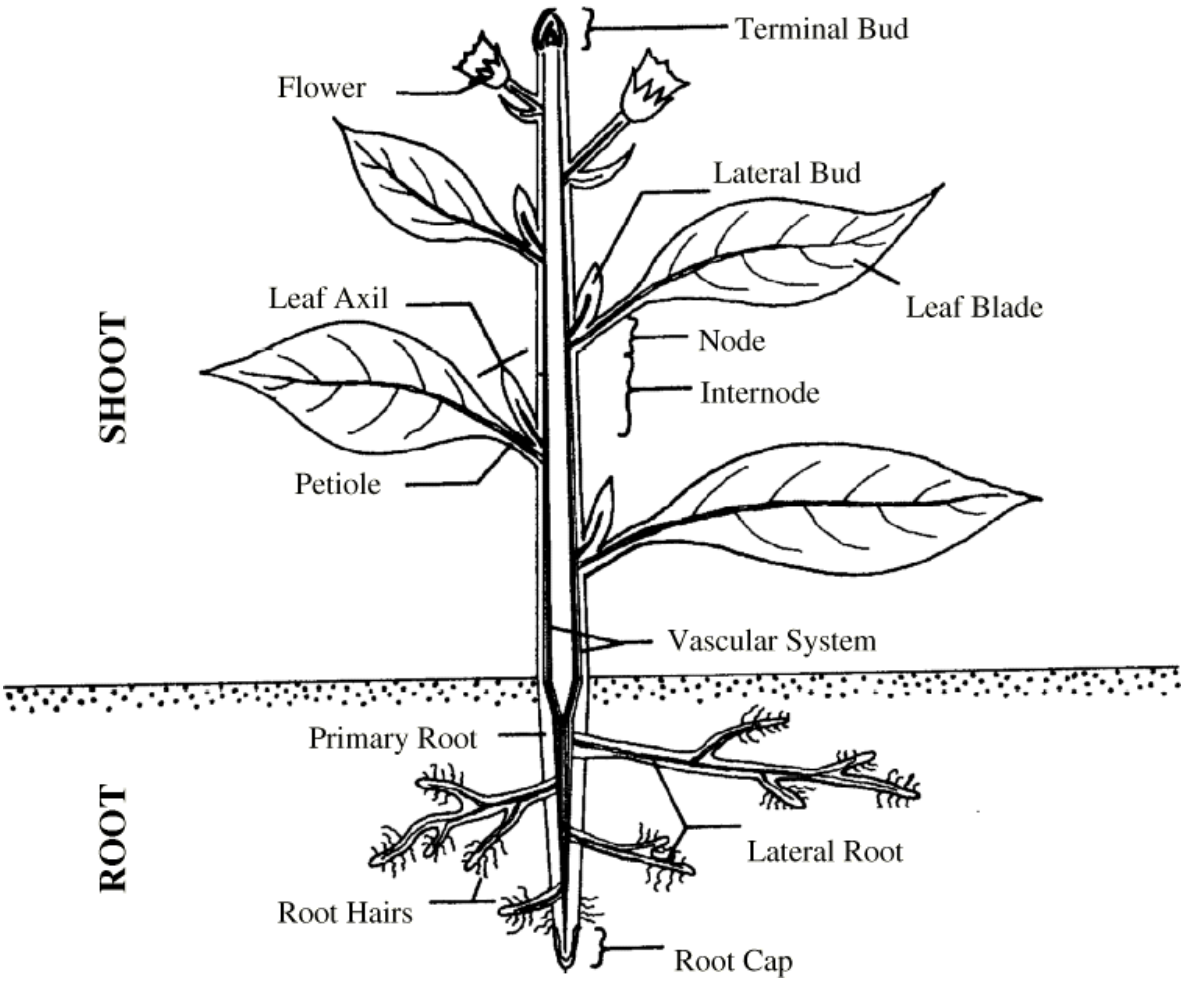
The vascular, flowering plants that you find on rangelands all have the same basic structure.

Vegetative parts: Roots, Stems, Leaves

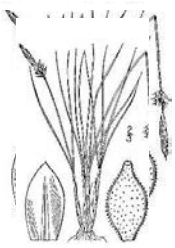
Reproductive parts: Seedheads

The characteristics of the roots, stems, leaves and seedheads are unique for each plant species. These differences affect plant physiology and growth. They also help us to classify plants.

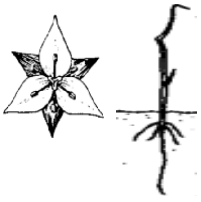
Principal Parts of a Vascular Plant



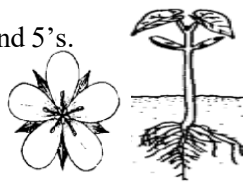
PLANT DIFFERENCES

	Plant Type	Visual	Roots	Stems	Leaves	Flowers
MONOCOTS (CAN ALSO INCLUDE FORBS)	**Grasses**		Fibrous	Hollow, jointed, has "knees"	Linear leaves with parallel veins	Non-showy, wind pollinated
	Grass-likes		Fibrous	Solid, round or triangle shaped stems ("Sedges have edges"), non-jointed	Linear leaves with parallel veins, sometime leaves reduced	Non-showy, wind pollinated
DICOTS	**Forbs**		Majority are tap	Solid, round or square shaped, non-jointed	Leaves variously shaped, leaf veins netted	Showy, pollinated by insects
	Shrubs & Trees		Tap	Woody with growth rings	Leaves variously shaped, leaf veins netted	Showy, pollinated by insects

Definitions



Monocot - has one seed leaf and consists of flower parts (pedals) mostly in 3's.
Includes: grasses, grass-likes and forbs.



Dicot – has two seed leaves and consists of flower parts (pedals) mostly in 4's and 5's.
Includes: forbs, shrubs and deciduous trees.

PLANT FAMILIES

Plants belong to families. Plants are divided into families by flower and vegetation characteristics. Family names usually end in **aceae**. Families are separated into genus and species.

Example Path: **Dicot** **Asteraceae** (family) **Arnica** (genus) **soria** (species)

Sometimes families are also divided into tribes. Tribe names end in **eae.**

Example Path: Monocot Poaceae (family) **Poaeae** (tribe) **Poa** (genus) **Pratensis** (species)

Grasses are in the family Poaceae, called Gramineae in some plant books. There are 14 tribes.

Some common "grass tribes" that we see at MRD each year include:

TRITICEAE - wheatgrasses

- Spikelets laterally compressed (squeezed)
- Spikelets 1 to many flowered, fall apart above the glumes
- Glumes 2, shorter than the lowest floret
- Usually a spike inflorescence
- Auricles

STIPEAE - needlegrasses

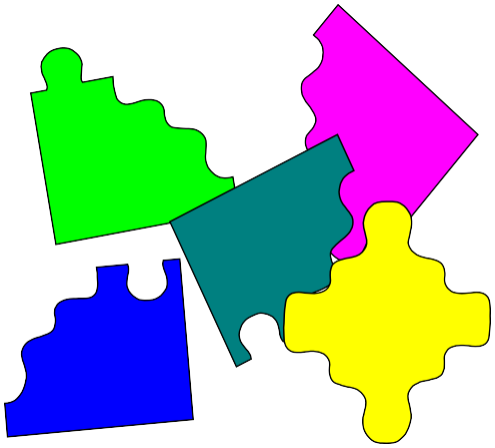
- Spikelets laterally compressed (squeezed)
- Spikelets 1 flowered, fall apart above the glumes
- Glumes 2, as long or longer than the lowest floret
- Lemmas harden with maturity (think about the needle on needle and thread)
- Lemmas awned
- Panicle inflorescence

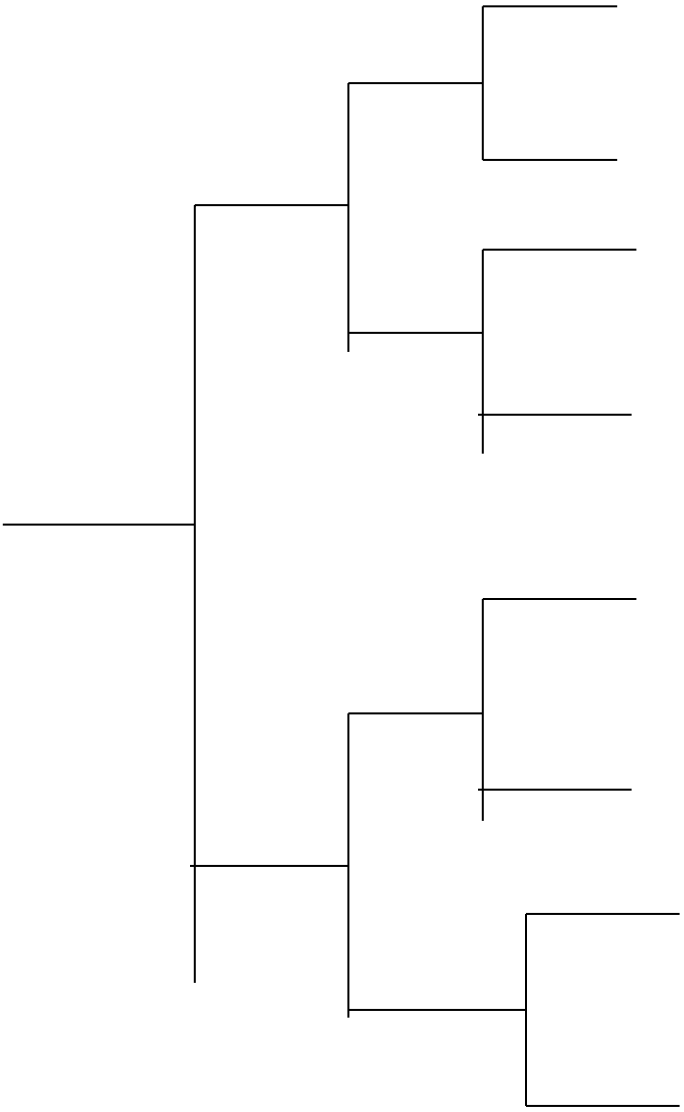
POEAE - bluegrasses

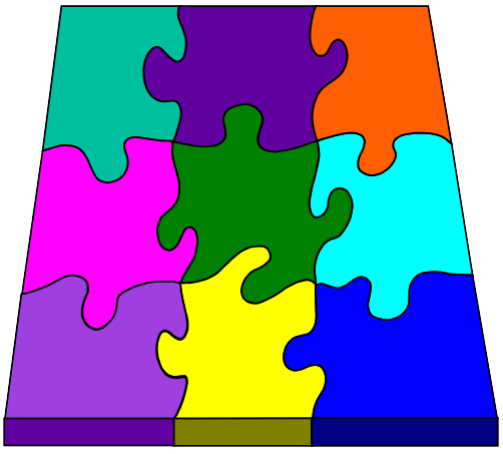
- Spikelets laterally compressed (squeezed)
- Spikelets many flowered
- Glumes 2, shorter than the lowest floret
- Panicle inflorescence
- Plants are monoecious (male and female flowers on the same plant)
- Ligules are membranous

How do we sort out all the plants? **Dichotomous keys** are useful tools. A dichotomous key can be thought of as a roadmap to the identity of a plant. The “di” in dichotomous means “two”.

A dichotomous key branches into two choices at each junction of the map. Your choices of which branch to take within the key will lead you to a plant name.







The dichotomous key below directs us to plant types.

DICHOTOMOUS KEY TO PLANT TYPES

1A. Plant has a fibrous root……(Hint: If yes go to 2a. If no go to 1B)

2a. Plant has a hollow stem *with joints* (nodes), parallel leaf veins and non-showy flowers ..... Grass

2b. Plant has a solid stem (sometimes hollow) *without joints* and parallel leaf veins.....

3a. Plant has non-showy flowers.....Grass-like

3b.Plant has showy flowers ..... Forb (monocot)

(ex. R.M. iris, wild onion)

1B. Plant has a tap root……..

4a. Plant stems are solid, not woody, leaves with net veins, flowers are Showy ..... Forb (dicot)

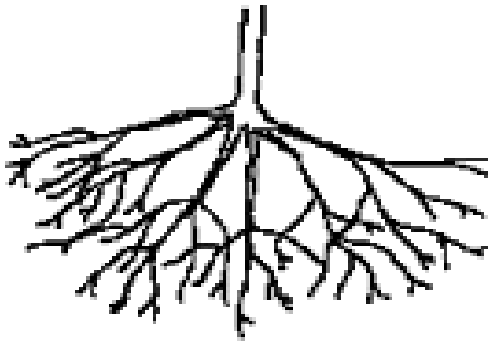
4b. Plant stems are woody with growth rings, leaves with net veins,

flowers are showy .....Shrubs

ROOTS

Roots keep the plant anchored and upright in the soil. They absorb water and nutrients from the soil profile.

Roots are generally shaped like a carrot (tap root) or like hair (fibrous root). Note the color and texture of roots. Ex. Threadleaf sedge has black, wiry roots. Bracted spiderwort has white roots.

TAP ROOT Most forbs For example: dandelion, milkwort, prairie coneflower, lupine	**FIBROUS ROOT** Grasses and some forbs For example: threadleaf sedge, needle and thread, Idaho fescue, bracted spiderwort, star lily
	

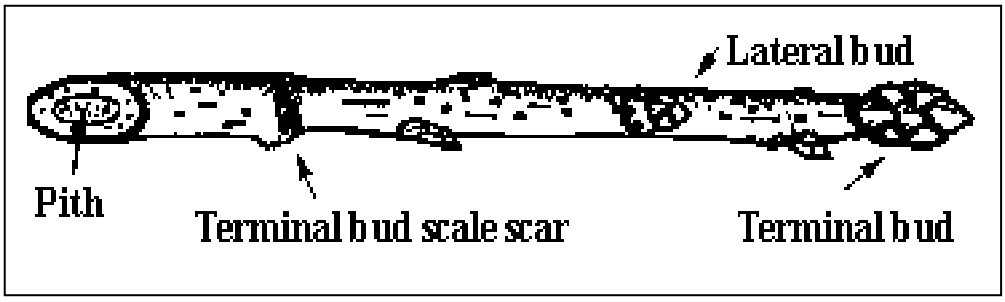
STEMS

Inside the stem of a plant, water, food, air and soil minerals are transported through veins to different plant parts. The stem produces and displays leaves, flowers and fruit. Stems also store food in modifications like tubers or bulbs.

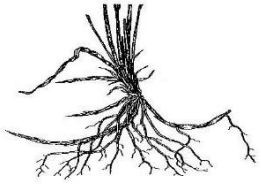
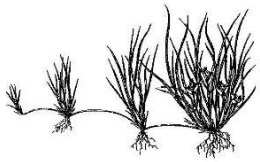
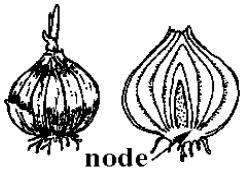
You can observe the shape and texture of a stem just by looking at it. Sedge stems will be triangle shaped. Northern bedstraw will have a square stem. Grass stems have visible nodes (knees). Prairie coneflower has a heavy-veined stem (ribbed).

If you cut through the stem, you can observe the inside also. Grass stems will be hollow. Forb stems will be solid. Woody stems will have growth rings and a pith inside.

TRY IT! Cut through a cottonwood branch, the pith is shaped like a star. Measure the age of a young deciduous tree by counting the terminal bud scale scars.

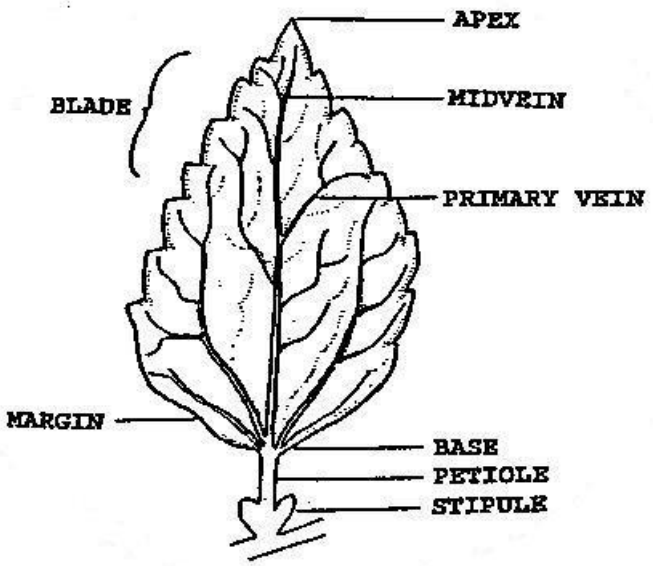


MODIFIED STEMS/STORAGE ORGANS

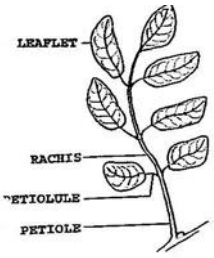
MODIFICATION	DESCRIPTION	VISUAL	EXAMPLE
RHIZOMES	A rhizome is a horizontal, underground stem, with nodes, internodes, leaf scales and buds. At the nodes, shoots may develop into new plants. Sod-forming grasses have rhizomes.		western wheatgrass, smooth bromegrass, western yarrow, silver sagebrush
STOLONS	A stolon is an above-ground horizontal stem. Stolons have nodes and long internodes. New plants may grow from the nodes.		buffalo grass, wild strawberries
CORMS	An enlarged, fleshy, underground stem. Corms are solid and not formed in layers. A corm has nodes, internodes, stems and buds. Lateral buds form along the nodes at the side of the corm. Regular buds and flower stems form at the top. Roots grow from the bottom.		Rocky Mountain iris, dotted gayfeather, timothy
BULBS	An underground modified stem, formed with layers of leaves surrounding a stem. The bulb stores food and water to sustain a plant through a cool or dry season. The food is stored in the leaves. In the spring, roots grow from the stem of the bulb. New shoots and bulbs originate from the growing points of the bulb's layered leaves. When you eat an onion, you are eating the leaves.		wild onion, death camas

LEAVES

Leaves are “food factories” for a plant. Plants use sunlight, water and carbon dioxide to manufacture plant food (carbohydrates) and oxygen. The oxygen is released into the atmosphere.



LEAF TYPE

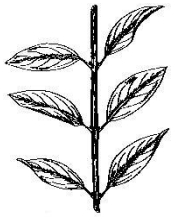
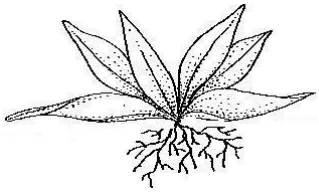
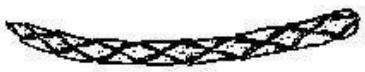
SIMPLE LEAVES - ***Leaf blade is a single, undivided structure.***	**COMPOUND LEAVES**- ***Leaf blade is divided into sub-structures.***
Example: prairie coneflower, hairy goldenaster, scarlet globemallow, penstemon spp., sunflower spp., pussytoes, snowberry spp., chokecherry, curlycup gumweed	Each substructure (leaflet) has its own stalk (petiole). Example: Purple prairie clover, lupine spp., milkvetch spp., American licorice, alfalfa, sweetclover, green ash, rose spp., skunkbush sumac, shrubby cinquefoil
	

LEAF ARRANGEMENT

Leaves are arranged different ways on the stem. If you are trying to tell the difference between a grass and a grass-like, you should pay attention to whether the leaves are 2 or 3 ranked.

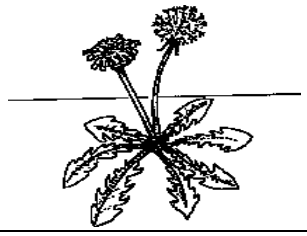
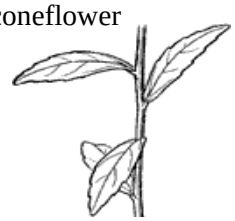
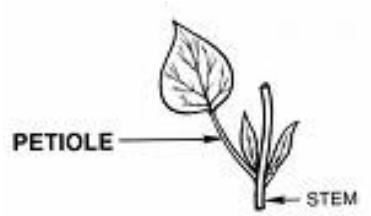
2-RANKED - Grass (leaves on 2-sides)	**3-RANKED – Grass-like (leaves on 3-sides)**
	

If you are examining a forb or a shrub, you might notice some of the following leaf arrangements:

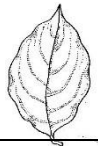
OPPOSITE -*Two leaves at each node.* Example: sugarbowl, Oregon grape, snowberry spp., phlox spp., stiff sunflower, arnica spp., penstemon spp., many spp. in the mint family, common St. Johnswort, silver buffaloberry, showy milkweed 	**ALTERNATE - *A single leaf at each node.*** Example: western yarrow, stonecrop, leafy spurge, curlycup gumweed, lupine spp., blue flax, skunkbush sumac, chokecherry, American licorice 
WHORLED - *More than two leaves per node.* Mostly the various bedstraws. Northern bedstraw is one example. Also windflowers (anemone spp.), prince's pine and bunchberry (Cornus canadensis). 	**ROSSETTE - *The basal first year growth of a biennial plant.*** yellow sweetclover, wavyleaf thistle, curlycup gumweed 
IMBRICATE - *Overlapping leaf arrangement.* Rocky Mountain juniper 	**FASCICLED - *Closely clustered or grouped.*** All species of pine. 

LEAF ATTACHMENT

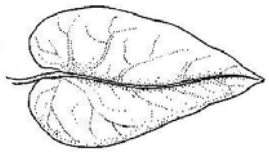
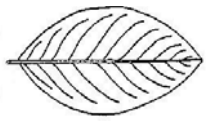
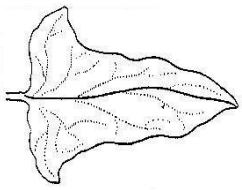
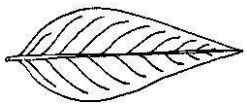
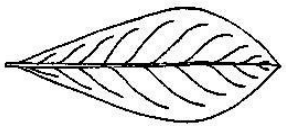
Plant leaves are attached to the stem in different ways. A dandelion would be a good example of a forb with basal leaves.

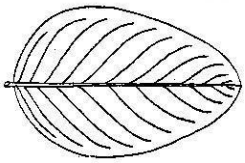
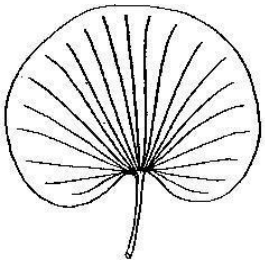
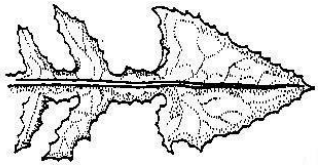
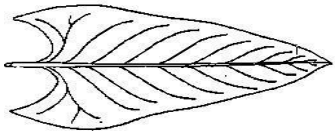
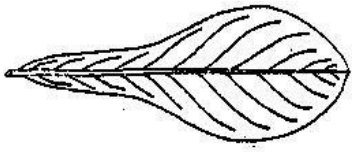
ACAULINE (BASAL) dandelion 	**CAULINE (SESSILE)** prairie coneflower 
CAULINE (PETIOLATE) cottonwood 	**CAULINE (CLASPING)** Dalmatian toadflax, Virginia pepperweed 

LEAF VENATION

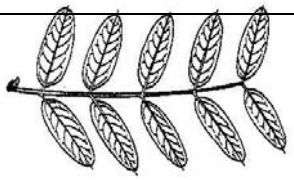
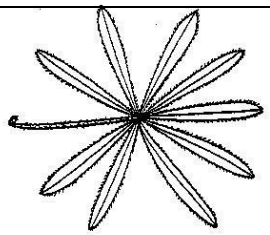
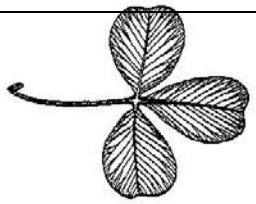
VENATION TYPE	DESCRIPTION	VISUAL	EXAMPLE
ARCUATE	Veins are curved upward like a bow		lilac, snowberry
PALMATE	Several main veins radiating from the base of the leaf with smaller veins branching from them.		snowbrush, black samson, false Solomon's seal
PARALLELL	Veins do not branch. Veins run straight up and down without intersecting.		Compare the veins of an iris, western wheatgrass and Kentucky bluegrass.
PINNATE	One main mid-vein with smaller, lateral veins branching from it.		chokecherry, elm spp., mountain ash leaflets
RETICULATE	Veins in the form of a network.		thimbleberry

SIMPLE LEAF SHAPES

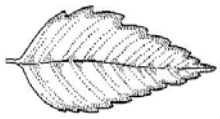
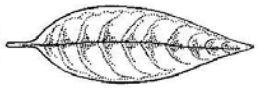
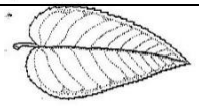
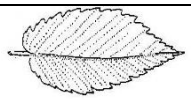
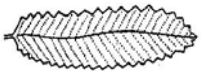
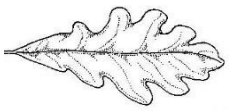
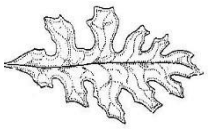
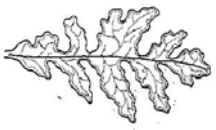
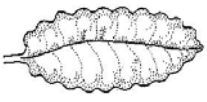
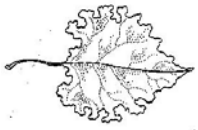
SIMPLE LEAF SHAPES	DESCRIPTION	VISUAL	EXAMPLE
ACICULAR	Needle-shaped		pine, fir, spruce species
CORDATE	Heart-shaped.		arnica spp., heart leaf alexanders, some violet spp., wild ginger
ELLIPTIC	Football shaped. Leaves rounded at both ends and widest at the middle.		elm, rose leaflets, chokecherry
HASTATE	Shaped like an arrowhead with the basal lobes pointed outward and spreading at a wide angle.		red sorrel, field bindweed
LANCEOLATE	Lance shaped. Leaves several times longer than wide, the widest half near the base. Tapering to the apex.		lupine leaflets, stonecrop, mountain ash, curlleaf mountain mahogany, fireweed
LINEAR	Leaves very narrow with parallel margins.		blue camas, broom snakeweed, rubber rabbitbrush, blue flax, leafy spurge, silver sagebrush, butter and eggs
OBLANCEOLATE	Lance shaped. Several times longer than wide. Wider towards the top of the leaf. Tapers to the base and the tip of the leaf.		houndstongue

OBOVATE	Opposite of ovate. The widest part is at the top of the leaf.		serviceberry, mountain mahogany, sweetclover leaflets
OVATE	Egg-shaped. Leaf attached at the broad end.		red osier dogwood, quaking aspen, snowberry
RENIFORM	Kidney shaped		common mallow
RUNCINATE	Sharply pinnately lobed with the lobes pointed backwards.		dandelion
SAGITATE	Leaves in the shape of an arrowhead with the basal lobes pointed backward towards the petiole.		arrowleaf balsamroot
SPATULATE	Spoon shaped. Broad and rounded at the top. Long and narrow toward the base.		Gardner saltbush, curlycup gumweed (sometimes), kinnikinnick

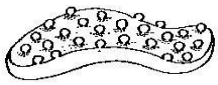
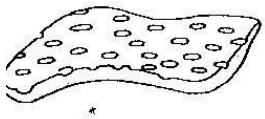
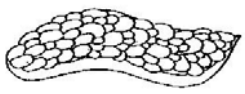
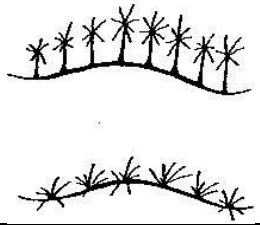
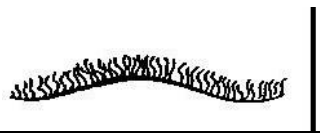
COMPOUND LEAF SHAPES

COMPOUND LEAF SHAPE	DESCRIPTION	VISUAL	EXAMPLE
EVEN-PINNATE	Leaflets are paired at the apex of the leaf.		American vetch
ODD-PINNATE	A single leaflet at the apex of the leaf.		Rosa spp., purple prairie clover, purple point loco, Oregon grape, tall cinquefoil
PALMATE	Leaflets radiate from a central point.		silverleaf scurfpea, lupine spp.
TRIFOLIATE	Three leaflets from one point.		goldenpea, alfalfa, sweetclover, slimflower scurfpea, milkwort spp.
TERNATE	Compound leaf divided into three from different points.		skunkbush sumac

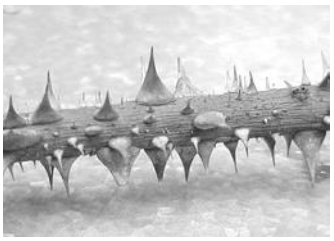
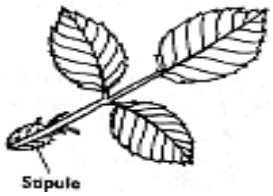
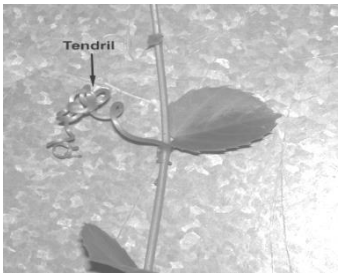
LEAF MARGINS

MARGINS	DESCRIPTION	VISUAL	EXAMPLE
SERRATE	Coarsely toothed with teeth pointing forward.		Rosa spp., snowbush ceanothus, Oregon grape, serviceberry, Wyoming kittentail (Besseya)
ENTIRE	Smooth leaf margin		showy milkweed, snowberry, broom snakeweed, fireweed, silver buffaloberry
SERRULATE	Finely serrated with teeth pointing forward.		chokecherry
DOUBLE SERRATE	Twice toothed leaf margin		mountain ash, mallow ninebark, black hawthorn (sometimes)
DENTATE	Angular teeth that are at right angles to the margin.		Some of the mint family
CILIATE	Leaf margins are fringed with fine hairs.		black samson, hairy goldenaster
LOBED	Divisions less than one-half the distance to the base or midvein.		golden currant, bur oak
CLEFT	Divisions that extend halfway or more to the midvein.		low larkspur, Tall larkspur
DIVIDED	Divisions that extend to near the midvein.		scarlet globemallow, pineappleweed, globeflower, prairie coneflower.
SINUATE	Strongly wavy margins		false dandelion, curly dock
EROSE	Appears eroded		cottonwood

LEAF SURFACES

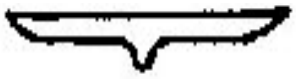
LEAF SURFACES	DESCRIPTION	VISUAL	EXAMPLE
GLABROUS	Smooth, without hair		penstemon, whitetop, scarlet gaura
GLANDULAR	Supplied with glands		common St. Johnswort, slimflower scurfpea, black sagebrush, curly cup gumweed, sticky geranium
HIRSUTE	With straight, stiff hairs		prairie coneflower
FARINOSE	Mealy, white material that scrapes off		lambsquarters
PITTED	With depressions in the surface of the leaf		dotted gayfeather
PUBESCENT	Covered with soft hairs		woolly plantain
SCURFY	Covered with small scales		buffaloberry
STELLATE	Star-like hairs		scarlet globemallow
STRIGOSE	Short, stiff hairs		hairy goldaster, black samson
TOMENTOSE	Matted, tangled hairs		rubber rabbitbrush, spotted knapweed

LEAF AND STEM MODIFICATIONS

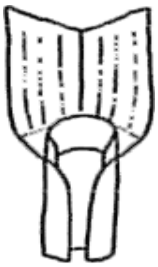
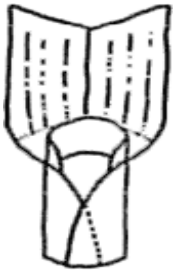
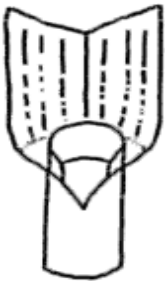
MODIFICATIONS	DESCRIPTION	VISUAL	EXAMPLE
PRICKLES	Modified skin (epidermal) cells		Rose spp.
SPINES	Modified leaves		cactus
STIPULES	Modified leaves at the leaf axil (paired)		rose, snowberry
TENDRILS	Modified leaves that twine		American vetch
THORNS	Modified branches		buffaloberry, hawthorn, Russian olive

GRASS LEAVES MAJOR GRASS LEAF PARTS

LEAF BLADE - *The leaf blade is much longer than wide and most commonly flat. This leaf breaks away from the stem at the collar. When you are looking at grass leaves, pay attention to the cross-section shape, the texture of the surface and the style of the veins.*

FLAT	ROLLED	V-SHAPED OR KEELED (FOLDED)
Images: Kansas State University 		
Ex. western wheatgrass, bluebunch wheatgrass, prairie junegrass, blue grama, cheatgrass, smooth brome	Ex. The leaves of many grasses roll with maturity or dry conditions. Indian ricegrass and Idaho fescue have rolled leaves all the time.	Ex. Kentucky bluegrass, little bluestem (sometimes)

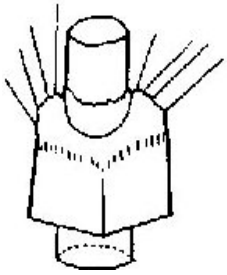
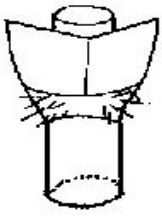
LEAF SHEATH - *The leaf sheath is the lower part of the leaf that begins at the node. The sheath encloses the stem to the collar.*

SPLIT-OPEN	SPLIT OVERLAP	CLOSED
Images: Kansas State University 		
Ex. blue grama	Ex. prairie sandreed	Ex. smooth brome

MINOR GRASS LEAF PARTS

You can find one or more minor leaf parts at the junction of the leaf blade and sheath. These structures are very useful for grass identification.

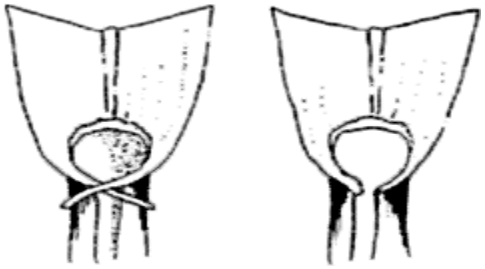
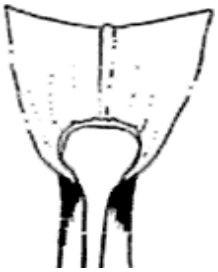
COLLAR - *The collar is a tiny band where the leaf blade and sheath join and is usually a different color.*

SMOOTH	CILIATE	HAIRY
Image: Kansas State University 		
Ex. smooth brome	Ex. sand dropseed, blue grama	Ex. pinegrass

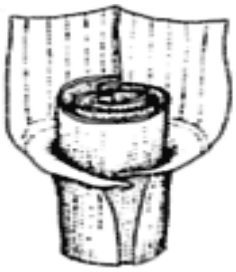
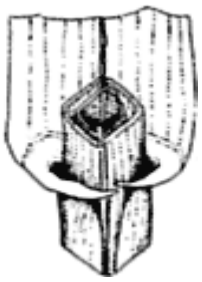
LIGULE - *The ligule is located inside the leaf next to the stem, and prevents dust and water from running between the sheath and stem of the grass. Ligules vary. They may be a white, papery membrane, or just hair. Some grasses do not have ligules at all.*

MEMBRANOUS	HAIRY/CILIATE	ABSENT
		
Ex. Needle and thread	Ex. blue grama, switchgrass	Ex. western wheatgrass

AURICLE - *Auricles are the "claws" that are located on the front side of the collar. Auricles hug the stem. Many grasses do not have auricles, but the wheatgrasses always do.*

PRESENT	ABSENT
Images: Kansas State University 	
Ex. western wheatgrass	Ex. smooth brome

VERNATION – *Vernation refers to how the leaves are arranged in the buds.*

ROLLED	FOLDED
Images: Kansas State University 	
Ex. western wheatgrass	Ex. Little bluestem

VEINS - *Veins are tiny vessels that carry food and water throughout the plant. Veins run up the sheath and down the leaf blade*

NODE - *The node is the point where the leaf begins its growth. The node hardens over time and then can support the stem. Some grasses have colored nodes.*

GRASS SEEDHEADS

Grasses do not have colorful, showy flowers, but once you understand the basic parts of a grass seedhead, you will begin to notice many differences between grass species.

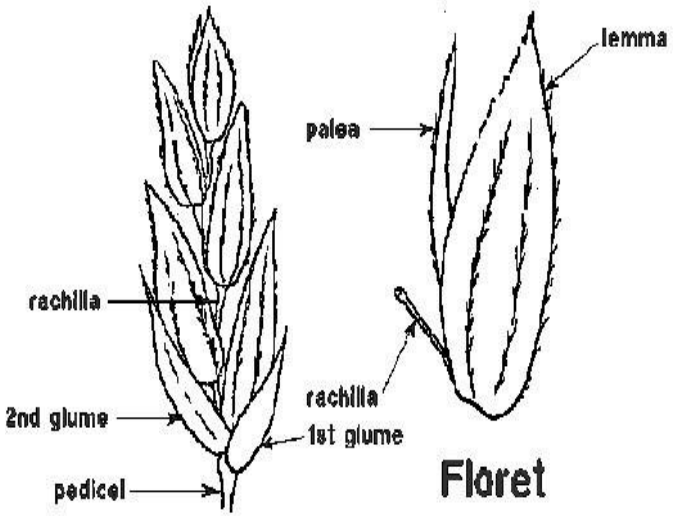
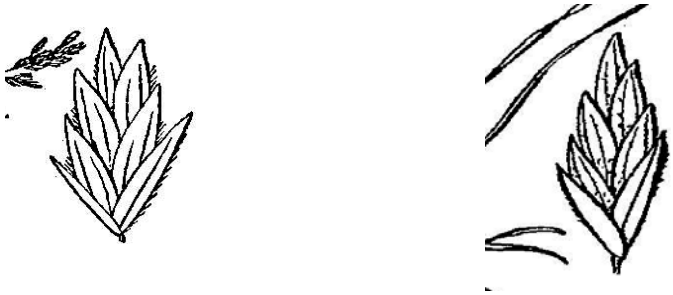
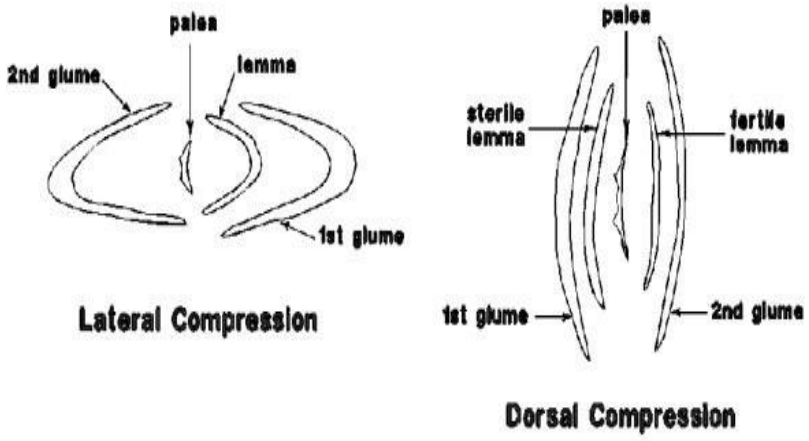


Image: University of Illinois Turfgrass Program

Grass seedheads have spikelets that consist of glumes (modified leaves) and florets (flowers). Look at some grass spikelets. The spikelets can be long and narrow (Sandberg bluegrass), or short and wide (Kentucky bluegrass). .



Spikelets might be squeezed or flattened a specific way. Most are squeezed (compressed) from top to bottom (laterally). Grasses in the panicum genus are compressed from the sides (dorsally).

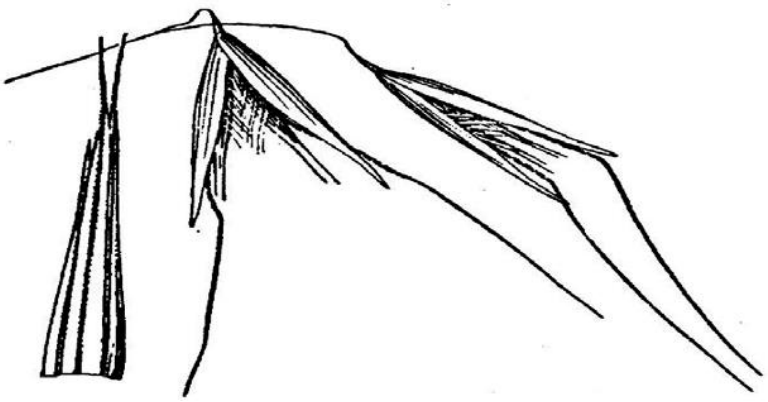


When some grass seedheads are mature the whole spikelet breaks off (disarticulates) below the glumes. Other grasses have glumes that remain on the seedhead, just the florets fall off.

(Image: University of Illinois Turfgrass Program)

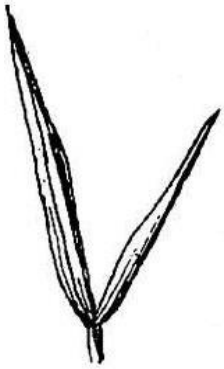
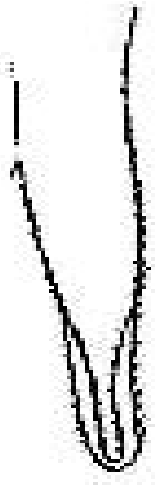
Sometimes awns on florets and/or glumes will help you identify grasses. The needlegrasses have very interesting awns.

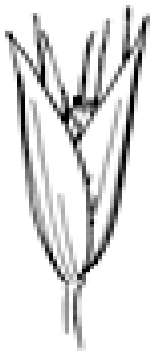
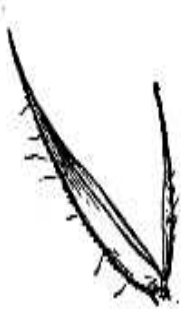
The number of nerves (lines) on the spikelet parts can also help with plant identification. Try counting the nerves on the glumes and florets of domestic oats or wild oats.



Spikelets will have unique glume characteristics that are easy to observe out in the field. Glumes can be long, short, equal or unequal. They can have a variety of textures: paper-like (membranous), bristle-like, awned or absent (missing). Some grasses have 1 or both glumes missing. See the illustrations below as you analyze the glumes.

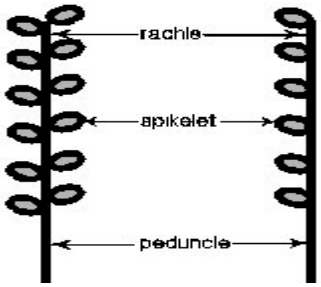
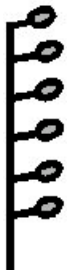
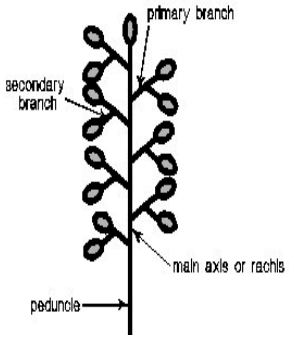
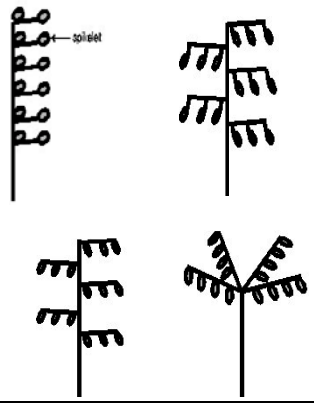
GLUME CHARACTERISTICS

Membranous	Bristle-like
	
Ex. smooth brome	Ex. Canada wildrye

Equal	Non-equal
	
Ex. Needle and thread	Ex. western wheatgrass

SEED HEAD ARRANGEMENTS

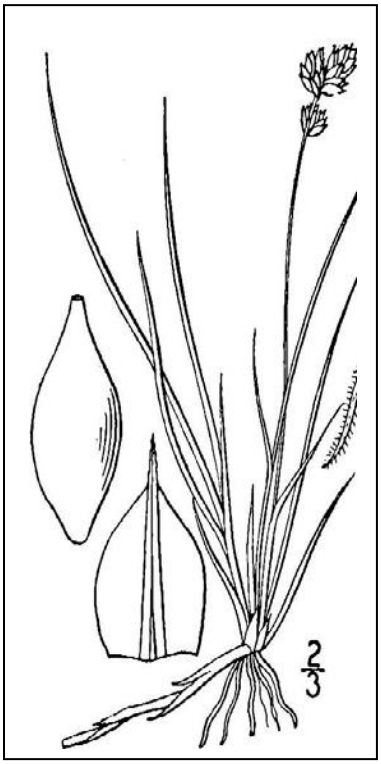
When studying grasses, there are three common types of seedhead arrangements: spike, raceme, and panicle. Warm season grasses also have a variety of spike-like inflorescences. These common arrangements also apply to other plant types.

COMMON SEEDHEADS	DESCRIPTION	VISUAL	EXAMPLE
SPIKE	Flowers are attached directly to the rachis		wheatgrasses, woolly plantain, yellow evening primrose, skunk cabbage
RACEME	Flowers attach to a pedicel which attaches to a rachis it is a raceme (one branch) Some racemes are spike-like. For example, think of the blue grama seedhead shaped like an eyebrow)		chokecherry, death camas, crazyweed, sweetclover, mustards, lupine, sideoats grama
PANICLE	Flowers attach to multiple pedicels which attach to a rachis (many branches) The length of the panicle branches varies. Japanese brome has long panicle branches, while prairie junegrass and timothy have very short branches (compact panicle).		prairie junegrass, Japanese brome, green needlegrass, Kentucky bluegrass, Idaho fescue, switchgrass
SPICATE RACEME/ SPICATE PANICLE	Panicle or raceme inflorescences that have spike-like branches. Typical of warm season grasses.		blue grama, sideoats grama, tumblegrass, little bluestem

GRASS-LIKE PLANTS

It is important to learn about grass-like plants because they are important to riparian areas and wetlands. These areas are important for livestock and also wildlife.

SEDGES



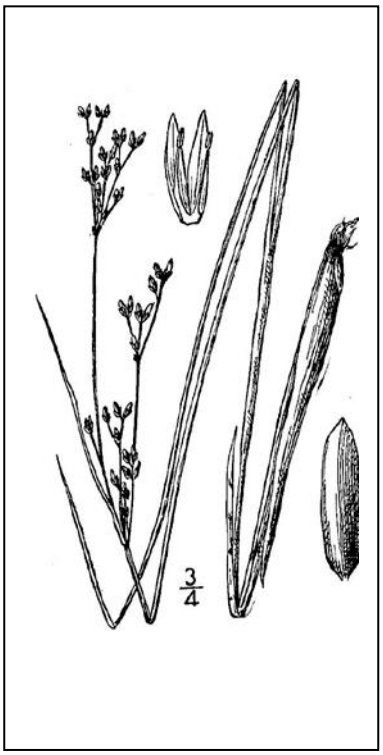
Sedges are very unique and fun to study.

Sedge leaves are in *three rows* along the stem. The sedge leaf is Divided into three parts: *the blade, sheath and ligule.* The ligule *is not* an important distinguishing characteristic on sedge plants.

Sedge leaf blades that appear to have raised nerves are called septate-nodulose. The cross sections of leaf blades vary from flat to involute (tightly rolled).

The leaf sheaths of some sedges fray along the nerves near the base of the culms and are called *filamentose.* Threadleaf sedge is an example.

When the lower leaves are reduced to bladeless sheaths they are referred to as *aphyllopodic. Phyllopodic* is the term used to describe well-developed lower leaf blades.



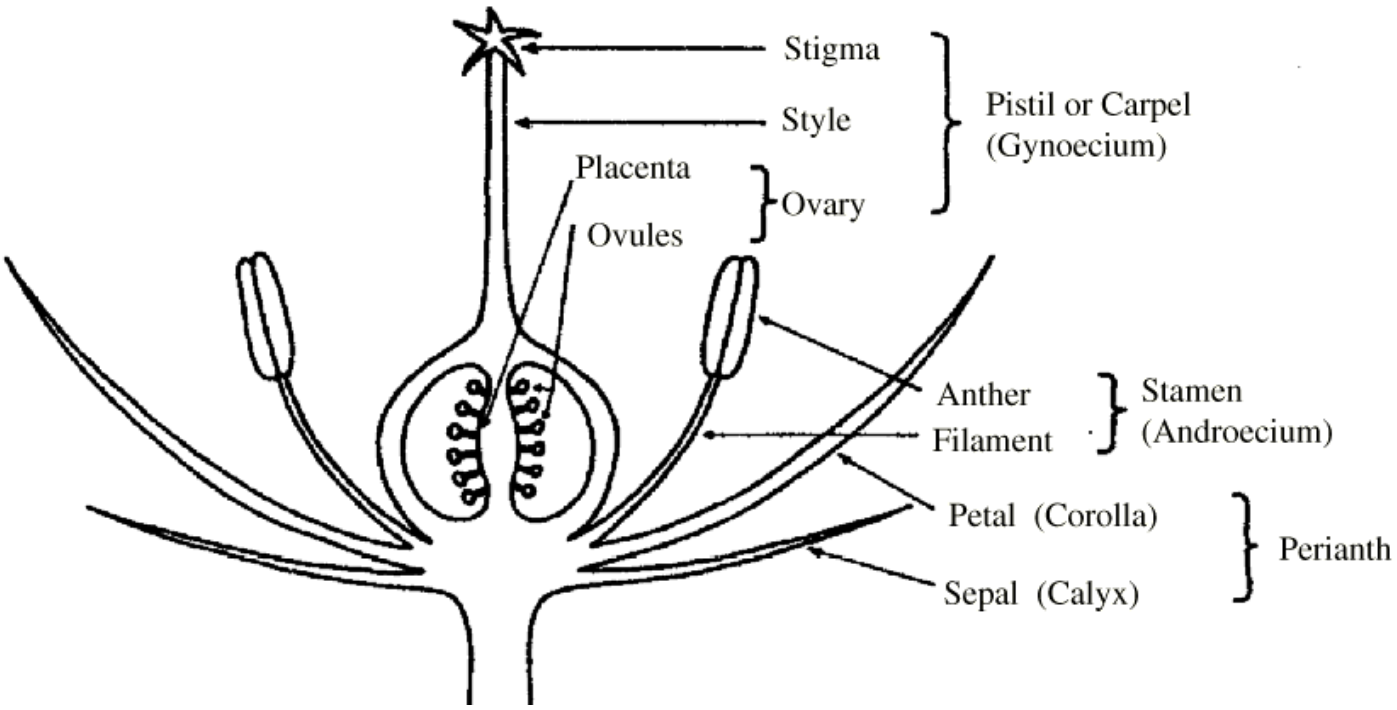
RUSHES, BULLRUSHES, SPIKERUSHES:

Leaves are in two rows along the stem and divided into three parts: the blade, sheath and auricle. Auricles can be either *membranous or cartilaginous (hard and tough). membranous or cartilaginous (hard and tough).*

The cross-sections of rush leaf blades vary from transversely flattened to terete (circular) to channeled to involute (tightly rolled).

FLOWERS

What we notice the most about flowers is their color, but there are many other differences that can be observed even on plant flowers that are not colorful.



The parts of a flower that you should concentrate on learning are:

Sepals **– Cover the buds before the blossoms emerge.**

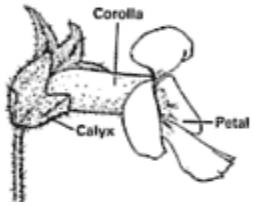
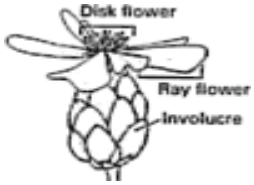
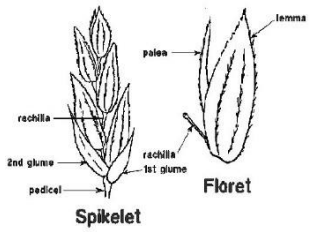
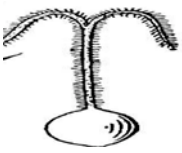
Petals **– Are usually showy. Attract insects to pollinate the plant.**

Pistil **– Consists of the stigma, style and ovary. Collects pollen.**

Ovary **– The seeds of the plant are formed in the ovary.**

Stamens **– Consist of anthers and filaments that produce pollen for the plant.**

IDENTIFYING BASIC FLOWER TYPES

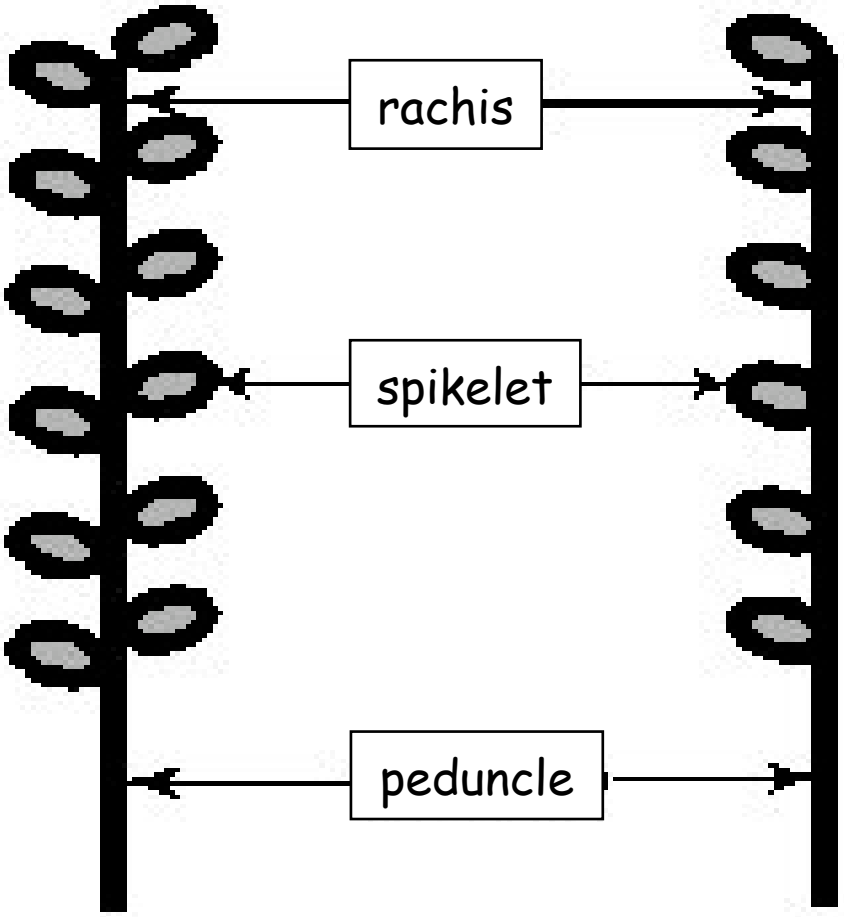
FLOWER TYPES	DESCRIPTION	VISUAL	EXAMPLE
REGULAR (TYPICAL)	Symmetrical – can be divided two ways		ROSE FAMILY, PHLOX FAMILY, BORAGE FAMILY, MUSTARD FAMILY prairie rose, Hood phlox, houndstongue, western wallflower
IRREGULAR (NON-TYPICAL)	Not symmetrical – can divide equally only once or not at all.		BUTTERCUP FAMILY, PEA FAMILY, MINT FAMILY larkspur, white point loco, lupine, wild bergamot
HEAD	Heads are made of many flowers.		ASTER FAMILY knapweeds, thistles, hairy goldenaster, sunflowers
GRASS	Grass flowers are not showy. They are made of two modified leaves called lemmas and paleas. Sometimes you can see the stamens and stigmas of grass flowers.		POACEAE FAMILY Kentucky bluegrass, western wheatgrass, needle and thread
GRASS-LIKE	Rush flowers are constructed like lily flowers, just smaller. The sedge flowers mature into capsules full of tiny seeds. Sedge flowers are contained in bracts. The male flowers are usually above the female flowers. The female flowers are held in a perigynia and have 2 or 3 stigmas.	 	CAREX FAMILY, RUSH FAMILY threadleaf sedge, needleleaf sedge, Baltic rush

Images: University of Illinois

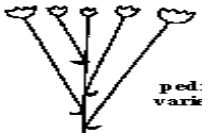
FLOWER (SEEDHEAD) ARRANGEMENTS

Flowers are arranged on seedstalks. The arrangements can be identified by studying the branching of the pedicels. Note that the main stem of a seedhead is called a rachis. The stems that branch off the rachis are called pedicels. The flowers sit on the pedicles.

(Grass Inflorescence**)**



There are other seedhead/flower variations in forb and shrub plant types, some of which are illustrated below.

SEEDHEADS/ FLOWER ARRANGELMENTS	DESCRIPTION	VISUAL	EXAMPLE
CATKIN	A dense spike or raceme with many small flowers.		cottonwood
COMPOUND UMBEL	A flower with two sets of umbel flowers. See umbel description below.		biscuitroot (Lomatium spp.), heart leaf alexanders, yampah, water hemlock, cow parsnip
CORYMB	A raceme inflorescence with branches that grow to the same height.		western yarrow, white spirea, common tansy
CYME	A flat-topped inflorescence with the middle flower opening first.		cinquefoil, phlox, red osier dogwood
HEAD	A dense cluster of flowers.		arrowleaf balsamroot, heart-leaf arnica, stiff sunflower, dandelion, daisy fleabane, Canada thistle
THYRSE	A long panicle inflorescence made of cymes that are arranged in a raceme. Starts blooming at the top first.		
UMBEL	A flat-topped inflorescence with branches that radiate from a common point.		onion, leafy spurge, buckwheat spp.

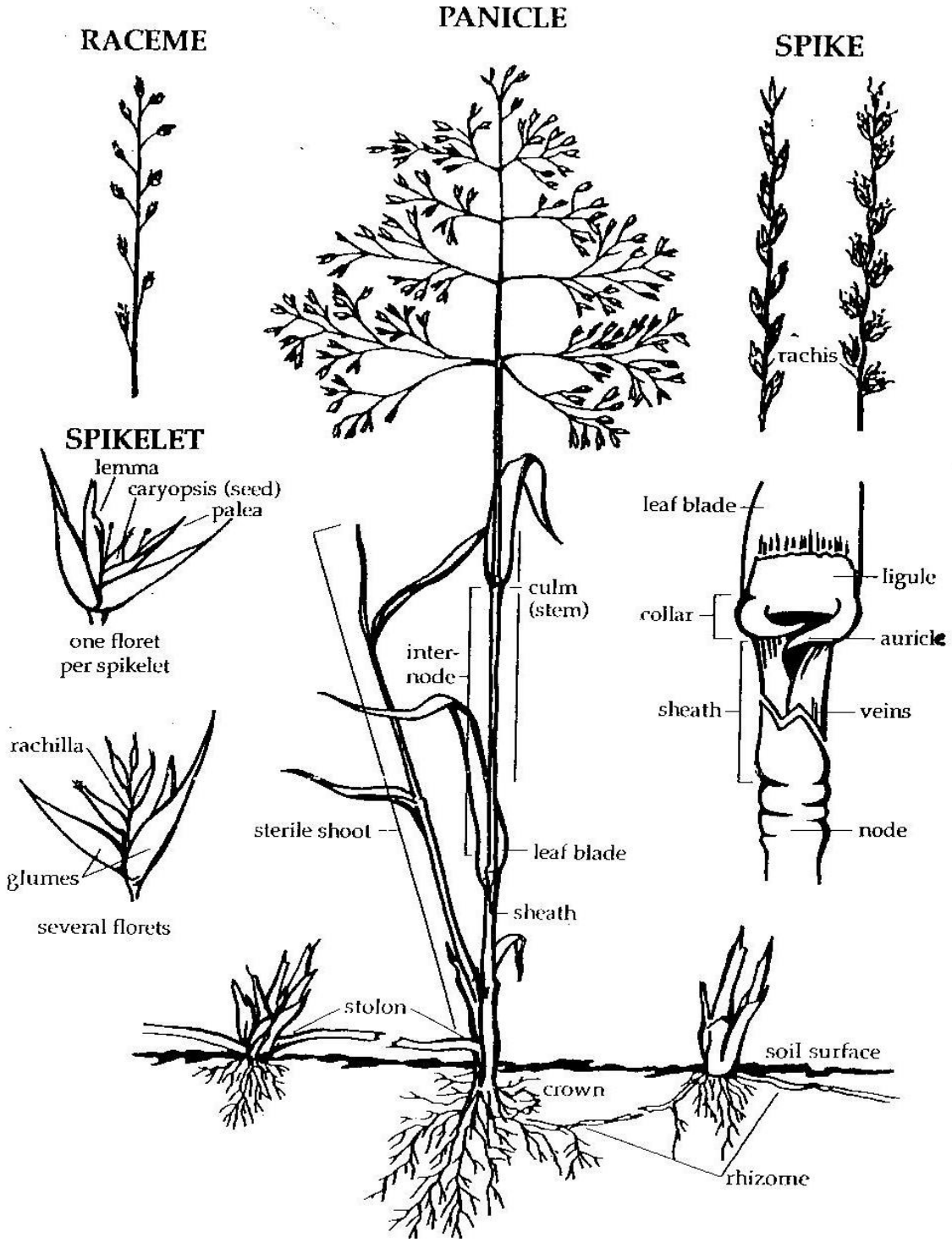
If you have figured out the plant type key, choose a grass plant as your suspect for today's exercise. Collect a sample.

With a few dissection tools, you will be able to perform a diagnostic

autopsy. Tools you might find useful would be:

small scalpel
tweezers
hand lens
pen light
unlined recipe cards
glue

Here is a diagram of a typical grass plant. Study the grass you have chosen. Using the plant anatomy reference material, record the characteristics on the Grass Plant Form. Then apply the information to the simple grass key provided on the following pages.



Plant Collection Documentation Form

- **Collector:**
- **Date:**
- **Location:**

Range Site		**Ex. Clayey, sandy**
Associated Plant Community		**Ex. western wheatgrass, prairie junegrass**
Growth Form		**Ex. Perennial Bunchgrass**
Roots		**Ex. Fibrous, shallow**
Stems		**Ex. stolons**
Leaf shape		**Ex. small leaves, leaves have curled tips, but are flat, not rolled.**
Leaf venation		**Ex. not prominent**
Leaf margin		**Ex. gland-based hairs**
Leaf surface texture (look at both upper and lower surfaces)		**Ex. smooth**
Leaf sheath		**Ex. open**
Collar Area		**Ex. hair**
Seedhead type		**Ex. spike-like raceme**
Glume characteristics		**Ex. 2 glumes, membranous, unequal, shorter than spikelet**
Floret characteristics		**Ex. 3 florets per spikelet, florets are not awned**

Brief Dichotomous Key to Common Perennial Grasses & Grass-likes

1b. Plants perennial (look for last year's leaves and stems)

5a. Stems solid, triangular or round, blades angular, 2 or 3 ranked.

6a. Bunch habit. Leaves are basal and "threadlike". Leaf sheaths are brown near the base, with the old leaf sheaths appearing frayed. Stems are slightly triangular and wiry. There is 1 terminal spike with male flowers above female flowers. 3 stigmas per flower, with the achene being triangular. **threadleaf sedge (Carex filifolia)**

6b. Sod-forming habit (with rhizomes). Stems triangular, mostly just three leaves. Many spikes. 2 stigmas per flower and a lenticular (lens-shaped) achene **needleleaf sedge (Carex eleocharis)**

5b. Stems hollow and jointed, round, blades flat, folded or rolled, not in ranks of three.

7a. Plants in bunches. ***not mat-forming***

8a. Seedhead inflorescence is a spike, ***spike-like raceme or has spike-like branches***

9a. Leaf sheaths rounded

10a. Spikelets crowded, strongly overlap. Leaf sheaths are open, but overlap. Leaf blades are flat and vary in width. The leaves are bright green. The stems grow upright. Glumes and lemmas taper into awns. **crested wheatgrass (Agropyron cristatum)**

10b. **Spikelets not crowded** and barely overlap. 4-8 florets per spikelet. Lemma awns bend to a 90 degree angle when mature. Leaf sheaths open and old sheaths are persistent. Auricles well developed and reddish-colored. **bluebunch wheatgrass (Pseudoroegneria spicatum)**

9b. Sheaths compressed (flattened)

11a. Spikelets hairy. Warm season plant that likes to grow on thin sites. Leaf sheaths are keeled. Spikelets are paired. One spikelet is fertile and the other is sterile. The sterile spikelet sits up on a pedicel that is covered with hairs. The fertile floret has a bent awned. **little bluestem (Schizachyrium scoparium)**

8b. Seedhead inflorescence a panicle.

12a. Plants with one floret per spikelet.

13a. Leaf collars and/or sheaths hairy. Leaves are large with waxy, dark, green backsides. Spikelets with almost equal glumes. One floret that is hard, sharp and awned. The awn is 2-3 cm and bent twice. **green needlegrass (Nassella viridula)**

13b. Leaf collars not hairy, but have notched, membranous ligules.
This ligule is often referred to as "rabbit-eared". Leaves are mostly basal and can be rolled. Leaf sheaths are open. Panicle inflorescences may be partially enclosed in the sheath of the "flag" leaf. Long, nearly equal glumes. Florets are hard and pointed ("needle") and have long, threadlike awns._____
needle and thread (Heterostipa comata)

12b. Plants with more than one floret per spikelet

14a. Leaves with "railroad tracks" (paired, parallel mid-grooves). Small stature grass. Spikelets narrow and pointed. Membranous ligule is also pointed._____**Sandberg bluegrass (Poa secunda)**

14b. Leaves without "railroad tracks". Small stature grass with basal leaves. Leaves deeply veined, but still soft and sometimes hairy. Open leaf sheaths. Panicle branches are very short (compact, spike-like panicle) unless the plant is flowering. Then the panicle spreads out._____**prairie junegrass (Koeleria macrantha)**

7b. Plants with rhizomes, stolons or "mat-forming" habits

15a. Seedhead inflorescence is a spike, *spike-like raceme or has spike-like branches*

16a. Auricles present. Lemmas not hairy. Leaf blades very rough on upper surface and margins. Leaves are colored blue. Auricles claw-like and often "purple" in color. Glumes unequal. Spikelets overlap by ½ of spikelet length._____**western wheatgrass (Pascopyrum smithii)**

16b. Auricles not present, plants often forming dense, mats

17a. Plants with wiry stolons. Leaves small, flat and curly, sparsely hairy. Ligules are ciliate. Plants dioecious (male and female flowers on separate plants). Female flowers are bur-like. Male inflorescences are very similar to blue grama, but with only 6-12 spikelets per branch._____**buffalograss (Bouteloua dactyloides)**

17b. Plants without stolons. The spicate branches curve. ("Grandma's eyebrows") and consist of 30-40 spikelets. Spikelets have one perfect floret and may have several sterile florets above. Lemmas are awned. Leaf collars are hairy, but not leaf blades. Plants have short rhizomes that allow it to spread out in "mats". _____
blue grama (Bouteloua gracilis)

15b. Seedhead inflorescence a panicle.

18a. Leaves with railroad tracks. Leaf blades soft, folded or flat with boat-shaped tips and paired, parallel mid-grooves ("railroad tracks"). Ligule short, flat (truncate). Hairs, "cobwebs" at the base of the spikelet. _____
Kentucky bluegrass (Poa pratensis)

18b. Leaves without "railroad tracks". Leaf blades with an "M". Leaves large, soft and flat. Membranous ligule. Large, panicle seedheads. Glumes are shorter than spikelet. Many florets per spikelet. Awn-tipped lemmas
smooth bromegrass (Bromus inermis)

Dichotomous Key to Common Grasses & Grass-likes

1a. Plants annual

2a. Leaf sheaths hairy and closed.

3a. 7-12 inflated florets per spikelet. Lemmas are awned. Panicle seedheads. Small, winter annual. **Japanese brome (Bromus arvensis)**

3b. 3-6 florets per spikelet. Lemmas awned. Panicle seedheads. Small, winter annual. Turns reddish-purple when ripe. **cheatgrass (Bromus tectorum)**

2b. Leaf sheaths are not very hairy and split open

4a. 5-17 florets per spikelet. Lemmas have short awns. Panicle seedhead. Very small plant that may grow solitary or in a bunch **sixweeks fescue (Vulpia octoflora)**

1b. Plants perennial (look for last year's leaves and stems)

5a. Stems solid, triangular or round, blades angular, 2 or 3 ranked.

6a. Bunch habit. Leaves are basal and "threadlike". Leaf sheaths are brown near the base, with the old leaf sheaths appearing frayed. Stems are slightly triangular and wiry. There is 1 terminal spike with male flowers above female flowers. 3 stigmas per flower, with the achene being triangular. **threadleaf sedge (Carex filifolia)**

6b. Sod-forming habit (with rhizomes). Stems triangular, mostly just three leaves. Many spikes. 2 stigmas per flower and a lenticular (lens-shaped) achene. **needleleaf sedge (Carex eleocharis)**

5b. Stems hollow and jointed, round, blades flat, folded or rolled, not in ranks of three.

7a. Plants in bunches, not mat-forming

8a. Seedhead inflorescence is a spike, spike-like raceme or has spike-like branches

9a. Leaf sheaths rounded

10a. Only one spikelet at each node

11a. Spikelets crowded,

12a. Glumes strongly nerved, spikelets are 3-7 flowered. Spiklets overlapping over half their length. Prominent glumes which are two thirds to as long as the spikelets **slender wheatgrass (Agropyron trachycaulum)**

12b. Glumes not strongly nerved, strongly overlap. Leaf sheaths are open, but overlap. Leaf blades are flat and vary in width. The leaves are bright green. The stems grow upright. Glumes and lemmas taper into awns **crested wheatgrass (Agropyron cristatum)**

11b. Spikelets not crowded and barely overlap. 4-8 florets per spikelet. Lemma awns bend to a 90 degree angle when mature. Leaf blades soft when green. _____ _____**bluebunch wheatgrass (Pseudoroegneria spicatum)**

10b. Spikelets more than one per node

13a. Awns.

14a. Glumes equal

15a. Bristly awns. S*pikelets two per node*. 2-6 flowers per spikelet. Rachis of the seedhead breaks apart easily. Small auricles_____
bottlebrush squirreltail (Elymus elymoides)

15b. Fine awns. *Spikelets three per node.* The middle spikelet has one floret. The seedhead rachis breaks apart easily. Nodes are dark colored. Leaf blades are flat. Poor forage for livestock. Grows in waste places, like saline seeps _____**foxtail barley (Hordeum jubatum)**

14b. Glumes sub equal: Native bunchgrass with an erect habit that can grow up to 4 feet. Auricles are claw-like and clasping arising from a broad yellowish or light green color. The spickelets are thick and bristly and can reach 10 inches in length. _____
Canada wildrye (Elymus Canadensis)

13b. No Awns Densely tufted bunchgrass with leaves that are deeply grooved on both surfaces. Membranous ligule, with an open sheath and rudimentary auricles. Inflorescence is a spike which disarticulates between the spikelets. Most of the leaves are basal._____**Russian wildrye (Elymus junceus)**

9b. Sheaths compressed (flattened)

16a. Spikelets hairy. Warm season plant that likes to grow on thin sites. Leaf sheaths are keeled. Spikelets are paired. One spikelet is fertile and the other is sterile. The sterile spikelet sits up on a pedicel that is covered with hairs. The fertile floret has a bent awns___
little bluestem (Schizachyrium scoparium)

8b. Seedhead inflorescence a panicle.

17a. Leaf collars and/or sheaths hairy

18a. Lemmas awned.

19a. Membranous ligule.

20a. Blades involute (folded inward) Ligule with a pointed tip. Long, rolled leaves. Leaf sheath is open. Collar is pubescent. Panicle seedhead branches in pairs (dichotomous). The spikelets are one flowered. Lemmas are awned. The awn falls off with maturity_____ **Indian ricegrass (Achnatherum hymenoides)**

20b. Leaf blades flat: Inflorescence is a panice with the lower branches elongating. Leaf blades are flat or folded with a prominent midrib. Ligule is membranous. It is one of the earliest species to grow in the spring. _____
orchardgrass (Dactylis glomerata)

19b. Membranous ligule 1-2 mm long, hairy collar.

21a. Leaves are large with waxy and dark green backsides. Spikelets with almost equal glumes. One floret that is hard, sharp and awned. The awn is 2-3 cm and bent twice_____
green needlegrass (Nassella viridula)

18b. Lemmas not-awned: Leaves are strongly ribbed and rough to the touch on the upper surface. Ligules are pointed. Inflorescence is a panicle with unequal glumes. This grass grows best in moist alkaline or saline soils.____
Nuttall's alkaligrass (Puccinellia nuttalliana)

17b. Leaf collars not hairy, but may have a hair-like ligule.

22a. Plants with one floret per spikelet

23a. Large, spreading panicle seedhead, florets with awns.

24a. Ligule with a notched end ("rabbit-eared"). Small-stature grass with open leaf sheath. Panicle inflorescence is often partially enclosed in the sheath of the "flag" leaf. Glumes nearly equal. Floret is hard and pointed ("needle") and has a long, threadlike awn. _____
needle and thread (Heterostipa comata)

24b. Ciliate ligule. No hair at the leaf collar. Large panicle inflorescence that has a pyramid shape and is often purple in color. Spikelets are one-flowered._____
alkali sacaton (Sporobolus airoides)

23b. Small, panicle seedhead. The seedheads are so tiny that they are hard to see. There is one floret per spikelet and no awns. Leaves are flat and have a bright green color. Leaf blades stand up fairly straight. Ligules are present, but very small. Plants often appear to grow in circles as the plant centers die out. _____
plains muhly (Muhlenbergia cuspidata)

22b. Plants with more than one floret per spikelet

25a. Leaves with "railroad tracks" (paired, parallel mid-grooves).

26a. Small stature grass. Spikelets narrow and pointed. Membranous ligule is also pointed._____
Sandberg bluegrass (Poa secunda)

25b. Leaves without "railroad tracks"

27a. Small stature grass with basal leaves. Leaves deeply veined, but still soft and sometimes hairy. Open leaf sheaths. Panicle branches are very short (compact, spike-like panicle)unless the plant is flowering. Then the panicle spreads out. _____
prairie junegrass (Koeleria macrantha)

7b. Plants with rhizomes, stolons or "mat-forming" habits

28a. Seedhead inflorescence is a spike, *spike-like raceme or has spike-like branches*

29a. Auricles present

30a. Lemmas hairy. The plants grow erect with a heavy growth of basal leaves. The plants seed heads and seeds are somewhat hairy. Pubescent wheatgrass is very similar to intermediate wheatgrass but is distinguishable by the presence of short stiff hairs of the heads and seeds. _____
pubescent wheatgrass (Agropyron trichoporum)

30b. Lemmas not hairy. Leaf blades very rough on upper surface and margins. Leaves are colored blue. Auricles claw-like and often "purple" in color. Glumes unequal Spikelets overlap by ½ of spikelet length. _____
western wheatgrass (Pascopyrum smithii)

31a. Leaf sheath open and smooth: Leaves are finely veined and auricles are small and not well developed. Spike seedheads can be 10-15 cm long with 3-7 flowers per spikelet. Glumes are usually awn-tipped._____
quackgrass (Elymus repens)

29b. Auricles not present, plants often forming dense, mats

32a. Plants with wiry stolons. Leaves small, flat and curly, sparsely hairy. Ligules are ciliate. Plants dioecious (male and female flowers on separate plants). Female flowers are bur-like. Male inflorescences are very similar to blue grama, but with only 6-12 spikelets per branch._____**buffalograss (Bouteloua dactyloides)**

32b. Plants without stolons.

33a. <u>The spicate branches curve.</u> ("grandma's eyebrows") and consist of 30-40 spikelets. Spikelets have one perfect floret and may have several sterile florets above. Lemmas are awned. Leaf collars are hairy, but not leaf blades. Plants have short rhizomes that allow it to spread out in "mats". **blue grama (Bouteloua gracilis)**

33b. <u>The spicate branches are turned to one side of the seedhead.</u> There are 30-80 branches and 3-8 spikelets per branch. There is one perfect floret and one sterile floret per spikelet. The lemmas are awned. Plants have scaly rhizomes and form scattered mats. Nodes are purple. Leaf blades have many hairs with pimple-like bases, which are very noticeable on the margins. **sideoats grama (Bouteloua curtipendula)**

28b. <u>Seedhead inflorescence a panicle.</u>

34a. <u>Leaves with railroad tracks.</u> Leaf blades soft, folded or flat with boat-shaped tips and paired, parallel mid-grooves ("railroad tracks"). Ligule short, flat (truncate). Hairs, "cobwebs" at the base of the spikelet. **Kentucky bluegrass (Poa pratensis)**

34b. <u>Leaves without "railroad tracks".</u>

35a. <u>Leaf blades with and "M".</u> Leaves large, soft and flat. Membranous ligule. Large, panicle seedheads. Glumes are shorter than spikelet. Many florets per spikelet. Awn-tipped lemmas **smooth brome (Bromus inermis)**

35b. <u>Leaf blades without an "M".</u>

36a. <u>Contracted panicles.</u>

37a. <u>Membranous ligule:</u>

38a. <u>Awned Lemma:</u> Plant appears similar to western wheatgrass, except that there is a prominent ligule. The leaves are rolled. Seedhead appears very similar to prairie junegrass. **plains reedgrass (Calamagrostis montanensis)**

38b. <u>Lemma not awned:</u> Broad erect leaves are dominantly basal. Inflorescence is a dense panicle which matures from top down and is often reddish in color. The stem is hairless and erect. Leaves are flat, 7-42 cm long and 7-16mm wide. **reed canarygrass (Phalaris arundinacea)**

37b. <u>Slightly membranous & hairy ligule:</u> Spikelets are either male or female. Male spikelets are straw-colored. Female spikelets are green. Leaves are "ranked" (2 sides), sharp pointed and rolled at the tip. Leaf internodes are short. Ligule is ciliate. Panicles are contracted. There are 5-13 florets per spikelet. **_____inland saltgrass (Distichlis spicata)**

39a. <u>Small spikelets. 1 floret per spikelet. Lemma has a bent awn.</u>

36b. <u>Large, spreading panicle.</u>

40. <u>Hairy collar:</u> Panicle branches are ascending. One floret per spikelet. The base of the floret has long hairs. Glumes are not equal. Culms are stiff and erect ("reedy"). Leaf sheaths are hairy at the throat and collar. Ligule is a fringe of hairs. Leaf blades roll at the top. **_____ prairie sandreed (Calamovilfa longifolia)**

40b. <u>Collar not hairy:</u> Height ranges from 6 to 12 feet. Flat, smooth leaf blade which is 1/2 to 2 inches wide. Inflorescence is an open panicle with a purplish or tawny color. This grass is considered a noxious weed in several states. Common reed is readily eaten by livestock before maturity. It cannot withstand prolonged heavy grazing. It grows best where the water level fluctuates from 6 inches below the soil surface to 6 inches above. **common reed (Phragmites communis)**

Brief Dichotomous Key to Common Perennial Grasses & Grass-likes

1b. Plants perennial (look for last year's leaves and stems)

5a. Stems solid, triangular or round, blades angular, 2 or 3 ranked.

6a. Bunch habit. Leaves are basal and "threadlike". Leaf sheaths are brown near the base, with the old leaf sheaths appearing frayed. Stems are slightly triangular and wiry. There is 1 terminal spike with male flowers above female flowers. 3 stigmas per flower, with the achene being triangular. **threadleaf sedge (Carex filifolia)**

6b. Sod-forming habit (with rhizomes). Stems triangular, mostly just three leaves. Many spikes. 2 stigmas per flower and a lenticular (lens-shaped) achene **needleleaf sedge (Carex eleocharis)**

5b. Stems hollow and jointed, round, blades flat, folded or rolled, not in ranks of three.

7a. Plants in bunches, *not mat-forming*

8a. Seedhead inflorescence is a spike, *spike-like raceme or has spike-like branches*

9a. Leaf sheaths rounded

10a. Spikelets crowded, strongly overlap. Leaf sheaths are open, but overlap. Leaf blades are flat and vary in width. The leaves are bright green. The stems grow upright. Glumes and lemmas taper into awns. **crested wheatgrass (Agropyron cristatum)**

***10b.* Spikelets not crowded** and barely overlap. 4-8 florets per spikelet. Lemma awns bend to a 90 degree angle when mature. Leaf sheaths open and old sheaths are persistent. Auricles well developed and reddish-colored. **bluebunch wheatgrass (Pseudoroegneria spicatum)**

9b. Sheaths compressed (flattened)

11a. Spikelets hairy. Warm season plant that likes to grow on thin sites. Leaf sheaths are keeled. Spikelets are paired. One spikelet is fertile and the other is sterile. The sterile spikelet sits up on a pedicel that is covered with hairs. The fertile floret has a bent awned. **little bluestem (Schizachyrium scoparium)**

8b. Seedhead inflorescence a panicle.

12a. Plants with one floret per spikelet.

13a. Leaf collars and/or sheaths hairy. Leaves are large with waxy, dark, green backsides. Spikelets with almost equal glumes. One floret that is hard, sharp and awned. The awn is 2-3 cm and bent twice. **green needlegrass (Nassella viridula)**

13b. <u>Leaf collars not hairy, but have notched, membranous ligules.</u>
This ligule is often referred to as "rabbit-eared". Leaves are mostly basal and can be rolled. Leaf sheaths are open. Panicle inflorescences may be partially enclosed in the sheath of the "flag" leaf. Long, nearly equal glumes. Florets are hard and pointed ("needle") and have long, threadlike awns._____
needle and thread (Heterostipa comata)

12b. <u>Plants with more than one floret per spikelet</u>

14a. <u>Leaves with "railroad tracks"</u> (paired, parallel mid-grooves). Small stature grass. Spikelets narrow and pointed. Membranous ligule is also pointed._____**Sandberg bluegrass (Poa secunda)**

14b. <u>Leaves without "railroad tracks".</u> Small stature grass with basal leaves. Leaves deeply veined, but still soft and sometimes hairy. Open leaf sheaths. Panicle branches are very short (compact, spike-like panicle) unless the plant is flowering. Then the panicle spreads out._____**prairie junegrass (Koeleria macrantha)**

7b. <u>Plants with rhizomes, stolons or "mat-forming" habits</u>

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16a. <u>Auricles present.</u> Lemmas not hairy. Leaf blades very rough on upper surface and margins. Leaves are colored blue. Auricles claw-like and often "purple" in color. Glumes unequal. Spikelets overlap by ½ of spikelet length._____**western wheatgrass (Pascopyrum smithii)**

16b. <u>Auricles not present, plants often forming dense, mats</u>

17a. <u>Plants with wiry stolons.</u> Leaves small, flat and curly, sparsely hairy. Ligules are ciliate. Plants dioecious (male and female flowers on separate plants). Female flowers are bur-like. Male inflorescences are very similar to blue grama, but with only 6-12 spikelets per branch._____**buffalograss (Bouteloua dactyloides)**

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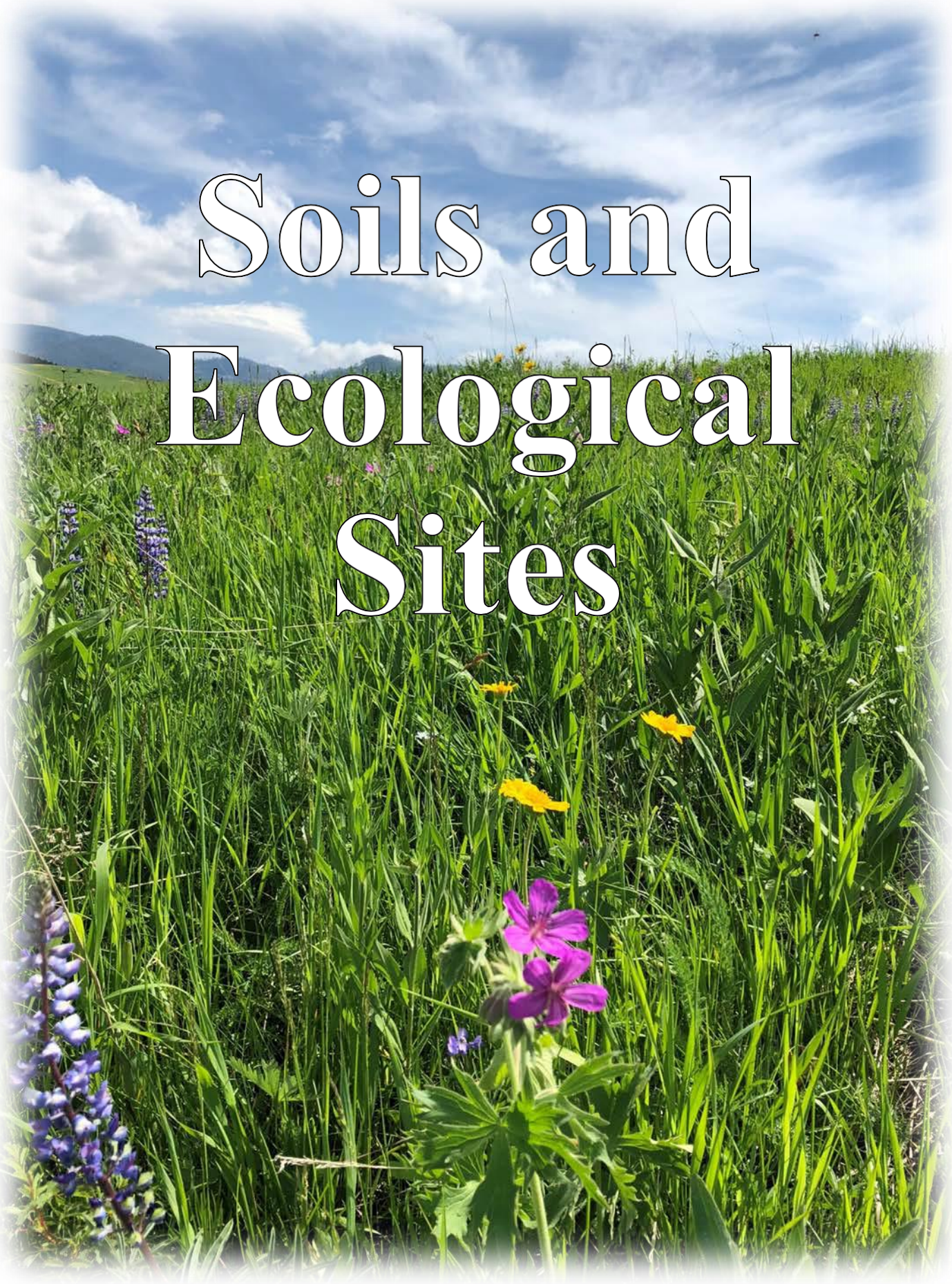
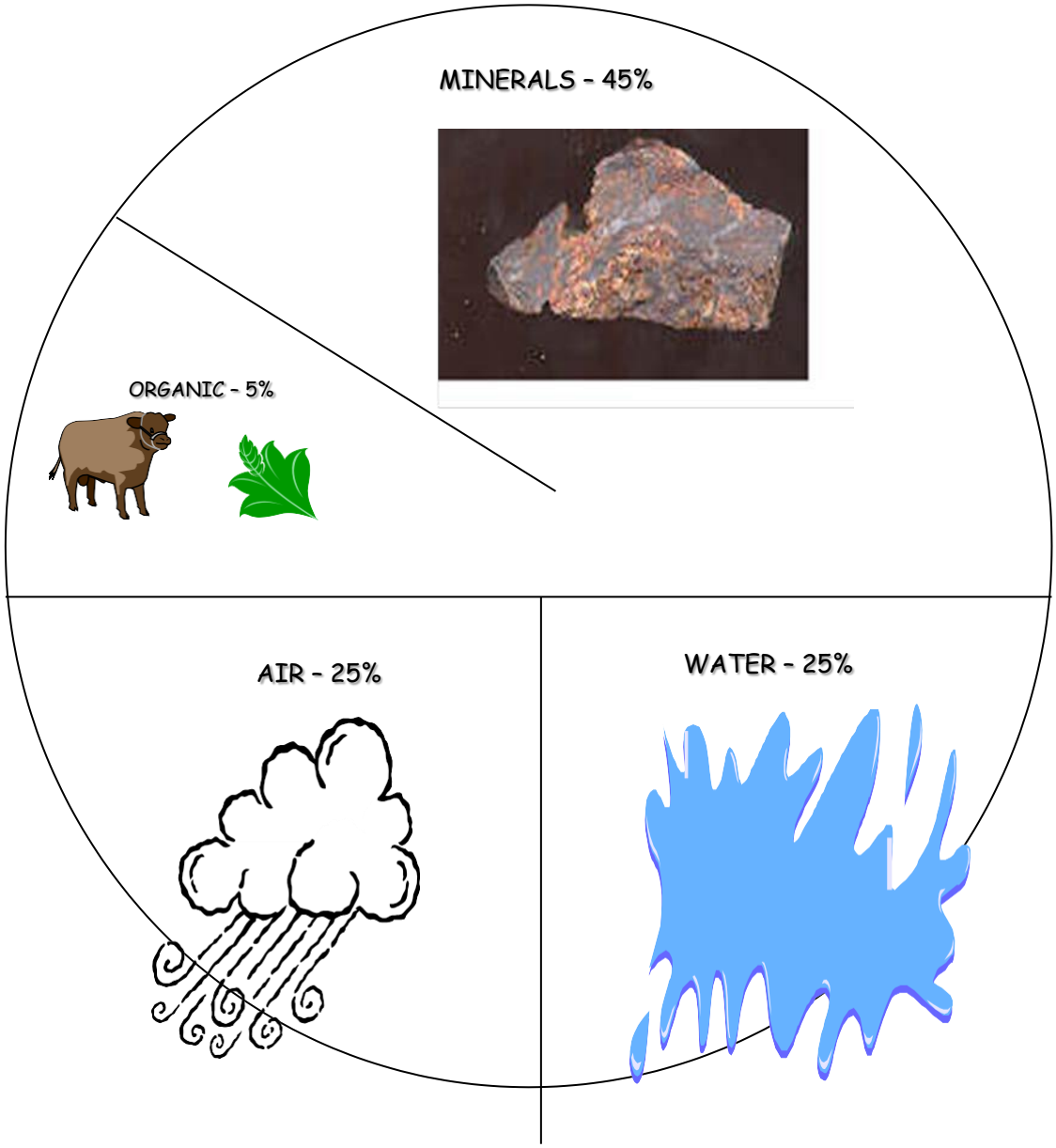
blue grama (Bouteloua gracilis)


Soils and
Ecological
Sites

SOIL IS THE NATURAL MEDIUM FOR PLANT GROWTH

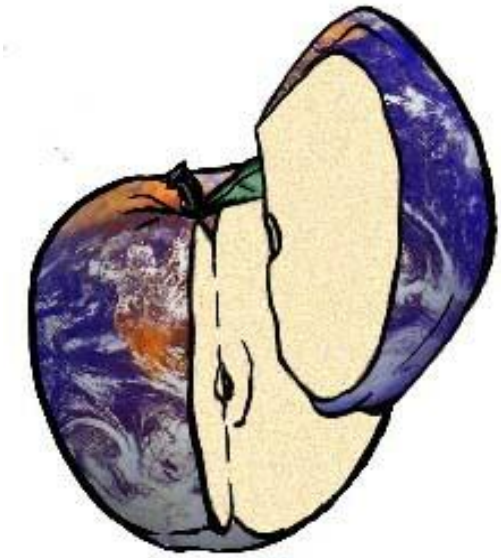
Soil is made of minerals, air, water and organic matter. Approximately 50% of a soil consists of pore space (water and air), while the remaining 50% is solid (minerals and organic matter).



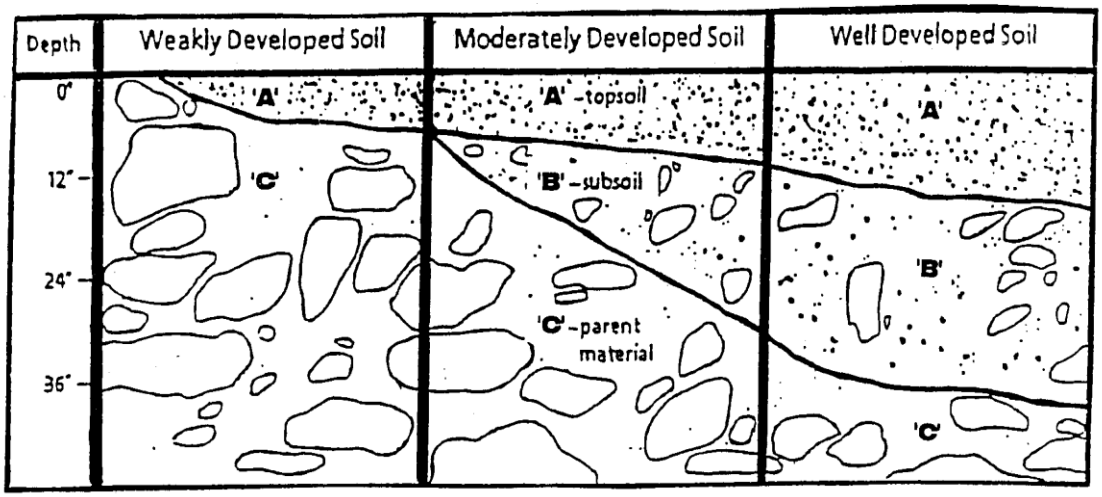
The earth is covered by a thin layer of soil. Only a tiny fraction of this layer is suitable for agriculture!

Think about an apple as the earth. ¾ of the apple would consist of oceans, which leaves ¼ of the apple for land area. Of the ¼ of the apple that represents land area, only ½ is hospitable for human life. So there is only 1/8 of the apple left. Now divide the remaining 1/8 of the apple into four pieces. Three of these pieces would represent areas that are too extreme for agriculture production (example – too wet, rocky or cold), or already covered by cities. The peel on the remaining 1/32 of apple would represent the amount of soil suitable for agriculture production. Not very much!

(Adapted from Agriculture in Montana Schools)



HOW IS A SOIL FORMED?



This diagram illustrates soil formation. Climate, living organisms and topography are factors that influence soil formation. These factors are different at each location. Therefore, all soils are not formed in the same way in the same amount of time. Soils develop as physical processes break down parent materials.

PARENT MATERIAL:

Parent material (c-layer) is the *loosely arranged mineral and organic matter* that soils are made from. Parent materials can be *volcanic ash, sediments moved and deposited by wind and water, or glacial deposited sand and rock.* Weathered (broken down) bedrock is another example of parent material.

CLIMATE:

Climate changes parent material (c-layer) into *subsoil* (b-layer) and *topsoil* (A-layer). *Freezing and thawing and wetting and drying break down parent materials. Rain water* also dissolves minerals and moves them deeper into the soil profile.

LIVING ORGANISMS:

Plants and animals change weathered parent material into subsoil and topsoil. Leaves, twigs, and bark from large plants fall on the soil and are broken down by *fungi, bacteria, insects, and other soil animals.* For example, insects and earthworms, burrowing through the soil, break organic matter and minerals into simpler compounds. When plants and animals die and decay, nutrients are added to the soil.

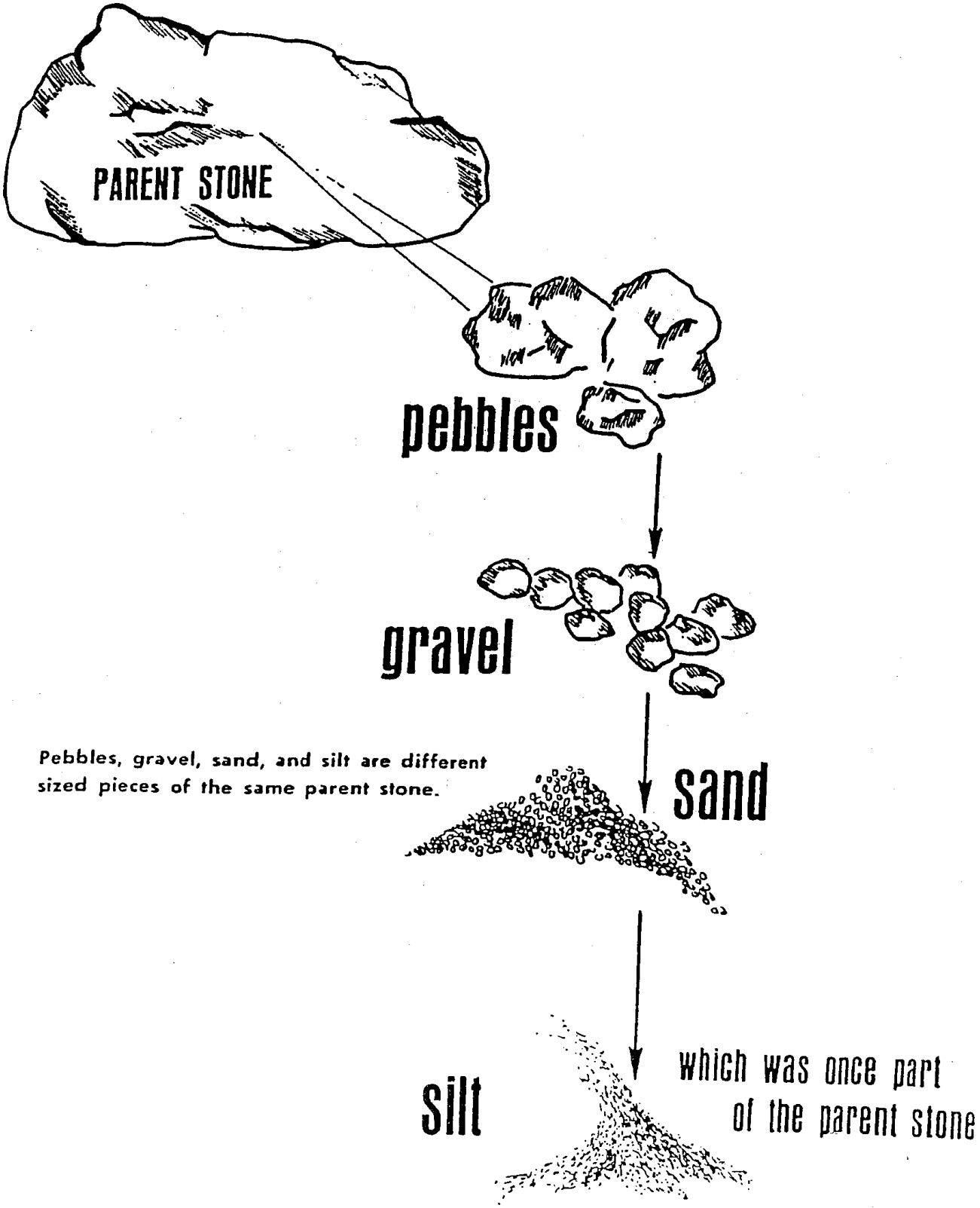
TOPOGRAPHY:

Topography refers to the *slope of the land.* On steeper slopes, topsoil may erode, leaving exposed subsoil or parent material *(weak soil development).* Soils located in land depressions or on level to rolling topography are generally *well developed.*

TIME:

The boxes in the diagram illustrate a soil at three different stages of development.

Soil formation is a gradual process……



Pebbles, gravel, sand, and silt are different sized pieces of the same parent stone.

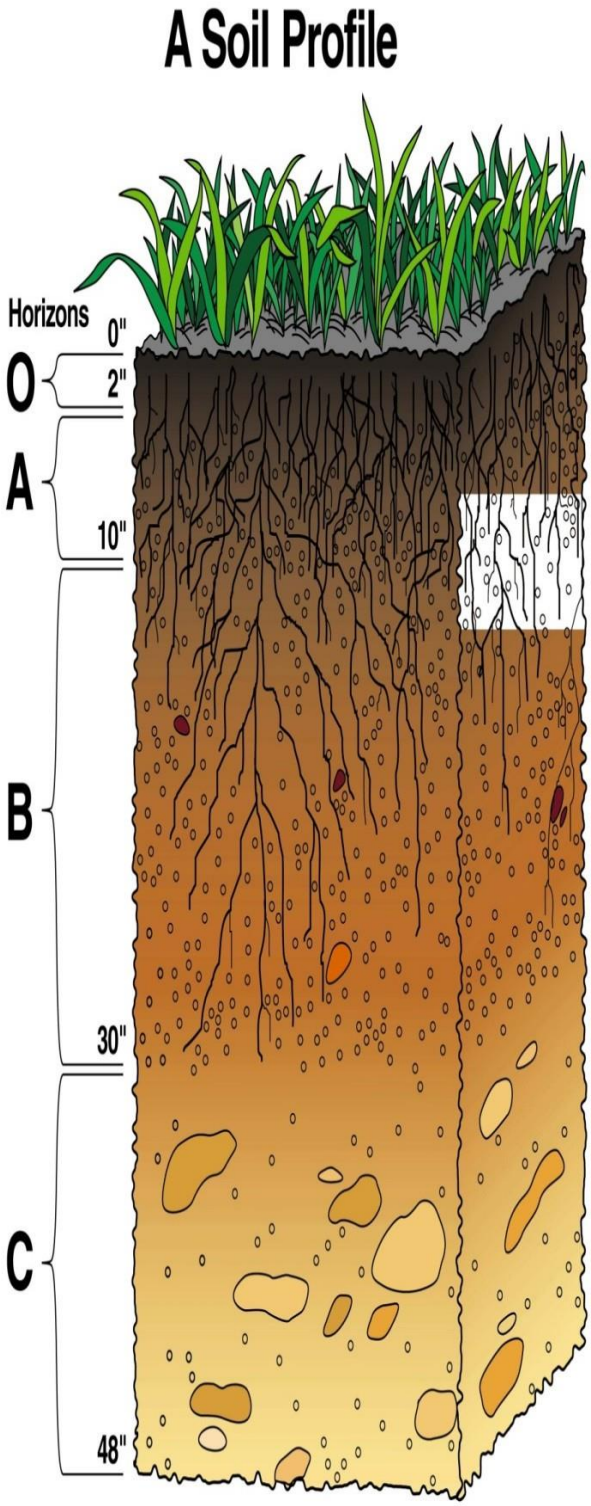
(A soil profile is a vertical “slice” of soil.)

O Horizon – Humus rich layer at the top of the profile, where organisms called decomposers break down dead plant and animal material to form organic matter (humus).

A Horizon – Dark brown/black color with granular or blocky structure. This part of the soil profile is often referred to as topsoil. Topsoil has a high percentage of organic matter compared to subsoil and parent material. Organic matter contributes to soil fertility, soil water holding capacity, soil structure, soil aggregate stability, etc. The A horizon is where the majority of plant roots grow.

B Horizon – Brown color with prismatic, block or columnar structure. Often referred to as subsoil. This horizon is identified by color change, structure change and increased clay content compared to the topsoil layer (As a soil profile ages, clay is leached through the profile into the subsoil.). There are more minerals and some organic matter at the top of the horizon. Plant roots extend deep through the B horizon searching for water.

C Horizon – Light brown color, with massive structure. Weathered parent material is contained in the C horizon. The depth of this layer depends on how much topsoil has formed. There are very few living organisms in this horizon, but plenty of rock and Calcium Carbonate (lime).

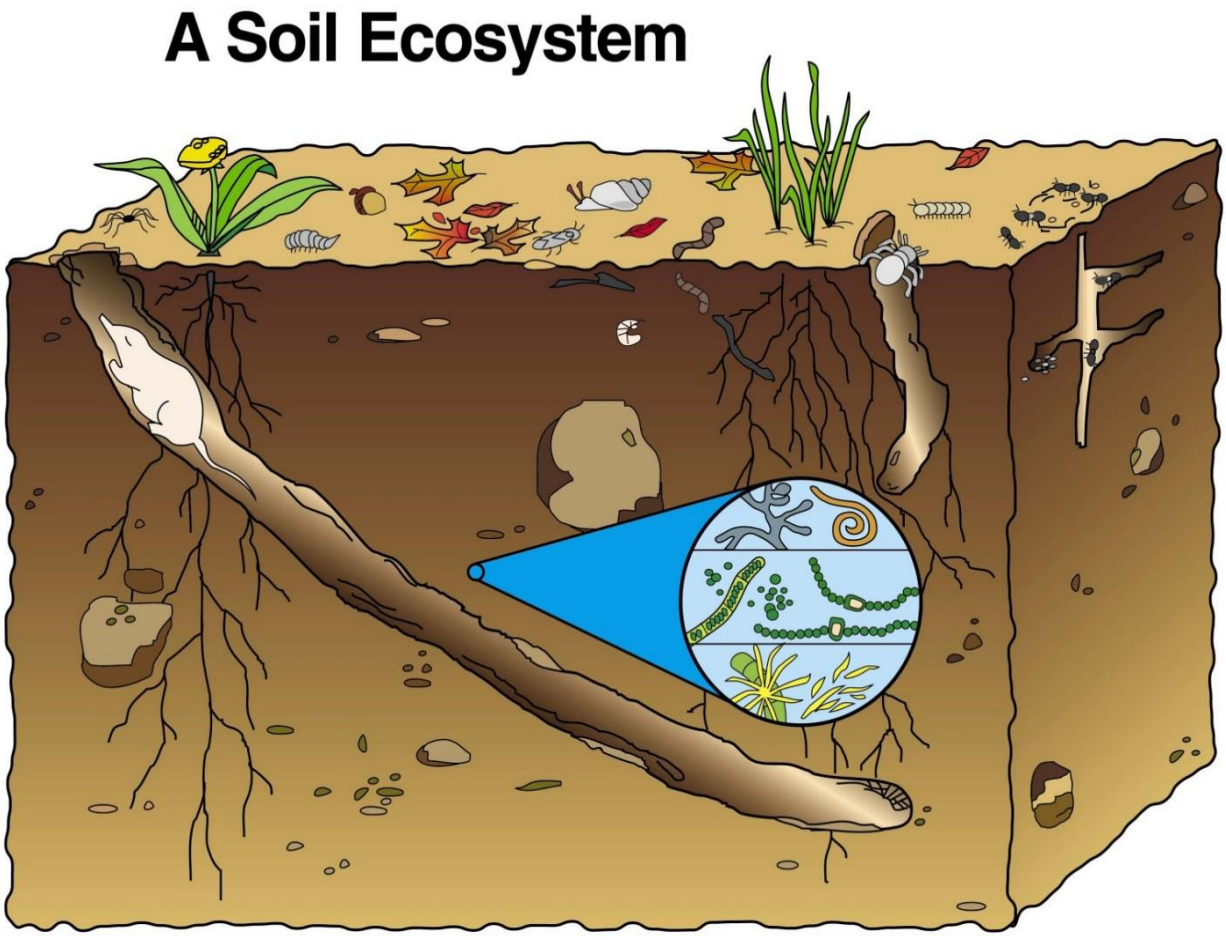


A soil profile is very much alive!

It is full of living creatures, such as:

- *Earthworms*
- *Arthropods (ants, centipedes, etc.)*
- *Nematodes (roundworms)*
- *Protozoa*
- *Bacteria (one-celled)*
- *Fungi (primitive, without chlorophyll)*
- *Soil biological crusts (small plants and bacteria)*

Many of these "critters" are so small, you would need a microscope to see them. However, in large numbers, these tiny organisms accomplish great things. They benefit the soil by converting dead plant and animal residues into organic matter. If you want to know more about soil biological communities, a great website to visit is the BLM National Science and Technology Center.



(Art by USDA-NRCS)

SOIL ORGANIC MATTER

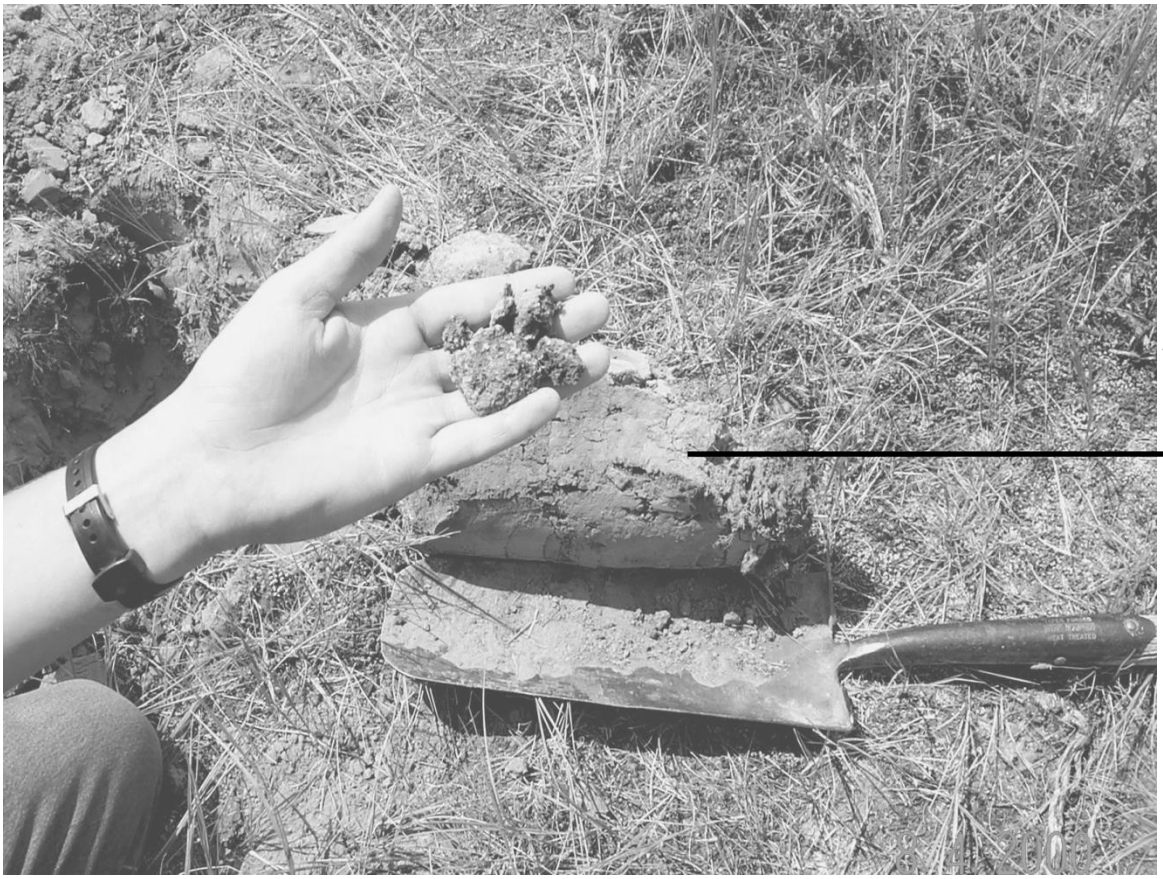
Soil Organic Matter is the dark colored portion of a soil profile, which includes plant and animal residues in various stages of decomposition.

Why is organic matter important to plants?

Organic acids are formed as organic matter decays. Organic acids dissolve soil minerals and incorporate the minerals into the soil solution (soil water), which plants utilize.

Organic matter is also important to plants because small amounts of organic matter in the soil can absorb and hold plenty of water!

The depth and percentage of organic matter in a rangeland soil profile is relative to plant production (above and below ground) on the site. In Montana, rainfall is the primary limiting factor to plant growth. Soils in Montana that receive more moisture develop thicker, darker layers of organic matter, because there is more plant litter and roots available to incorporate into the topsoil.



(Photo Courtesy of Rebecca Wolenetz)

GENERAL RULES OF SOIL DEPTH

- PLANT ROOTS GROW DEEPER IN DEEP SOILS.
- AS PLANT ROOTS GROW DEEPER, MORE WATER AND NUTRIENTS ARE AVAILABLE TO GROWING PLANTS
- PLANTS RECEIVING MORE WATER AND NUTRIENTS PRODUCE MORE POUNDS OF FORAGE
- MORE FORAGE PRODUCTION SUPPORTS MORE GRAZING ANIMALS!

(Photo courtesy of Ekalaka NRCS)

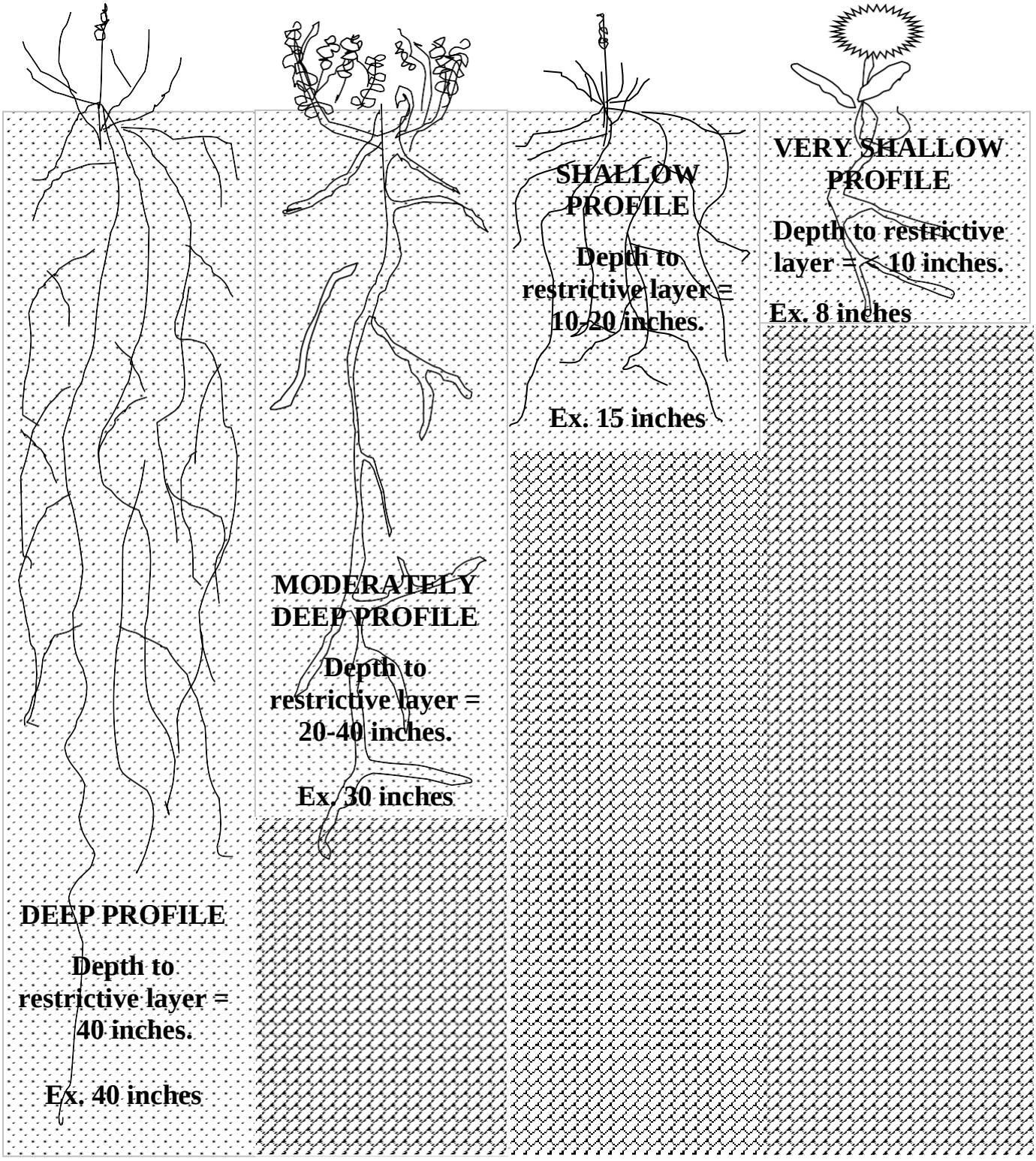
SOIL DEPTH CLASSES

***Shallow soils*:**

Shallow soils have restrictive layers within 20 inches of the surface.

Deep soils:

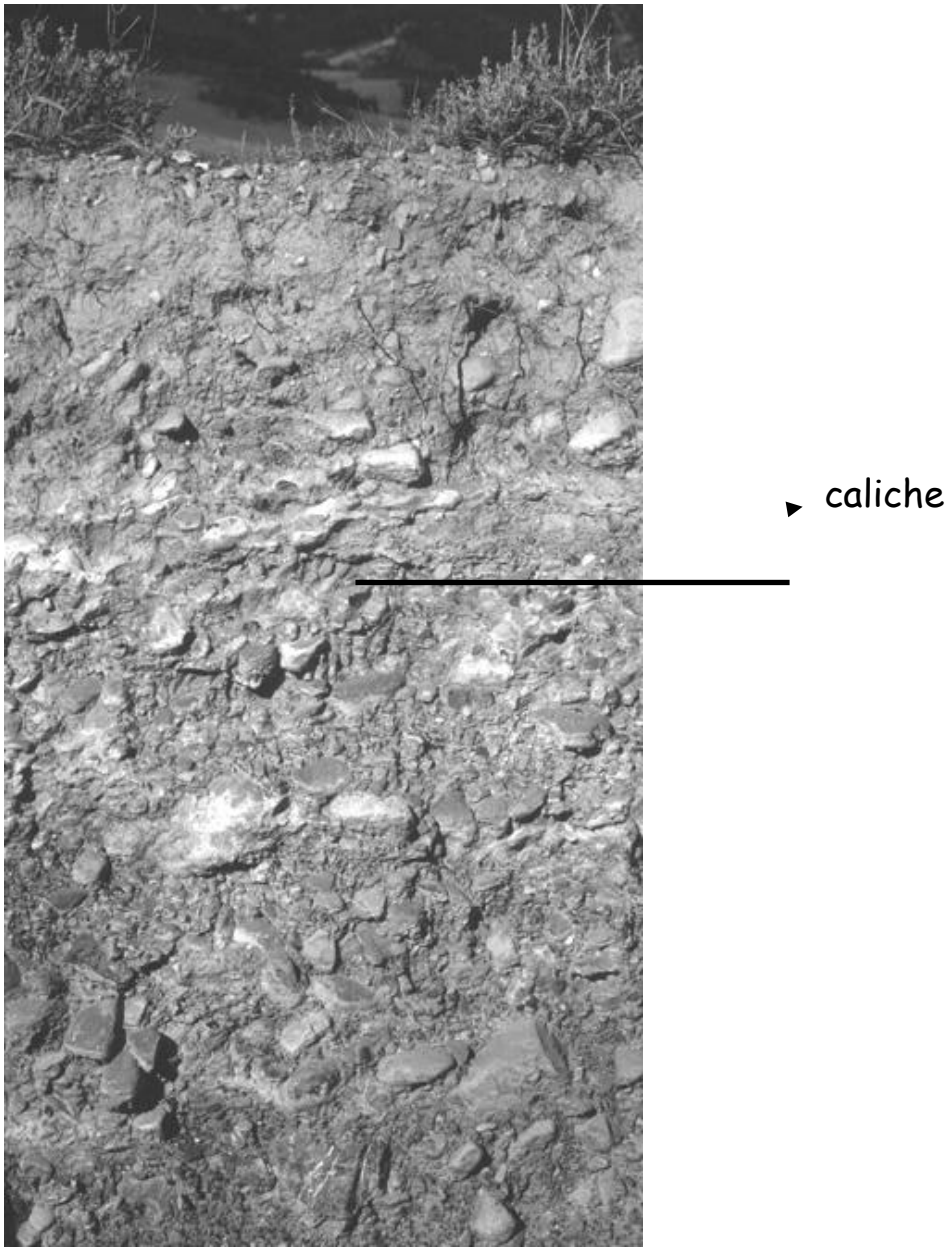
Soils that have profiles greater than 20 inches are considered *deep*



SOIL DEPTH: RESTRICTIVE LAYERS

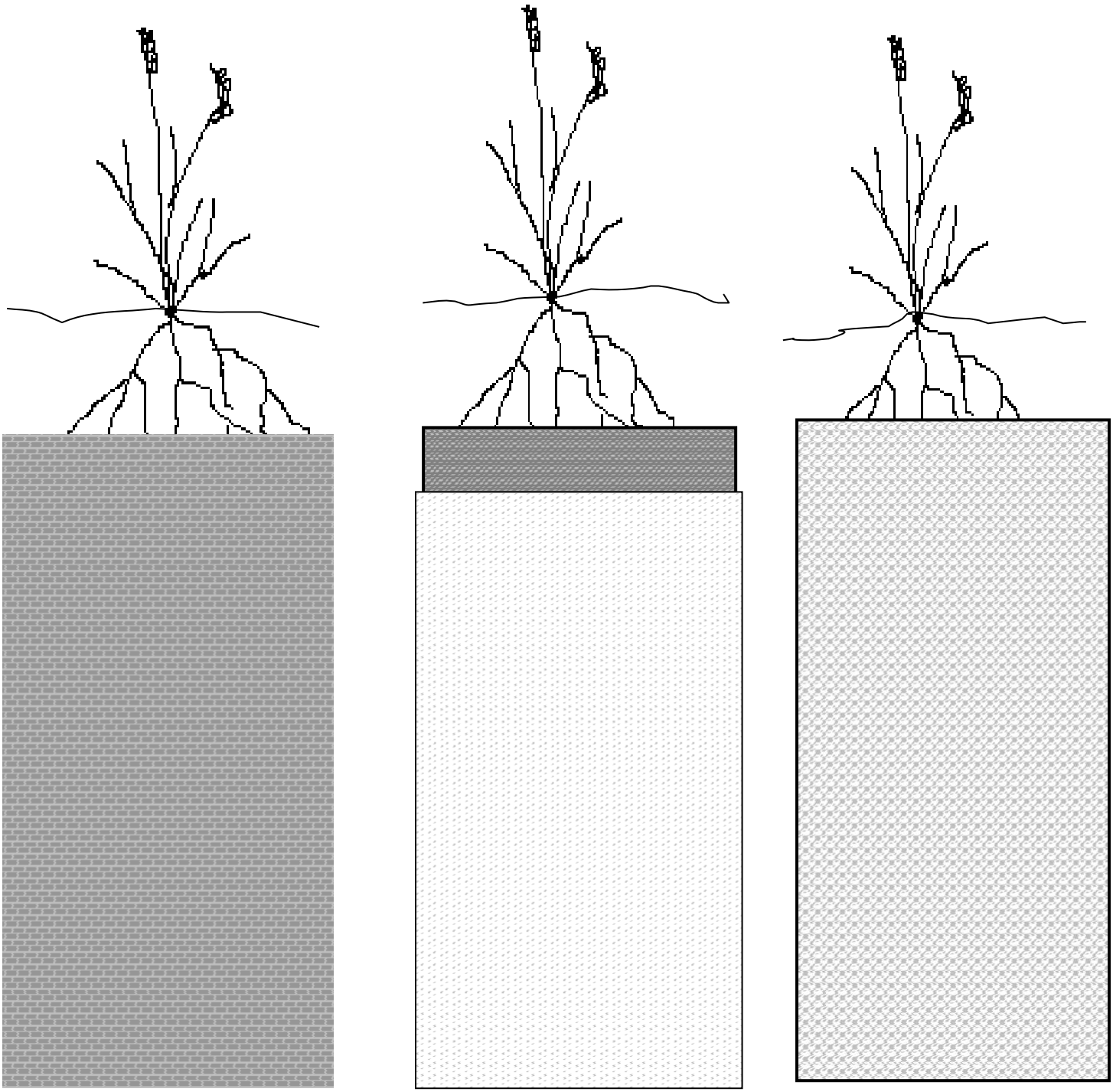
Soil depth varies depending on the location of a *restrictive layer* within the profile.

Restrictive layer: A layer of material that restricts plant root growth and development beyond its depth within the profile. Examples of restrictive materials include layers of *bedrock, heavy clay, gravel, sand, shale and caliche (loosely cemented material).*



(Photo courtesy of USDA-NRCS)

EXAMPLES OF RESTRICTIVE LAYERS



HARD BEDROCK

HEAVY CLAY

LOOSE GRAVEL, SHALE OR SAND

SOIL STRUCTURE

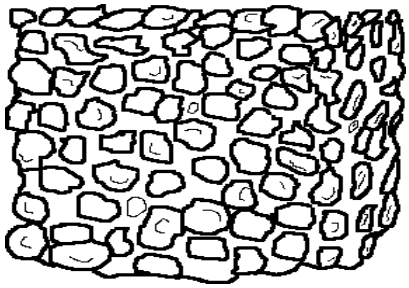
Soil structure refers to the arrangement (size and shape) of individual soil particles into aggregate clusters or clumps within the soil mass.

(Photo courtesy of Rebecca Wolenetz)

BASIC KINDS OF SOIL STRUCTURE

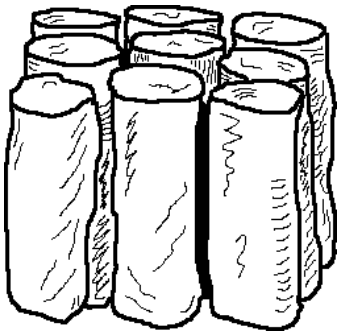
Single Grained: Soil particles are not bound together.

There is no structure. Think of beach sand.

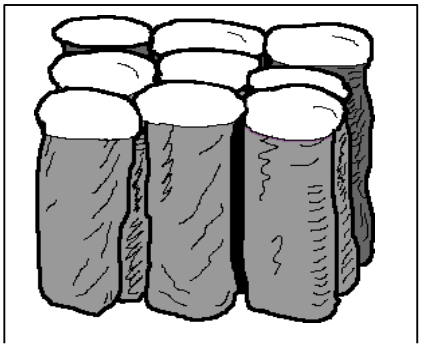


Granular: Small, non-porous clusters of soil particles with irregular, rounded surfaces.

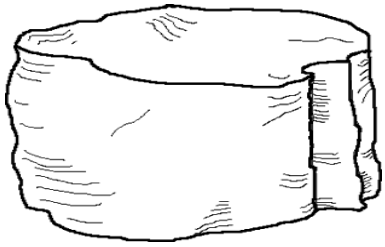
Blocky: Cube-shaped cluster of soil particles. Angular blocks have prominent edges. Sub-angular blocks have rounded edges.



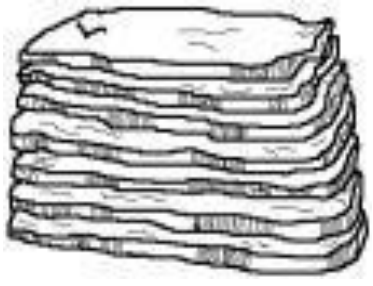
Prismatic: Pillar-shaped cluster of soil particles. The cluster is longer than wide and has a flat top.



Columnar: A prism shaped cluster of soil particles with a rounded top. Characteristic of sodic soils.



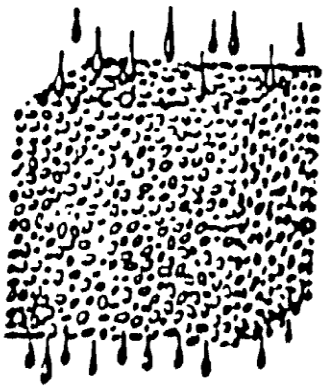
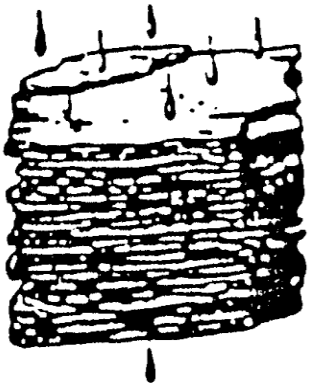
Massive: Soil particles are clustered together, but with little definition. No structure.

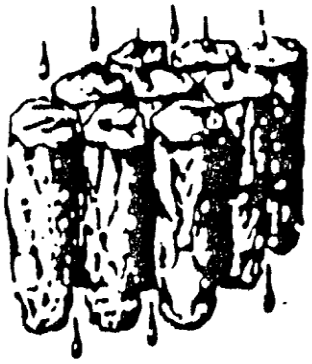
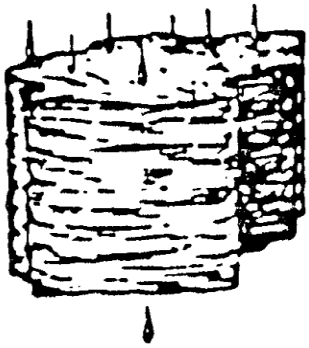


Platy: Cluster of soil particles consisting of thin sheets.

(Images from NASA's Goddard Space Flight Center website)

EFFECT OF SOIL STRUCTURE ON WATER MOVEMENT

SINGLE GRAIN	BLOCKY	PLATY
		
RAPID	MODERATE	SLOW

GRANULAR	PRISMATIC	MASSIVE
		
RAPID	MODERATE	SLOW

SOIL TEXTURE

Soil texture influences soil productivity and management more than any other physical soil characteristic.

The surface layer soil texture influences:

1. ***soil tilth***
2. ***ease of tillage***
3. ***resistance to erosion***
4. ***water holding capacity***
5. ***nutrient availability***
6. ***plant species composition***

(Photo courtesy of Rebecca

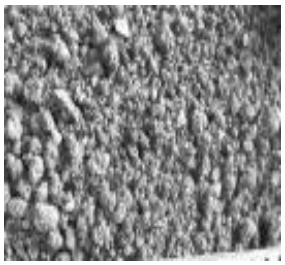
SOIL PARTICLES

Soil texture describes the proportion of SAND, SILT and CLAY particles in a soil.

DESCRIPTIONS OF SOIL PARTICLES AND TEXTURES

Sand is a piece of a parent stone that has not undergone any chemical changes. Sand is comprised of hard minerals such as quartz or feldspar. Sand grains are large (.05-2.0 mm) and can be seen and felt (gritty). *A sandy textured soil usually contains enough silt and clay particles to stick together and form a cast when moist. The cast will bear careful handling without breaking, but will not be sticky or plastic.*

Silt particles are smaller than sand (.002-.05 mm), with the same composition as the original stone. Silt is formed when sand grains are mechanically broken and dissolved by chemicals. The combination of breaking and dissolving results in soil particles with rounded corners that are often compared to grains of flour. Silt particles can feel smooth or slightly gritty (geographic regions influenced by historic glacier activity often have silty soils that feel very smooth.) *A silty textured soil sample will form a caste that can be handled freely without breaking. A wet sample will be slightly sticky and slightly plastic and will form a rough, broken ribbon.*



Clay particles are mineral crystals formed when acids react chemically with other minerals. The resulting flat crystals fit closely together and have more surface area than equal amounts of sand and silt. Clay particles are very small (.002mm or less) and feel greasy and sticky when wet. *Clayey textured soils form hard lumps or clods when dry. A moist sample forms a cast that can be molded in different shapes without breaking. Wet soils form plastic ribbons that bear their own weight.*

PARTICLE SIZE

- The *relative sizes* of sand (coarse), silt (medium) and clay (fine) particles are compared below.

SAND

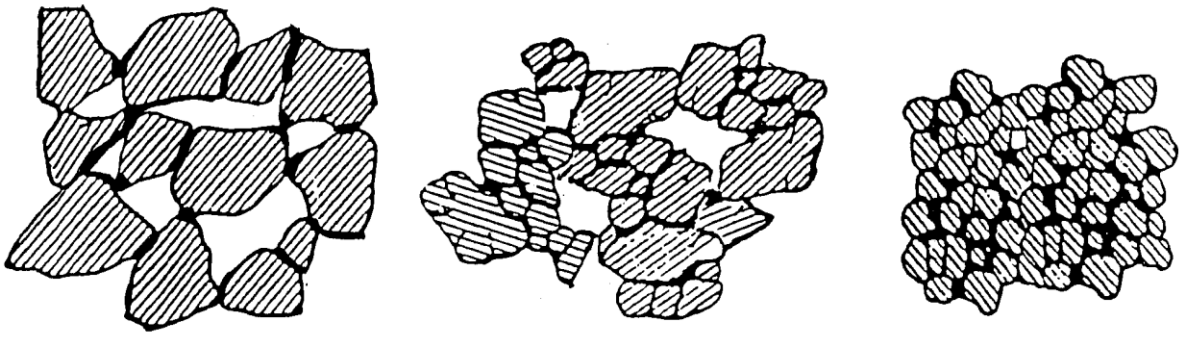
SILT

CLAY

RELATIVE SURFACE AREA

The relative surface area of soil particles determines the amount of water and nutrients a soil can absorb and store for plant use.

Relative surface area is illustrated below. The solid black represents water held in pore space. The empty areas represent air held in pore space.



SAND SILT CLAY

Medium textured soils **are generally considered ideal for agricultural uses.**

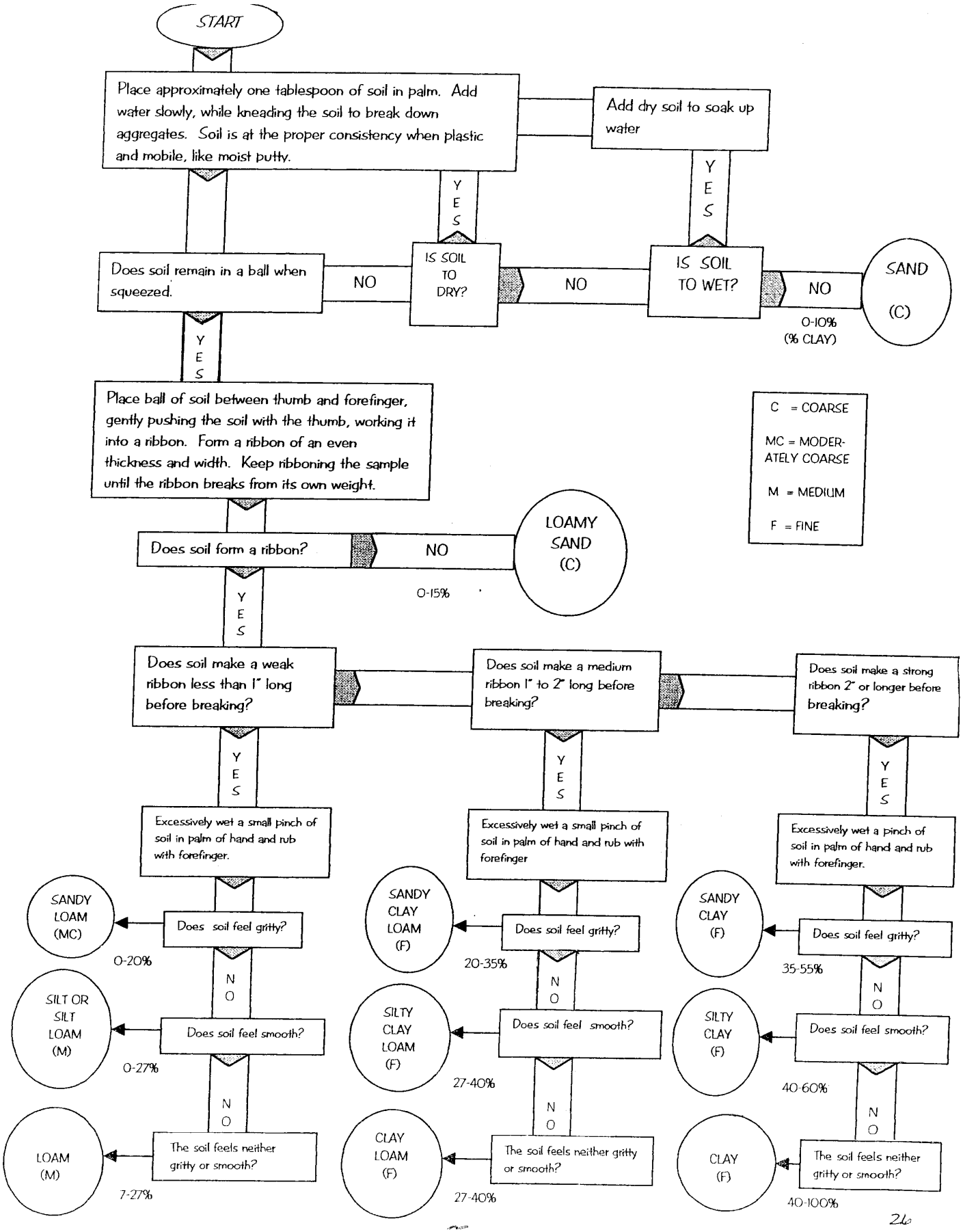
DETERMINING SOIL TEXTURE BY FEEL

1. Place one tablespoon of soil in your hand.

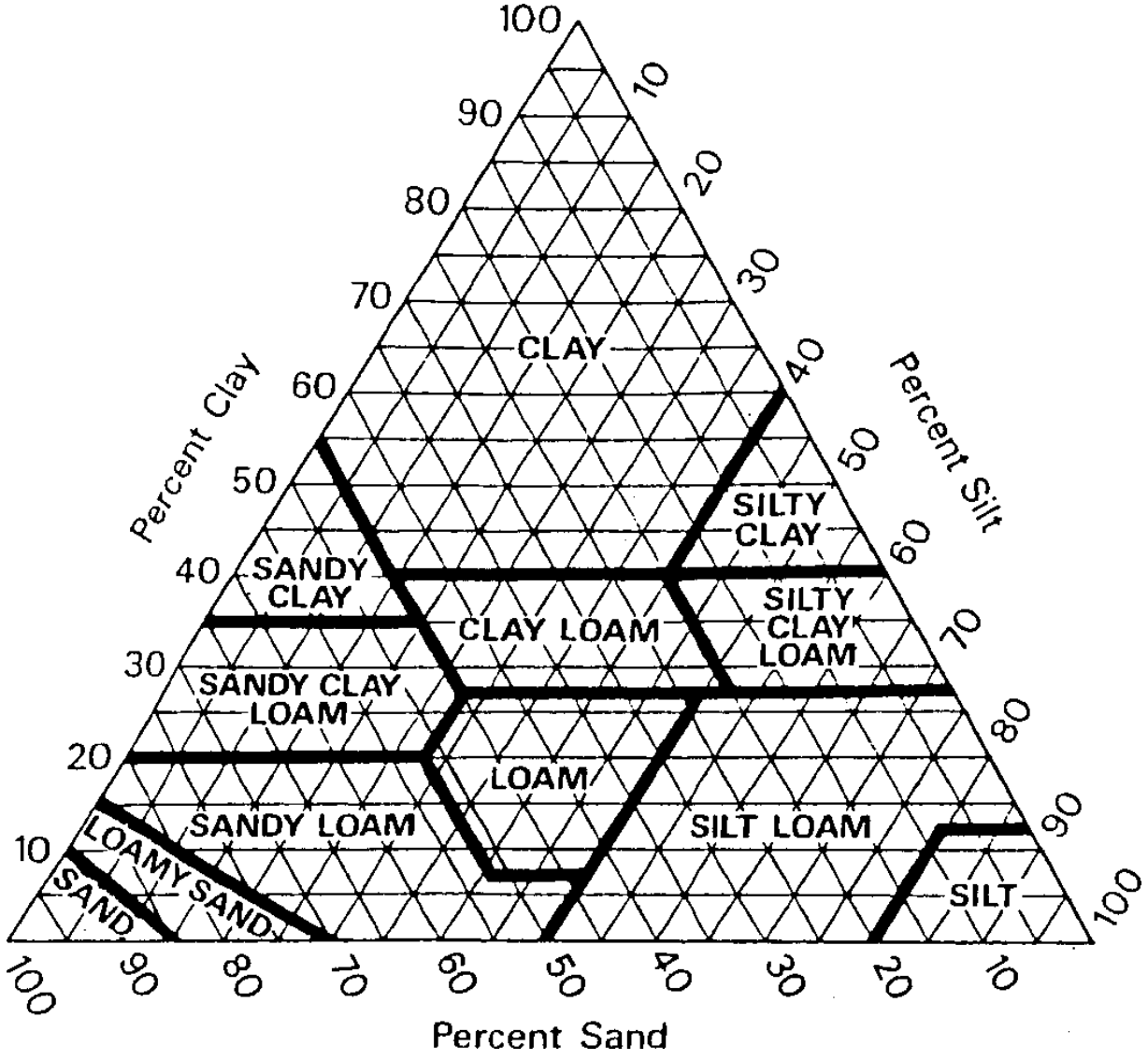
2. Remove roots, rocks and other foreign material from the sample and break up the clods.

3. Slowly add water to the sample. The sample is wet enough when the soil feels like putty or clay. The soil is too wet if you can squish water out of your palm when squeezing the sample.

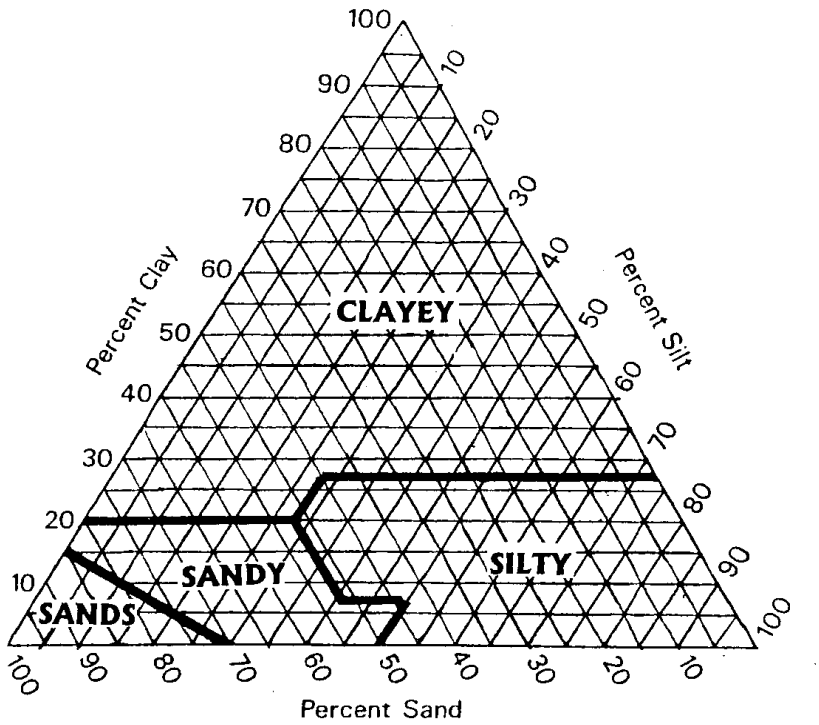
NOW YOU ARE READY TO DETERMINE SOIL TEXTURE USING THE KEY PROVIDED ON THE NEXT PAGE!


START
Place approximately one tablespoon of soil in palm. Add water slowly, while kneading the soil to break down aggregates. Soil is at the proper consistency when plastic and mobile, like moist putty.
Add dry soil to soak up water
YES
Does soil remain in a ball when squeezed.
NO
IS SOIL TO DRY?
NO
IS SOIL TO WET?
NO
SAND (C)
0-10% (% CLAY)
YES
Place ball of soil between thumb and forefinger, gently pushing the soil with the thumb, working it into a ribbon. Form a ribbon of an even thickness and width. Keep ribboning the sample until the ribbon breaks from its own weight.
C = COARSE
MC = MODERATELY COARSE
M = MEDIUM
F = FINE
Does soil form a ribbon?
NO
LOAMY SAND (C)
0-15%
YES
Does soil make a weak ribbon less than 1" long before breaking?
Does soil make a medium ribbon 1" to 2" long before breaking?
Does soil make a strong ribbon 2" or longer before breaking?
YES
YES
YES
Excessively wet a small pinch of soil in palm of hand and rub with forefinger.
Excessively wet a small pinch of soil in palm of hand and rub with forefinger
Excessively wet a pinch of soil in palm of hand and rub with forefinger.
SANDY LOAM (MC)
Does soil feel gritty?
0-20%
SANDY CLAY LOAM (F)
Does soil feel gritty?
20-35%
SANDY CLAY (F)
Does soil feel gritty?
35-55%
NO
NO
NO
SILT OR SILT LOAM (M)
Does soil feel smooth?
0-27%
SILTY CLAY LOAM (F)
Does soil feel smooth?
27-40%
SILTY CLAY (F)
Does soil feel smooth?
40-60%
NO
NO
NO
LOAM (M)
The soil feels neither gritty or smooth?
7-27%
CLAY LOAM (F)
The soil feels neither gritty or smooth?
27-40%
CLAY (F)
The soil feels neither gritty or smooth?
40-100%

GUIDE FOR SOIL TEXTURAL CLASSIFICATION



GUIDE FOR DETERMINING TEXTURAL ECOLOGICAL (RANGE) SITES BY SOIL TEXTURAL CLASSIFICATION



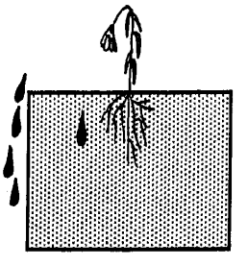
Range Site Texture Group	Textural Class	Basic Texture
Sands	Coarse	Sandy Loamy Sand
Sandy	Moderately Coarse	Sandy Loam Fine Sandy Loam
Silty	Moderately Fine	Very Fine Sandy Loam Silt Loam Loam
Clayey	Moderately Fine	Sandy Clay Loam Clay Loam Loam
Clayey	Fine	Sandy Clay Silty Clay Clay

Soil texture affects how much water runs off or soaks into a soil during a rain. Texture also affects how much soil water is available to plants.

Imagine if 5 raindrops fell from the sky.....

Scenario 1 - Soil with mostly clay particles

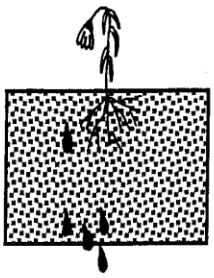
One raindrop stayed to water the plant, while four ran away.



*water runs off fast
*water soaks slowly into the soil
*there may not be enough water available for plants

Scenario 2 - Soil with mostly sand particles

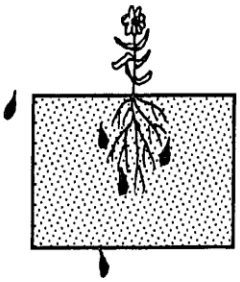
One raindrop stayed to water the plant, while four ran through the soil.



*water soaks into the soil fast
*the soil does not hold water
*plants often suffer drought

Scenario 3 - Soil with silt, sand and clay particles

Three raindrops stayed to water the plants, one drop ran away and one drop ran through the soil.



*water soaks into the soil well
*the soil holds onto most water
*plants have plenty of water available

This illustration demonstrates water holding capacity and the relationship between soil texture and plant species composition. Due to basic differences in plant physiology, some plants are better suited to grow on certain soil textures. For example, prairie sandreed generally prefers coarse soils, and green needlegrass likes finer soils.

In summary, soil texture influences the plant composition of a site, which affects forage production, which affects the amount of forage grazing animals can harvest, which in turn affects the rancher's pocketbook!

IDENTIFICATION OF ECOLOGICAL SITES

AN ECOLOGICAL (RANGE) SITE *is an area with similar soil and climate conditions. These conditions determine the kind and amount of forage produced on that site.*

Note that a sandy site in Eastern Montana may not produce the same type of forage or amount of forage that a sandy site in Western Montana will.

(Photo courtesy of the Montana Natural Heritage Program website)

Major ecological (range) site factors which influence plant species composition and forage production include:

- *Surface soil depth*
- *Soil texture*
- *Available soil moisture*
- *Land slope and exposure*
- *Soil salinity*
- *Native soil fertility*
- *Geographic location (ex. Foothills or Plains)*
- *Precipitation Zone (ex. 10-14 inches per growing season)*

Ecological sites within a landscape

When studying ecological sites, it is first important to observe your location within a landscape. Are you standing in a drainage, or are you on the top of a hill? Your landscape location will narrow the choices as to which ecological site you might be working in, because topography influences the moisture conditions of an ecological site. Sites in a low spot or drainage would have water running into them. Sites on a hill would have water running off.

(Photo courtesy of Ekalaka NRCS)

A BEGINNER'S KEY TO ECOLOGICAL SITES

This simple key gives us a place to start when learning about ecological sites. It focuses on just 3 landscape positions and their relation to water within a rangeland. When you can work through this key, you are ready to move on to the MRD Ecological Site key.

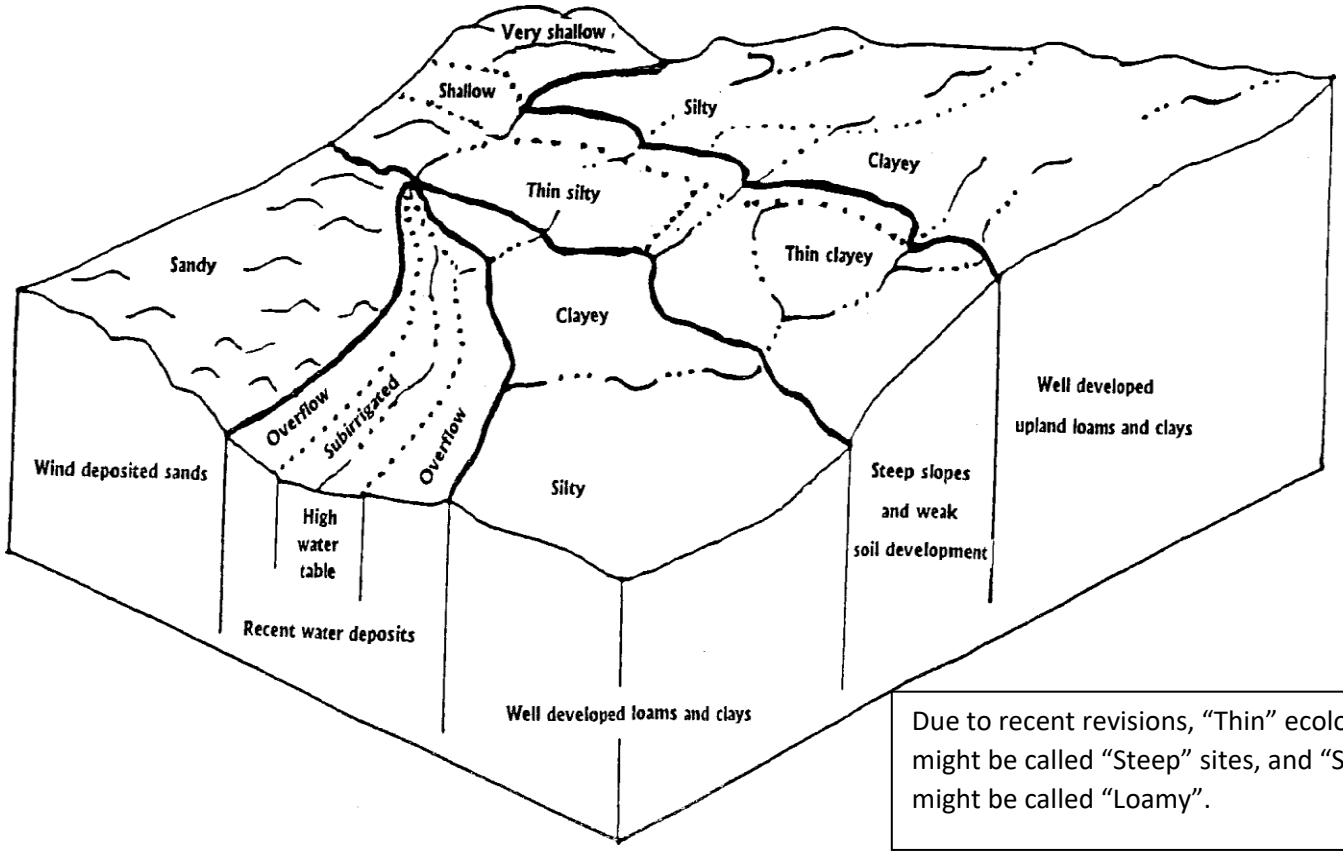
TO IDENTIFY AN ECOLOGICAL SITE, DETERMINE WHICH ONE OF THESE THREE QUESTIONS CAN BE ANSWERED "YES".

1. Does the site receive additional moisture from overflow? Or does it have groundwater close to the surface (within 40 inches) at least part of the growing season?
   If yes, the ecological site is ..... **RUN – IN**
   If no, go the next question.

2. Is the soil depth at least 20 inches from the surface with no sign of significant additional moisture? Does the slope of the site range from 0 – 8%?
   If yes, the ecological site is ..... **NORMAL**
   If no, go to the next question.

3. Is the site located on slopes greater than 8%? Or is the soil depth less than 20 inches to un-weathered parent material? If yes, the ecological site is ..... **RUN – OFF**
   If no, start again at the beginning of the key.

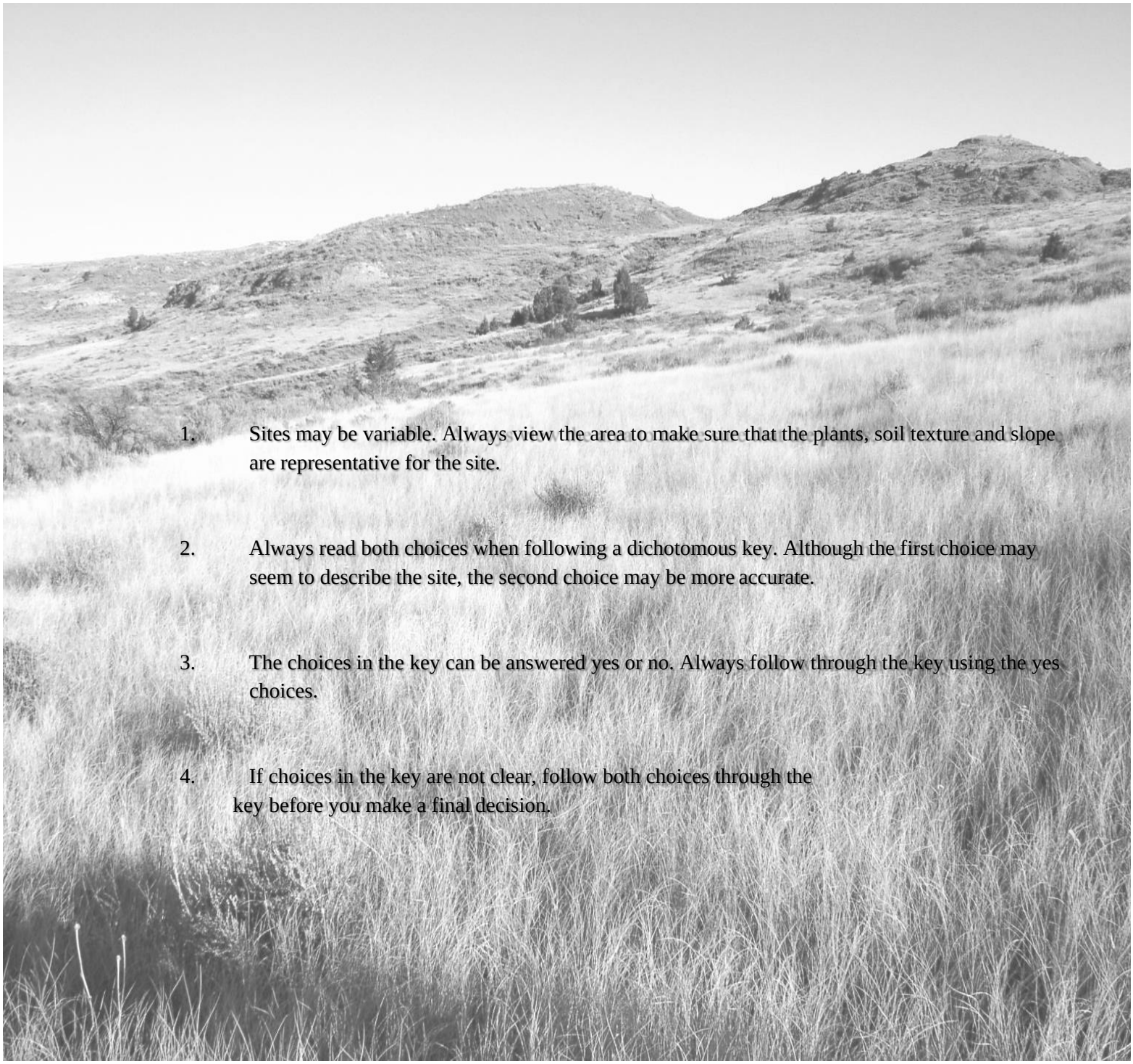
Ecological (range) sites as they might occur on a landscape.



Due to recent revisions, "Thin" ecological sites might be called "Steep" sites, and "Silty" sites might be called "Loamy".

MONTANA RANGE DAYS ECOLOGICAL (RANGE) SITE KEY

The MRD Ecological Site Key has more choices, but it is still a "map" to help you determine the correct ecological site. The three basic landscape positions that we studied above are broken down into more specific categories in the following key. Here are some user-friendly tips to consider:



1. Sites may be variable. Always view the area to make sure that the plants, soil texture and slope are representative for the site.

2. Always read both choices when following a dichotomous key. Although the first choice may seem to describe the site, the second choice may be more accurate.

3. The choices in the key can be answered yes or no. Always follow through the key using the yes choices.

4. If choices in the key are not clear, follow both choices through the key before you make a final decision.

(Photo courtesy of Ekalaka NRCS)

ECOLOGICAL SITE KEY

To identify an ecological site, first determine which one of these three questions can be answered "YES", then go to the appropriate group.

1. Does the site receive significant additional moisture from overflow or sub-irrigation, or does it have ground water at the surface during part of the growing season? (Go to Group I)

2. Is the soil depth 20 inches or more from the surface with no sign of significant additional moisture? (Go to Group II)

3. Is the soil depth less than 20 inches to hard or soft bedrock? (Go to Group III)

GROUP I SOILS RECEIVING ADDITIONAL MOISTURE

1. Groundwater appears at the surface during part of the growing season and is no deeper than 20 inches during the rest of the growing season… ..... **WET MEADOW (WM)**

2. Groundwater is within 20 to 40 inches of the surface during at least part of the growing season with no significant salt accumulations ..... **SUBIRRIGATED (Sb)**

3. Site receives additional moisture from runoff or stream overflow..... **OVERFLOW (Ov)**

GROUP II SOILS AT LEAST 20 INCHES DEEP – NO ADDITIONAL MOISTURE

1. Is there loose sand and/or significant gravel within 20 inches of the surface? (Go to Subgroup A)

2. Does the surface layer have a sand, loamy sand or sandy loam texture? (Go to Subgroup B)

3. Does the surface layer have a loam or silt loam texture? (Go to Subgroup C)

4. Does the surface layer have a clayey or clay loam texture? (Go to Subgroup D)

Subgroup A

1. Loamy surface layer over loose sand and gravel at 10-20" ..... **SHALLOW TO GRAVEL (SwGr)**

2. Loamy sand with 50% or more gravel and cobbles though out..... **GRAVEL (Gr)**

Subgroup B

1. Strongly or violently effervescent in surface mineral 4". Lime concentration increasing with depth (typically limestone parent material)..... **LIMY (Ly)**

2. Surface layer is coarse to fine sandy loam, and water drains through fairly fast. Nearly level to strongly sloping landscapes (<15% slopes) ..... **SANDY (Sy)**

3. Surface layer is coarse to fine sandy loam, and water drains through fairly fast. Strongly sloping landscape (>15% slope) ..... **SANDY STEEP (SyStp)**

Subgroup C

1. Surface layer is strongly or violently effervescent (bubbles)……**LIMY (Ly)**

2. Loam or silt loam surface >20" deep with a dark surface layer, on >15% slopes. Weak to no structure in Subsoil ……**LOAMY STEEP (LoStp)**

3. Loamy surface over a slowly permeable dense claypan subsoil ..... **CLAYPAN (Cp)**

4. Surface layer is loam or silt loam; on level to rolling (0-15%) slopes ..... **LOAMY (Lo)**

5. Soil has gravels or cobbles greater than 35% in surface 20 inches……. **DROUGHTY (Dr)**

6. Soil has gravels or cobbles greater than 35% in surface 20 inches, on >15% slopes. Weak to no structure in subsoil ..... **DROUGHTY STEEP (DrStp)**

Subgroup D

1. Loam to silty clay surface, mod, to strongly saline, on <8% slopes ..... **SALINE UPLAND (SU)**

2. A thin surface layer of clayey texture on slopes of hilly landscapes (>15% slopes). Weak to no structure in subsoil ..... **CLAYEY STEEP (CyStp)**

3. Relatively impervious clay soil with non-granular crust, very sticky when wet and extremely hard when dry..... **DENSE CLAY (DC)**

4. Granular acidic clay surface. Subsurface materials are porous clay with small shale chips, which act like sand. Sandy site plants grow in this soil ..... **COARSE CLAY (CC)**

5. Granular clay surface, clayey subsoil with blocky or prismatic structure, <15% slope…**CLAYEY (Cy)**

GROUP III SOIL DEPTH LESS THAN 20 INCHES

1. Is the soil depth 10 to 20 inches? (Go to Subgroup A)

2. Is the soil depth less than 10 inches? (Go to Subgroup B)

Subgroup A

1. Clayey soils, over shale or dense clay……**SHALLOW CLAY (SwCy)**

2. All other shallow soils,
……**SHALLOW (Sw)**

Subgroup B

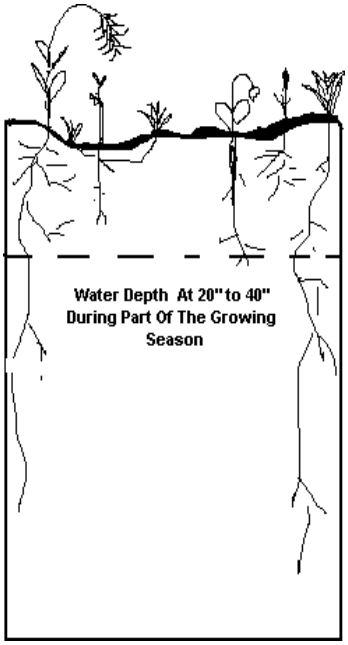
1. All soils less than 10 inches deep over root-limiting bedrock ..... **VERY SHALLOW (VSw)**

2. Clayey surface with some angular shale fragments and parent shale within 10"..... **SHALE (Sh)**

ECOLOGICAL SITE Profiles and Descriptions

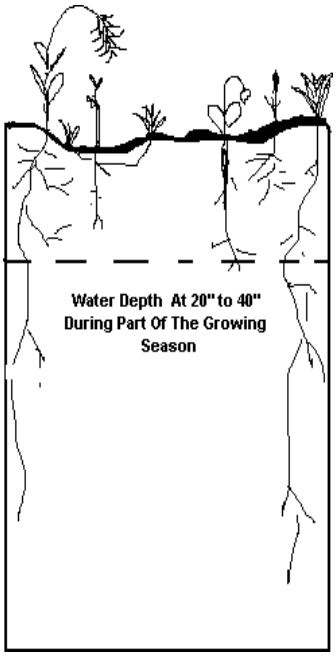
(INDICATES PLANT SPECIES THAT INCREASE WITH GRAZING PRESSURE)*

WET MEADOW



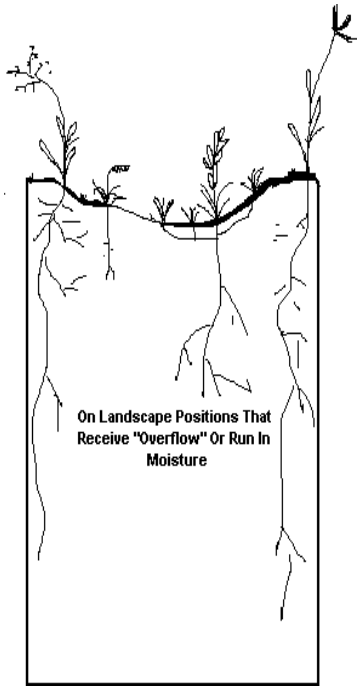
- PHYSIOGRAPHIC FEATURES: Occurs on low terraces, fans and flood plains. Slopes range from 0-2%.
- NATIVE CLIMAX VEGETATION: The potential plant community is comprised of 90% grasses and grass-likes and 10% forbs. Shrubs and trees usually do not grow on this site. Common plant species include prairie cordgrass, bluejoint reedgrass, American sloughgrass, American Mannagrass, tufted hairgrass, western wheatgrass, tall sedges and rushes, *low sedges, *cinquefoil species and *blue-eyed grass. *Kentucky bluegrass, *foxtail spp., thistles and other weedy forbs commonly invade this site.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production of wet meadow sites with high similarity indexes varies from 6700 pounds/acre on a good year to 4880 pounds/acre on a poor year.
- GRAZING: Wet meadow sites respond well to deferred grazing systems. These sites should not be grazed when submerged and boggy.

SUBIRRIGATED



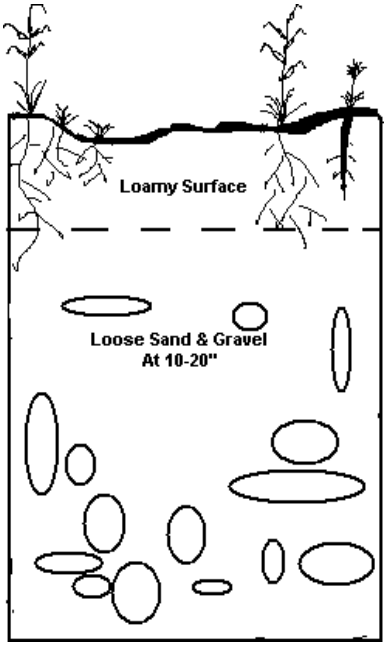
- PHYSIOGRAPHIC FEATURES: Occurs on level terraces and flood plains. Slopes range from 0-2%.
- NATIVE CLIMAX VEGETATION: The potential plant community is comprised of 80% grasses and grass-likes, 10% forbs and 10% trees and shrubs. Common plant species include prairie cordgrass, Canada wildrye, reed canarygrass, northern reedgrass, basin wildrye, *western wheatgrass, slender wheatgrass, tall sedges, *low sedges, cinquefoil spp., prairie thermopsis, cow parsnip, goldenrod spp., horsemint, bedstraw, willow spp., rose spp., chokecherry, *buffaloberry, American plum, cottonwood, boxelder and red-osier dogwood. Kentucky bluegrass, foxtail barley, thistles and weed-like forbs commonly invade these sites.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production on subirrigated sites with high similarity indexes varies from 5460 pounds/acre on a good year to 3467 pounds/acre on a poor year.
- GRAZING: Subirrigated sites respond well to grazing systems that alter the season of use. These sites should not be utilized when overly wet.

OVERFLOW



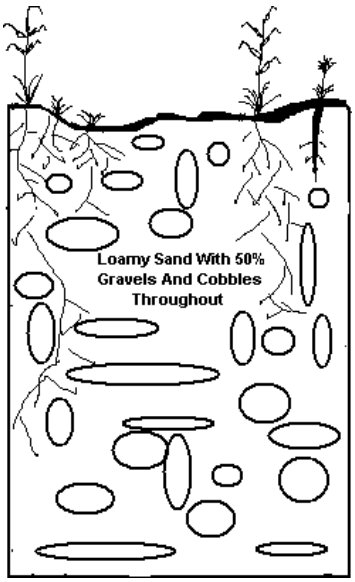
- PHYSIOGRAPHIC FEATURES: Occurs on low terraces, flood plains, or areas subject to frequent flooding. Slopes range from 0-2%.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 80% grasses and grass-likes, 5% forbs and 15% trees and shrubs. Common plant species include western wheatgrass, needlegrass spp., slender wheatgrass, basin wildrye, prairie junegrass, *bluegrass spp., sedges, western yarrow, prairie thermopsis, American vetch, astragalus spp, buffaloberry, *snowberry, prairie rose, chokecherry, *silver sagebrush, and golden current. Prairie rose, silver sagebrush, foxtails, thistles and weed-like forbs commonly invade this site.
- TOTAL ANNUAL HERBAGE PRODUCTION (air dry): Forage production on overflow sites with high similarity indexes is 3715 pounds/acre on a good year and 2260 pounds/acre on a poor year.
- GRAZING: These sites respond poorly to continuous, year-long grazing during the growing season.

SHALLOW TO GRAVEL



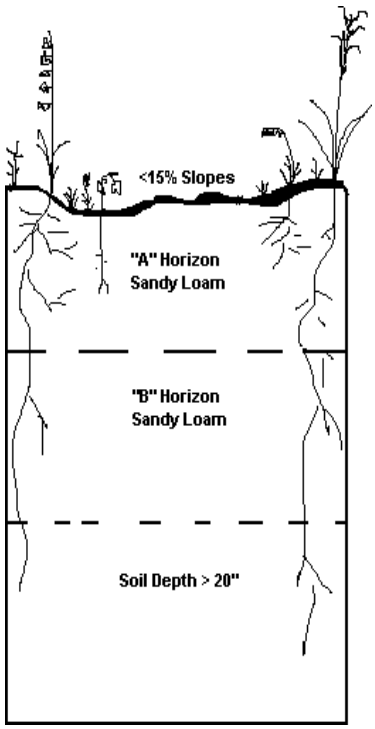
- PHYSIOGRAPHIC FEATURES: Occurs on strong to moderately sloping, rolling uplands. Slopes range from 0-15%.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is composed of 85% grasses and grass-likes, 10% forbs and 5% shrubs. Common plant species include bluebunch wheatgrass, Idaho fescue, western wheatgrass, plains reedgrass, *needle and thread, prairie junegrass, purple threeawn, *threadleaf sedge, prairie clover, astragalus spp., scurfpea spp., dotted gayfeather, hairy goldenaster, *fringed sagewort, common yarrow, winterfat, lupine, death camas, larkspur, skunkbush sumac, and woods rose. Broom snakeweed, pricklypear cactus, curlycup gumweed, hairy goldenaster and other weed-like forbs commonly invade the site.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production on shallow to gravel sites with high similarity indexes ranges from 1600 pounds/acre on a good year to 990 pounds/acre on a poor year.
- GRAZING: This site responds well to management systems that rotate the season of use.

GRAVEL



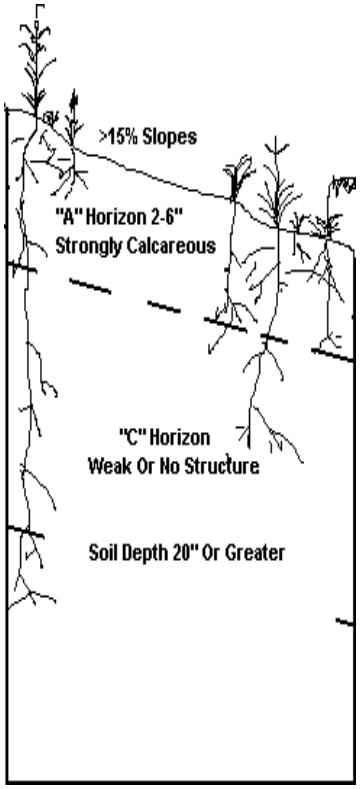
- PHYSIOGRAPHIC FEATURES: Occurs on uplands, terrace breaks and floodpains with nearly level to very steep slopes.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 80% grasses, 10% forbs and 10% shrubs. Common plant species include bluebunch wheatgrass, Idaho fescue, western wheatgrass, plains reedgrass, *needle and thread, prairie junegrass, *purple threeawn, threadleaf sedge, *fringed sagewort, common yarrow, hairy goldenaster, lupine, death camas, larkspur, prairie clover, winterfat, Woods rose. Needle and thread, annual weeds, clubmoss, bluegrama and threadleaf sedge commonly invade the site.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production on gravel sites with high similarity indexes varies from 1700 pounds/acre on a good year to 990 pounds/acre on a poor year.
- GRAZING: This site responds well to grazing system that rotate season of use with light grazing.

SANDY



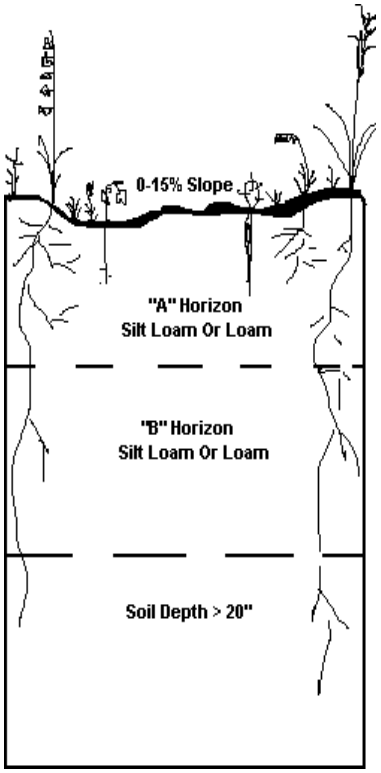
- PHYSIOGRAPHIC FEATURES: Sandy sites occur on rolling uplands, low terraces, fans and flood plains. Slopes are generally less than 8 percent.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 85% mid/short grasses, 10% forbs and 5% shrubs. Common plant species include prairie sandreed, *needle and thread, indian ricegrass, bluebunch wheatgrass, plains muhly, western wheatgrass, blue grama, prairie junegrass, *red threeawn, threadleaf sedge, scurfpea spp., astragalus spp., American licorice, dotted gayfeather, hairy goldenaster, fringed sagewort, green sagewort, stiff sunflower, goldenrod spp., eriogonum spp. prairieclovers, silver sagebrush, snowberry, skunkbush sumac, rose species, creeping juniper, cottonwood and yucca. Annual bromes, broom snakeweed and sagewort species commonly invade this site.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production on sandy sites with high similarity indexes varies from 2300 pounds/acre on a good year to 1000 pounds/acre on a poor year.
- GRAZING: These sites respond well to rotational grazing systems that prevent wind erosion by maintaining ground cover.

LOAMY STEEP



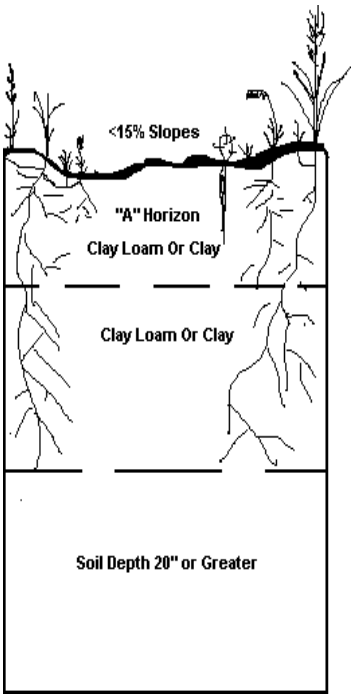
- PHYSIOGRAPHIC FEATURES: Loamy steep sites occur on steep, undulating hills and on steep side slopes along narrow ridges. Surface texture can be loam, silt loam or very fine sandy loam. Slopes are 15% or greater.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 80% grasses, 10% forbs and 10% shrubs/trees. Common plant species include: western wheatgrass, thickspike wheatgrass, bluebunch wheatgrass, needlegrass spp., *needle and thread, *blue grama, prairie junegrass, Sandberg bluegrass, oatgrass spp., plains reedgrass, threadleaf sedge, dotted gayfeather, scurfpea spp., scarlet globemallow, prairie coneflower, *fringed sagewort, goldenrod spp., astragalus spp., western yarrow, winterfat, *creeping juniper, shrubby cinquefoil, *silver sagebrush, nuttall saltbush, rabbitbrush spp., chokecherry, buffaloberry, rose spp., Rocky Mountain juniper, ponderosa pine, cottonwood, green ash. Creeping juniper, blue grama, needle and thread, threadleaf sedge, annual bromes, wooly plantain and broom snakeweed increase and/or invade as the site deteriorates.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production on loamy steep sites with high similarity indexes varies from 1800 pounds/acre on a good year to 800 pounds/acre on a poor year.
- GRAZING: This site deteriorates rapidly under continuous grazing systems. Well planned rotational grazing systems limit soil erosion and maximize forage production.

LOAMY



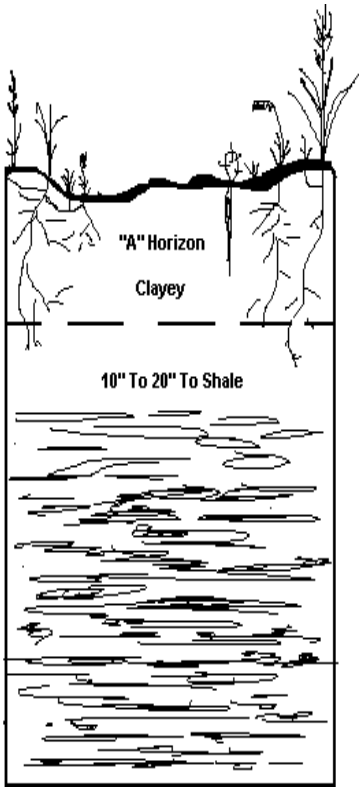
- PHYSIOGRAPHIC FEATURES: Loamy sites occur on rolling uplands, terraces, fans and flood plains. Slopes are generally less than 8 percent.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 85% grasses, 10% forbs and 5% shrubs. Common plants species include: bluebunch wheatgrass, Idaho fescue, mountain brome, *western wheatgrass, thickspike wheatgrass, needlegrass spp., *needle and thread, *prairie junegrass, Sandberg bluegrass, plains reedgrass, *threadleaf sedge, purple threeawn, hairy goldenaster, astragalus spp., scurfpea spp., sticky geranium, American vetch, lupine, arrowleaf balsamroot, prairie clover spp., biscuit root, eriogonum spp., prairie coneflower, western yarrow, larkspur, death camas, green sagewort, fringed sagewort, big sagebrush. Annual bromes, needle and thread, blue grama, dense clubmoss and sagebrush spp. commonly invade this site.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production of loamy sites with high similarity indexes varies from 2714 pounds/acre on a favorable year to 1875 pounds/acre on an unfavorable year.
- GRAZING: Loamy sites respond well to deferred grazing systems that vary season of use and incorporate rest.

CLAYEY



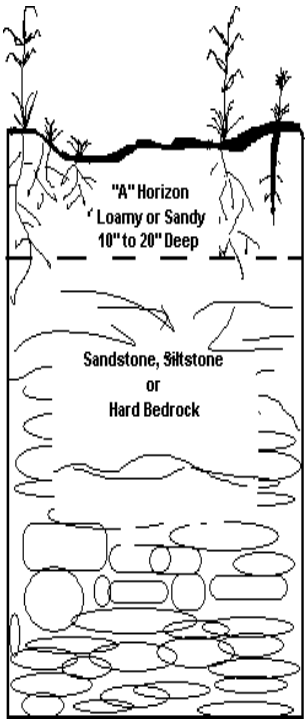
- PHYSIOGRAPHIC FEATURES: Clayey sites occur on rolling uplands, low terraces, fans and flood plains. Slopes generally range from 4 to 8%.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 80% grasses/grasslikes, 10% forbs and 10% shrubs. Common plant species include bluebunch wheatgrass, western wheatgrass, Idaho fescue, oatgrass spp., needlegrass spp., *blue grama, needleleaf sedge, Cusick's bluegrass, prairie junegrass, biscuit root, aster spp., dotted gayfeather, wild onion, American vetch, fringed sagewort, scarlet globemallow, western yarrow, lupine, larkspur, death camas, *pricklypear cactus, winterfat, rabbittbrush spp., *big sagebrush. Annual bromes, fescues, wooly plantain, salsify and pepperweed commonly invade clayey sites.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production of clayey sites varies from 2478 pounds/acre on a good year to 1440 pounds/acre on a poor year.
- GRAZING: Clayey sites respond well to deferred grazing systems that vary seasons of grazing and incorporate adequate rest periods.

SHALLOW CLAY



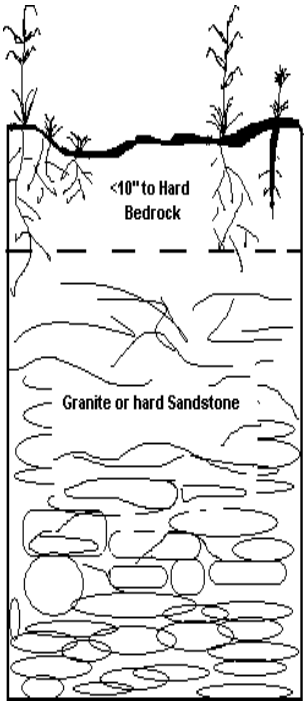
- PHYSIOGRAPHIC FEATURES: Shallow clay sites occur on rolling to strongly dissected uplands. Slopes range from 0-35%.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 80% grasses, 10% forbs and 10% shrubs. Common plant species include: bluebunch wheatgrass, Idaho fescue, *western wheatgrass, spike fescue, green/Columbia needlegrass, *blue grama, plains reedgrass, Sandberg bluegrass, prairie junegrass, *purple threeawn, needleleaf sedge, scarlet globemallow, spiny phlox, buckwheat spp., lupine, biscuit root, wild onion, dotted gayfeather, American vetch, *fringed sagewort, *big sagebrush, winterfat, rabbitbush spp., silver sagebrush, broom snakeweed. Sandberg bluegrass, salsify, broom snakeweed, annual bromes and weedy forbs commonly invade the site.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production of shallow clay sites with high similarity indexes varies from 1400 pounds/acre on good years to 1045 pounds/acre on poor years.
- GRAZING: Shallow clay sites respond well to grazing systems that incorporate rest during the growing season.

SHALLOW

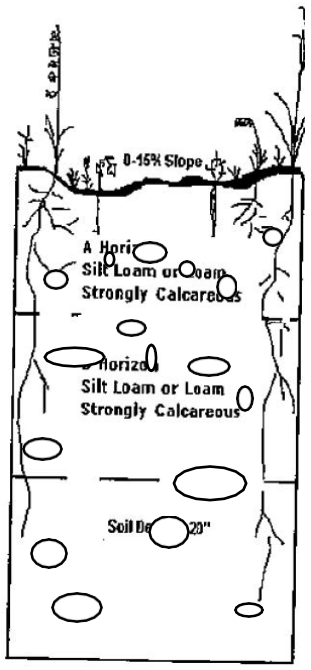


- PHYSIOGRAPHIC FEATURES: Shallow sites occur on rolling hills on uplands with outcrops of shale or sandstone. Slopes range from 0-35%.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 80% grass, 10% forbs, 10% shrubs and trees may occur on this site. Shallow sites can have up to 35% bare ground and still be in high ecological condition. Common plant species include: bluebunch wheatgrass, *western wheatgrass, needlegrass spp., plains reedgrass, *needle and thread, *threadleaf sedge, *blue grama, Sandberg bluegrass, prairie junegrass, dotted gayfeather, prairieclover spp., common yarrow, astragalus spp., hairy goldenaster, phlox spp., locoweed, death camas, fringed sagewort, woods rose, big sagebrush, broom snakeweed. Various annual and weed-like species commonly invade this site.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production of shallow sites with high similarity indexes varies from 1560 pounds/acre on a good year to 918 pounds/acre on a poor year.
- GRAZING: Grazing systems that rotate season of use maximize forage production and limit erosion on shallow sites.

VERY SHALLOW

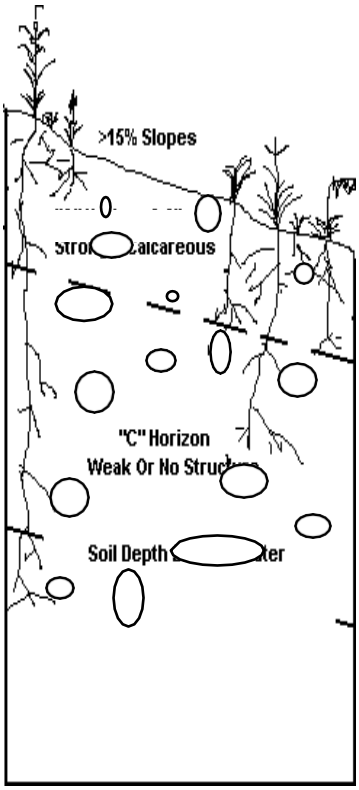


- PHYSIOGRAPHIC FEATURES: Very shallow sites occur on level to moderately sloping landscapes where soils are less than 10 inches deep. Surface textures can be variable given parent material.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 70% grasses, 5% forbs and 25% shrubs and trees. Common plant species include: bluebunch wheatgrass, western wheatgrass, Idaho fescue, Indian ricegrass, *needle and thread, plains reedgrass, prairie junegrass, Sandberg bluegrass, threadleaf/needleleaf sedge, *purple threeawn, hairy goldenaster, phlox spp., pussytoes, scurpea spp., bitter root, locoweed, Eriogonum spp., *fringed sagewort, juniper spp., big sagebrush, *plains pricklypear, skunkbush sumac, broom snakeweed, yucca. Broom snakeweed, threeawn spp., pricklypear, wooly plantain and curlycup gumweed commonly invade very shallow sites.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production of very shallow sites with high similarity indexes varies from 1010 pounds/acre on a good year to 630 pounds/acre on a poor year.
- GRAZING: Very shallow sites respond best to grazing systems that discontinue grazing during the growing season.



DROUGHTY

- PHYSIOGRAPHIC FEATURES: Sites occur on nearly level to sloping landscapes. Slopes range from 0-15%, mainly less than 8%. Soils are very gravelly and very cobbly loams, more than 20 inches deep. Rock fragments compose greater than 35% by volume in 10- 20" of the soil surface. Not strongly or violently effervescent within 4 inches of the surface.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 80% grasses, 15% forbs and 5% shrubs and trees. Common plant species include: bluebunch wheatgrass, thickspike wheatgrass, Idaho fescue, green needlegrass, *needle and thread, plains reedgrass, prairie junegrass, Sandberg bluegrass, threadleaf sedge, *purple threeawn, hairy goldenaster, phlox spp., pussytoes, locoweed, *fringed sagewort, black sagebrush, *plains pricklypear, broom snakeweed. Broom snakeweed, threeawn spp., pricklypear, and annual grasses commonly invade this site.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production of very shallow sites with high similarity indexes varies from 1900 pounds/acre on a good year to 800 pounds/acre on a poor year.
- GRAZING: Droughty sites respond best to shorter grazing periods and providing adequate regrowth after grazing.



DROUGHTY STEEP

- PHYSIOGRAPHIC FEATURES: Sites occur on steep, undulating hills and on steep side slopes along narrow ridges. Surface texture can be almost anything. Slopes are 15% or greater. Rock fragments compose greater than 35% by volume in 10- 20" of soil surface. Not strongly or violently effervescent within 4 inches of the surface.
- NATIVE (CLIMAX) VEGETATION: The potential plant community is comprised of 80% grasses, 10% forbs and 10% shrubs/trees. Common plant species include: western wheatgrass, thickspike wheatgrass, bluebunch wheatgrass, Idaho fescue, needlegrass spp., *blue grama, prairie junegrass, Sandberg bluegrass, plains reedgrass, sedge spp., dotted gayfeather, aster spp., scarlet globemallow, lupine, larkspur, astragalus spp., western yarrow, *fringed sagewort, winterfat, *creeping juniper, shrubby cinquefoil, skunkbush sumac, common snowberry, *silver sagebrush, Wyoming big sagebrush, rabbitbrush spp., prairie rose, buffaloberry, Rocky Mountain juniper, ponderosa pine.
- TOTAL ANNUAL HERBAGE PRODUCTION (AIR DRY): Forage production on loamy steep sites with high similarity indexes varies from 1800 pounds/acre on a good year to 450 pounds/acre on a poor year.
- GRAZING: This site deteriorates rapidly under continuous grazing systems. Well planned rotational grazing systems limit soil erosion and maximize forage production.

Inventory and Monitoring

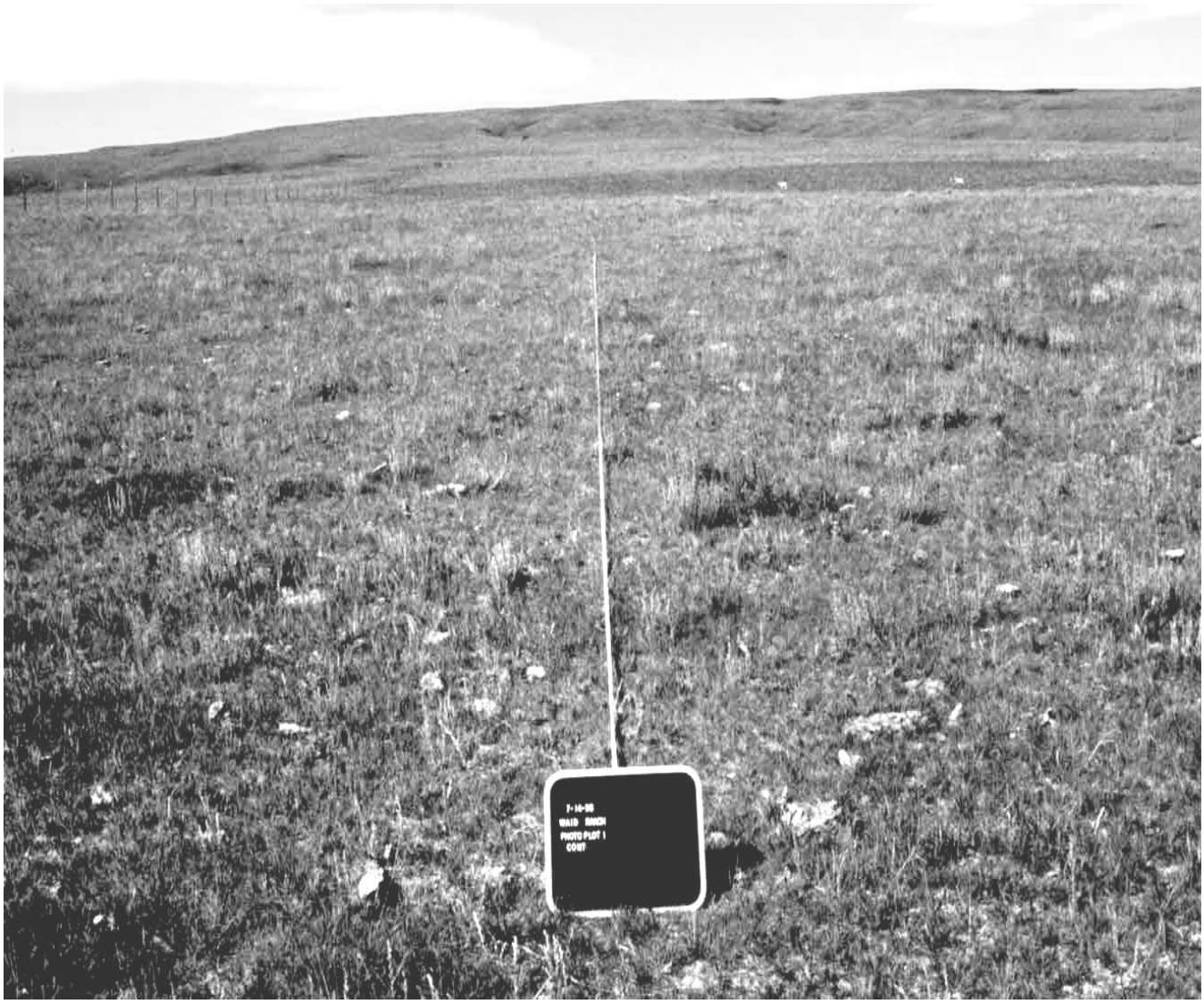
Rangeland Plant Community Dynamics

The Historic Climax Plant Community generally consists of tall and mid-sized perennial grasses. There is a high diversity of plants, including several native forbs and occasional shrubs.

(Prepared by Sue Noggles, NRCS Rangeland Management Specialist, Bozeman, Montana, April 2000. 2007/2008 local revisions provided by Jon Siddoway, NRCS Rangeland Management Specialist, Bozeman, Montana)

Plant Community Dynamics:

Other plant communities will evolve on the same rangeland ecological site over time with improper grazing or other disturbances. Once the tall, palatable grasses are gone, they are replaced with plants more resistant to grazing, such as rhizomatous grasses, short grasses, and unpalatable forbs and shrubs.



With continued grazing pressure, and other disturbances, some plant communities become invaded with undesirable species. These plants are often biennials or annuals, and do not hold the soil as well as deep-rooted grasses. The site may eventually lose its topsoil, and become susceptible to erosion. These sites often lose their values for livestock forage and wildlife habitat.

Plant Grazing Response

To help understand how grazing affects plants and plant communities, we separate plants into the following classes:

Decreasers

Increasers

Invaders

Clipart courtesy of USDA-NRCS

Decreasers

– Generally tall, palatable, leafy plants, preferred by grazing animals, and dominant in Historic Climax Plant Community.

Clipart courtesy of USDA-NRCS

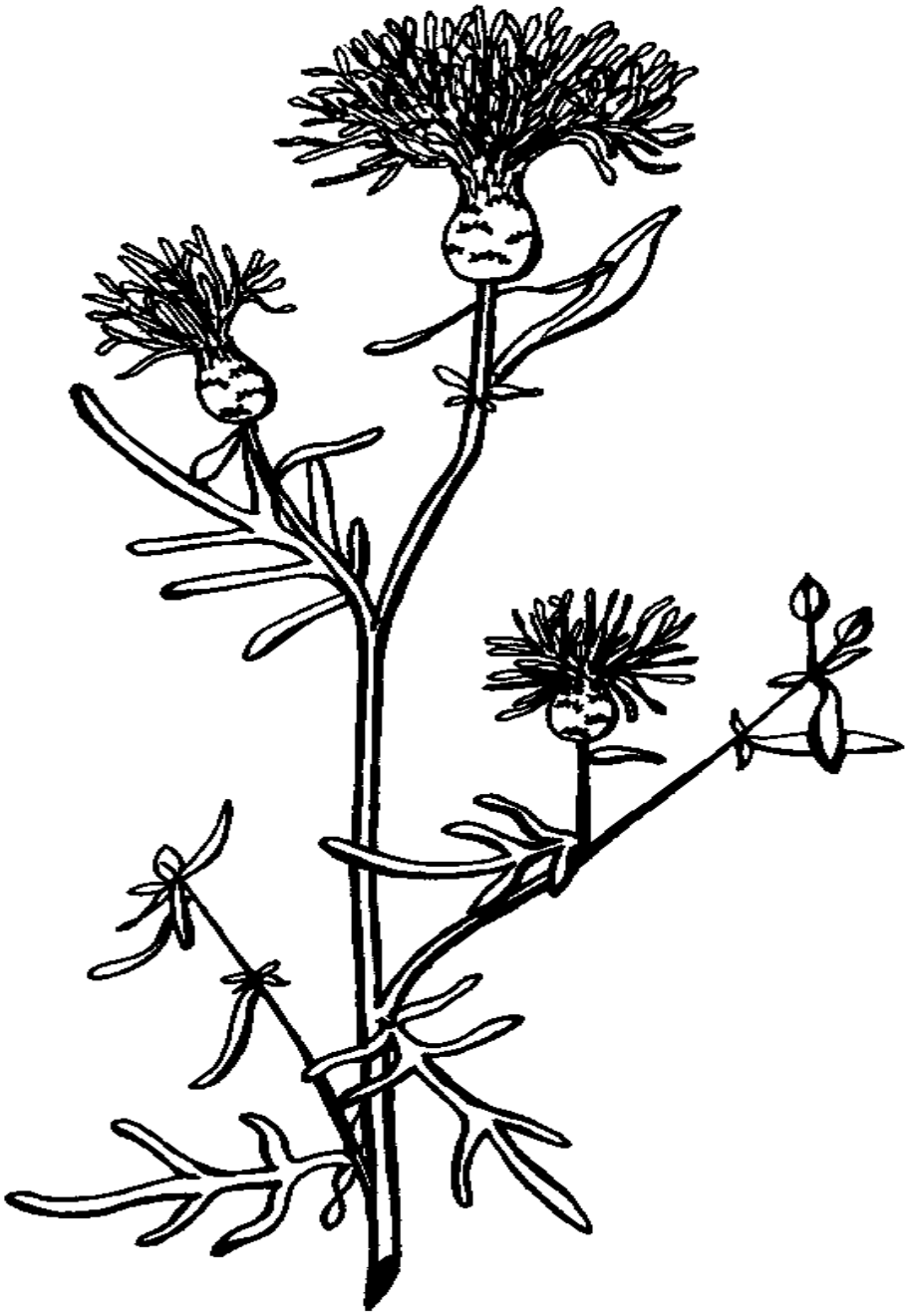
Increasers

– Mid-size to short grasses, forbs, and most shrubs, fairly unpalatable to livestock OR have significant protection from overgrazing, such as rhizomatous root systems.

Clipart courtesy of USDA-NRCS

Invaders

- Non-native plants, including noxious weeds, other undesirable plants, and tame grass species. Invaders are often annuals or biennials which do not have deep root systems to prevent soil erosion.



Clipart courtesy of USDA-NRCS

Grazing Response

With improper grazing, the more palatable decreaser plants will begin to disappear from the rangeland. They will be replaced by increaser plants, which usually have less forage quality and production. Many increasers can become dominant and weedy on the rangeland.

Over time, if high grazing pressure continues, invader plants may become more common. These plants are often very difficult and expensive to control, and generally have little if any forage value.

Rangeland inventory techniques, including Similarity Index, are used to determine the percentage of each type of plant that occurs on the rangeland.

Photo courtesy of USDA-NRCS

EVALUATING AND RATING ECOLOGICAL (RANGE) SITES

- **PLANT COMMUNITY COMPOSITION AND PRODUCTION**
- **SIMILARITY INDEX (RANGE CONDITION)**
- **RANGELAND TREND**
- **RANGELAND HEALTH**

Why Do We Inventory Rangeland?

- **To answer the following questions:**
  - ✓ What rangeland resources do I currently have?
  - ✓ Is my rangeland producing the types of plants that I desire?
  - ✓ How much forage is my rangeland producing?
  - ✓ What is the potential for my rangeland to produce forage and desirable plants?
  - ✓ What resource problems do I have (weeds, soil erosion, etc.)?

Photo courtesy of Phillips County Range Committee

Why Do We Monitor Rangeland?

❖ **To answer the following questions:**

- ✓ Am I meeting my goals for the types of plants and production that I desire?
- ✓ How is my rangeland changing over time?
- ✓ Is my grazing management changing my rangeland for better or worse?
- ✓ Are undesirable plants or other pests invading on to my rangeland?
- ✓ To tie in future grazing management decision-making with grazing and climate records (stocking rates, turn-in and turn-out dates, utilization levels, high rainfall events, hail, drought, pest invasions, etc.).

Photo courtesy of USDA-NRCS

PLANT COMMUNITY COMPOSITION AND PRODUCTION

This inventory method is used to:

Determine the types and amounts of different plant species in a rangeland community.

1. Determine the forage production of a rangeland ecological site in its present condition.
2. Assess the presence or absence of undesirable plants or weeds.
3. As the basis for determining Similarity Index (Range Condition).
4. As the basis for determining safe stocking rates.

STEPS FOR DETERMINING PLANT COMMUNITY COMPOSITION AND PRODUCTION:

1. Determine the rangeland ecological site you wish to inventory.
2. Walk to find a good representative area to sample.
3. Mark out a 100 to 200-foot straight line transect.
4. Walk along the transect and record all plant species you find. Separate by grasses and grass-likes, forbs, shrubs, and possibly trees.
5. Use a 9.6 or 4.8 square foot hoop to sample 5 to 10 plots along the transect.
6. Follow the instructions on the following pages to do either:
   - ✓ Clipping and Weighing,
   - ✓ Visual Estimation Using Plant Weight Units, or
   - ✓ Estimating Species Composition Using a Grid
7. When complete, calculate total production (air-dry weight) for the site, and percent composition of each plant species.

Photo courtesy of Ekalaka NRCS

DETERMINING SPECIES COMPOSITION AND FORAGE PRODUCTION

There are three basic methods to determine species composition and production:

- *Clipping and Weighing,*
- *Visual Estimation Using Plant Weight Units, and*
- *Estimating Species Composition Using a Grid*

Here are some terms you will need to know:

A. Total annual production: The total above-ground production in pounds per acre of all plants in the community for an entire year. This is just the current year production and doesn't include plant material that is remaining from previous years.
☺ *Remember:* This includes all plants, not just the ones that are good for forage!!

B. Percent Species Composition by weight: The percent that each plant makes up in the community related to the total annual production. For example: 30% bluebunch wheatgrass, 15% needleandthread, 5 % blue grama, etc.

C.

D. Percent dry matter: All plants have differing amounts of water or moisture in them, depending on the type of plant they are, and also the time of year you are sampling them.

😊 ***Remember:*** **To measure all plants the same way, we must weigh them on an air-dry weight basis. This is the amount of plant material left after all moisture is evaporated out.**

Clipart courtesy of USDA-NRCS

The following information can be used to determine the percent of air-dry weight of different types of plants throughout the year:

Exhibit 4–2 Percentage of air-dry matter in harvested plant material at various stages of growth—Continued

Shrubs	New leaf and twig growth until leaves are full size (%)	Older and full-size green leaves (%)	Green fruit (%)	Dry fruit (%)
Evergreen	55	65	35	85
big sagebrush				
bitterbrush				
ephedra				
algerita				
gallberry				
Deciduous	35	50	30	85
snowberry				
rabbitbrush				
snakeweed				
Gambel oak				
mesquite				
Yucca and yucca-like plants	55	65	35	85
yucca				
sotol				
saw-palmetto				

Forbs	Initial growth to flowering (%)	Flowering to seed maturity (%)	Seed ripe; leaf tips dry (%)	Leaves dry; stems drying (%)	Dry (%)
Succulent	15	35	60	90	100
violet					
waterleaf					
buttercup					
bluebells					
onion, lilies					
Leafy	20	40	60	90	100
lupine					
lespedeza					
compassplant					
balsamroot					
tickclover					
Fibrous leaves or mat	30	50	75	90	100
phlox					
mat eriogonum					
pussytoes					

Succulents	New growth pads and fruits (%)	Older pads (%)	Old growth in dry years (%)
Prickly pear and barrel cactus	10	10	15+
Cholla cactus	20	25	30+

Exhibit 4–2 Percentage of air-dry matter in harvested plant material at various stages of growth

Grasses	Before heading; initial growth to boot stage (%)	Headed out; boot stage to flowering (%)	Seed ripe; leaf tips drying (%)	Leaves dry; stems partly dry (%)	Apparent dormancy (%)
Cool season	35	45	60	85	95
wheatgrasses					
perennial bromes					
bluegrasses					
prairie junegrass					
Warm season					
Tall grasses	30	45	60	85	95
bluestems					
indiangrass					
switchgrass					
Midgrasses	40	55	65	90	95
side-oats grama					
tobosa					
galleta					
Short grasses	45	60	80	90	95
blue grama					
buffalograss					
short three-awns					

Trees	New leaf and twig growth until leaves are full size (%)	Older and full-size green leaves (%)	Green fruit (%)	Dry fruit (%)
Evergreen coniferous	45	55	35	85
ponderosa pine, slash				
pine-longleaf pine				
Utah juniper				
rocky mountain juniper				
spruce				
Live oak	40	55	40	80
Deciduous	40	50	35	85
blackjack oak				
post oak				
hickory				

Materials Needed To Clip and Weigh

- ✓ A 9.6 Square Ft. or 4.8 Square Ft. hoop
- ✓
- ✓ A set of sturdy clippers
- ✓
- ✓ A portable gram scale
- ✓
- ✓ Several small paper sacks (lunch bag size)

Photo courtesy of USDA-NRCS

Instructions for clipping and weighing:

After you find a good location for a transect line, lay the first hoop down randomly. Clip each species in the hoop separately and put plant material into brown paper sacks. Using the gram scale, weigh the green samples and record the number of grams on a data form. (Remember to subtract the weight of the bag!!) Once you have all the plants weighed, you may keep the material to air dry, or use the dry weight tables to convert to dry weight.

To calculate the actual pounds per acre of plant production, total the dry weight of the plant and multiply by the following conversion factors:

9.6 plot: 1 gram x 10 = pounds per acre
4.8 plot: 1 gram x 20 = pounds per acre

Complete the above procedure for all 10 plots. When complete, total the production from all plots for each species and this will give you total annual production for the plant community.

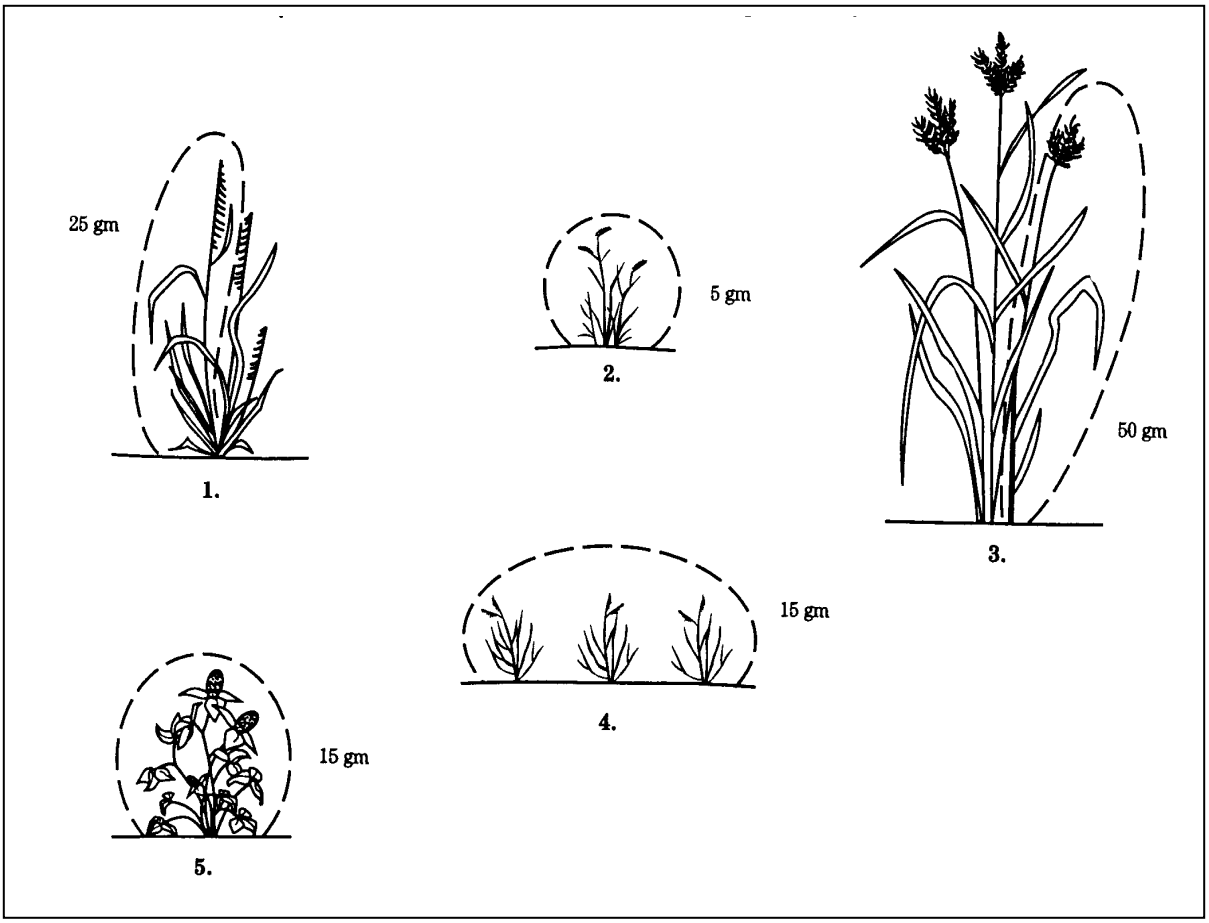
To determine the percent composition of each species, simply divide the lbs/acre for each plant by the total lbs/acre. For example: Green needlegrass is 160 lbs/acre divided by 894 total lbs. = 18%.

Example:

Plant name	Clipped weight	Dry weight %	Conversion factor	Total annual production (lbs./acre)	Percent composition
Green needlegrass	40 grams	.40	10	160	18
Needleandthread	60 grams	.50	10	300	34
Prairie Junegrass	40 grams	.60	10	240	27
Blue grama	20 grams	.40	10	80	9
Western yarrow	10 grams	.30	10	30	3
Silver sagebrush	14 grams	.60	10	84	9
Total	xxx	xxx	xxx	**894**	**100**

Estimating Using Plant Weight Units

Once you have some experience clipping, you can begin to estimate plant production. The best way to do this is to give each plant a representative weight unit. This is a clumping or a representative unit for each plant, as shown in the following examples:



For example, if you weigh a "typical" clump of bluebunch wheatgrass, and it weighs 5 grams, and you have 3 clumps in your plot, you would estimate 15 grams of bluebunch wheatgrass.

Follow the procedures for clipping, but instead of weighing each plant, estimate them. ☺ Remember to use the dry weight tables to calculate air-dry weight for each species.

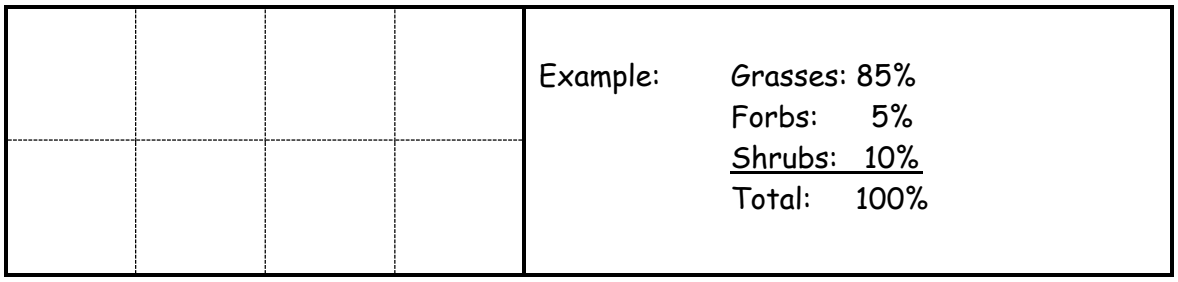
This method is less accurate, but saves a lot of time because you don't have to clip and weigh each plant.

Estimating Species Composition Using a Grid

Another method for estimating plant production is to use an imaginary grid to determine the relative percent composition of plants. This method is not very accurate in determining actual weights of plants, but can be used where accurate productivity rates are not that important.

Using your imagination, break the plot into grids. You can use halves, quarters, or eighths. First, estimate the total percent of each type of plant: grasses, forbs, or shrubs.

Sample grid:



Now break down the 85% of grasses into individual species. In this example, you have 5 grasses, so you must determine the amount by weight of each grass species. Use the grid to help you estimate:

Grasses:	**Estimated %:**
Green needlegrass	20
Needleandthread	30
Prairie junegrass	*25*
Blue grama	10
Total	**85%**

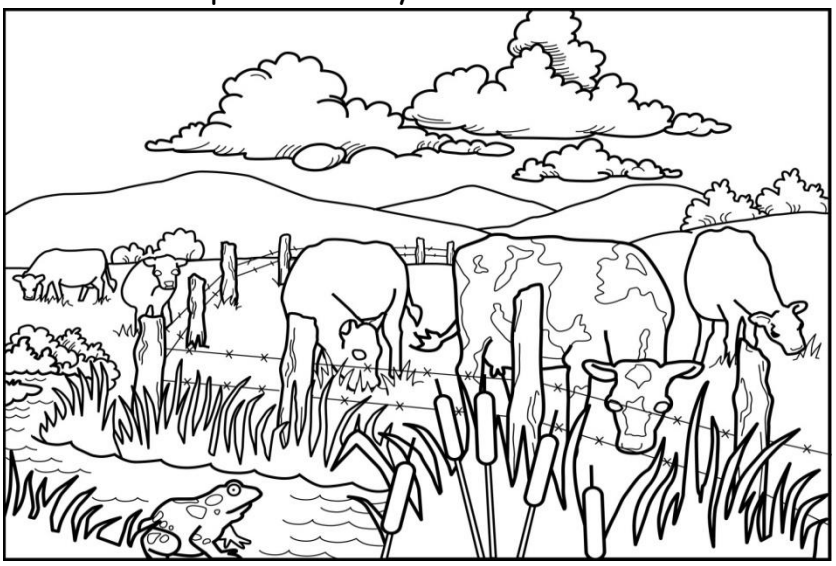
Repeat this procedure for forbs and shrubs to determine the total percent composition for the community.

If you wish to determine the weight of each species using this method, you must first estimate the total annual production of the site. Then you can multiply the percent composition of each species by the total production amount, to get a weight value for each species.

Example: 900 lbs/acre total production x .20 (green needlegrass) = 180 lbs./acre green needlegrass

Grasses:	Estimated %:	Total Production (lbs./acre):
Green needlegrass	20	180
Needleandthread	30	270
Prairie junegrass	*25*	*225*
Blue grama	10	90
Western yarrow	5	45
Silver sagebrush	10	90
Total	**85%**	**900 pounds**

Clipart courtesy of USDA-NRCS



SIMILARITY INDEX

Rangeland ecological sites are defined by the **soils, topography and climate** that make them unique from other sites. Each ecological site has a **characteristic plant community** that has developed on the site according to its site forming factors. We call this the **"Historic Climax Plant Community".**

The Historic Climax Plant Community is described by the **types, amounts, and proportions of different plant species** that occupy the site. Information about the Historic Climax Plant Community is used to describe the **potential plant community and potential productivity** of each range site.

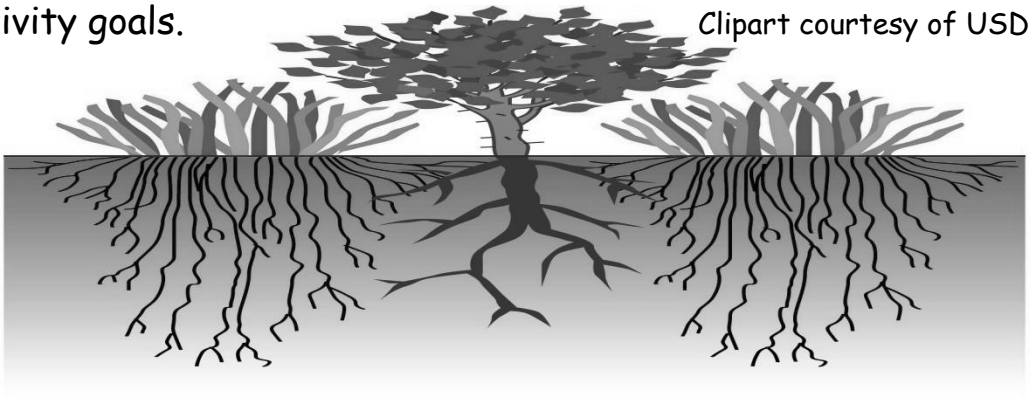
Rangelands change over time with different management practices, disturbances, and/or climatic shifts. Our **plant communities today are often very different** from what is described in the Historic Climax Plant Community.

As part of our rangeland inventory information, we can describe **how similar the current plant community on a site is to the Historic Climax Plant Community**. This comparison is called the "**Similarity Index"** (previously called "Range Condition").

The purpose for determining "Similarity Index" is to describe the extent and direction of changes that have taken place on a site from its original condition. We can then predict what changes could occur from implementing a new grazing management strategy or other practices (grazing land mechanical treatment, prescribed burning, etc.).

Similarity Index evaluations provide a starting point for **establishing goals and objectives for grazing management**. Changes in Similarity Index can be **monitored over time** to determine if you are meeting your plant community and productivity goals.

Clipart courtesy of USDA-NRCS



PROCEDURE FOR DETERMINING SIMILARITY INDEX
Using the Similarity Index Worksheet

1. Determine the geographical area, rangeland ecological site, and annual precipitation zone of the area, and record it on the top of the Worksheet.
For example: Sandy, 10-14" precip., Eastern Sedimentary Plains.

2. Identify plants on your transect or in your plot and list them in Column A.
Hint: list the best perennial plants first, then other perennials, then annuals.

3. After clipping or estimating the total annual production for the site, record the pounds dry weight at the bottom of Column C.

4. Multiply the percent composition figure for each plant (from Column B) times the Total Pounds/Acre you just wrote at the bottom of Column C.
Check your math! Make sure this column totals the amount at the bottom.

5. Using the Guide for Determining Similarity Index, transfer the Historic Climax Plant Community percent composition and lbs. /acre for each species to Columns D and E.
You may have to lump some plants together. Noxious weeds don't count even though they may be perennials.

6. From the bottom of the Guide for Determining Similarity Index, find the total production for the site and record it at the bottom of Column E.
This number is not the total of Column E!

7. Choose the smaller of the two weights for each species, in Column C and Column D. Record this maximum allowable weight in Column F.

8. Total the allowable pounds in Column F.

9. Divide the total of Column F by the total pounds in HCPC, bottom of Column E.

10. This number, the percent Similarity Index, represents how close the site is to Historic Climax Plant Community.

Sample **SIMILARITY INDEX WORKSHEET**

Ecological Site: *loamy, 11-14" precip., Sedimentary Plains*

	Present Plant Composition [1/]	**Historic Climax Plant Community** [2/]

Plant List (A)	**(B) Percent Composition**	**(C) Pounds per acre**	**(D) Percent Composition**	**(E) Pounds per acre**	**Allowable pounds (F)**
GRASSES:					
Western wheatgrass	*35*	*420*	*20*	*360*	*360*
Green needlegrass	*10*	*120*	*20*	*360*	*120*
Needle and thread	*10*	*120*	*15*	*270*	*120*
Prairie junegrass	*5*	*60*	*5*	*90*	*60*
Sandberg bluegrass	*5*	*60*	*5*	*90*	*60*
Japanese brome	*5*	*60*	*0*	*0*	*0*
Threadleaf sedge	*5*	*60*	*5*	*90*	*60*
FORBS:					
Prairie coneflower	*10*	*120*	*5*	*90*	*90*
Western yarrow	*5*	*60*	*5*	*90*	*60*
Cudweed sagewort	*5*	*60*	*5*	*90*	*60*
SHRUBS:					
Silver sagebrush	*5*	*60*	*5*	*90*	*60*
TOTAL:	100%	*1200 lbs/ac*		* *1800 lbs/ac*	*1050*

SIMILARITY INDEX:

(Column F total, divided by *) *1050/1800 = 58%*

[1/] Data taken from on-site rangeland inventory.

[2/] Data taken from the NRCS Ecological Site Description or the **Guide for Determining Similarity Index**.

***** This is <u>not</u> the total of Column E

SIMILARITY INDEX WORKSHEET

Ecological Site:

	Present Plant Composition [1/]		Historic Climax Plant Community [2/]		
Plant List (A)	**(B) Percent Composition**	**(C) Pounds per acre**	**(D) Percent Composition**	**(E) Pounds per acre**	**Allowable pounds (F)**
GRASSES:					
FORBS:					
SHRUBS:					
TOTAL:	100%			*	

SIMILARITY INDEX:

(Column F total, divided by *)

[1/] Data taken from on-site rangeland inventory.

[2/] Data taken from the NRCS Ecological Site Description or the **Guide for Determining Similarity Index**.

***** This is <u>not</u> the total of Column E

Rangeland Trend Determination

What is rangeland trend?

- Trend is defined as the direction of change a plant community is taking, either towards or away from the Historic Climax Plant Community (HCPC).

Why do we estimate or measure trend?

- It gives valuable information on how current or past management practices are effecting the plant community.
- It gives an idea if you are meeting your goals or not.
- It can be a warning sign if serious negative changes are occurring.

How is trend determined?

- Apparent trend is estimated looking at 5 major factors:
  - ✓ Plant Composition Changes
  - ✓ Abundance of Seedlings and Young Plants
  - ✓ Plant Litter and Residue
  - ✓ Plant Vigor
  - ✓ Condition of Soil Surface

☺ Remember, rangeland trend looks at the current plant community compared to the historical plant community to determine the direction of change, if any.

How is trend rated?

- ***Toward – Moving towards the Historic Climax Plant Community.***
- **Not Apparent**- No change is detectable.
- **Away from** – Moving away for the Historic Climax Plant Community.

Rangeland Trend Factors (*use with worksheet*)

1. ***Find a representative area to look at within the range site you wish to evaluate.***
2. ***Walk around to get a good idea of what the plant community and soil surface look like.***
3. ***Rate the following factors from 1 to 5.***
   - ❖***1 is very low compared to Historic Climax Plant Community.***
   - ❖***5 is very High compared to Historic Climax Plant Community.***
   - ❖**3 is average compared to Historic Climax Plant Community.**

A. Apparent Change in Plant Composition:

5 = All major plant species in HCPC are present and in proper proportions.
3 = A mixture of both native plants, with some weeds or undesirable plants present.
1 = Plant community is composed mostly of invader species and weeds.

B. Vigor of Key Species and Desirable Plants:

5 = Native plant species are of good size for their age and appear healthy.
3 = Native plants appear generally healthy, but exhibit some stress from grazing or other disturbance.
1 = Native plants are very small in size, appear unhealthy, and may be dead or dying.

C. Litter and Residue Amount, Placement and Accumulation:

5 = A large amount of plant litter is evident and in place on soil surface.
3 = Plant residue is average for the site.
1 = Plant residue is absent, much open space and bare ground are present.

D. Reproductive Capability of Key and Desirable Species:

5 = Native plants are reproducing at an appropriate rate, and young plants are visible for dominant plant species.
3 = Plant reproduction is average for the site.
1 = Plant reproduction of native plants is not occurring. There are a high number of seedlings and young plants of weeds or undesirable plants.

E. Soil Surface Condition:

5 = Soil surface horizons are in tact, with no evidence of soil erosion taking place.
3 = Some soil loss has taken place, some plant pedestals are occurring.
1 = Severe soil loss has taken place. Soil surface may be gravel pavement or bare ground. Plant pedestals are very evident.

(Photo courtesy of the Phillips County Range Committee)

Rangeland Trend Worksheet

RANGELAND TREND INDICATORS: Rate each factor from a low of 1 to a high of 5 based on ecological site potential.					
	1	**2**	**3**	**4**	**5**
A. Apparent Change in Plant Composition					
B. Vigor of Key Species and Desirable Plants					
C. Litter and Residue Amount, Placement, and Accumulation					
D. Reproductive Capability of Key and Desirable Species					
E. Soil Surface Condition					
TOTAL:					

TOTAL SCORE: DIVIDED BY 5 = AVERAGE SCORE:

OVERALL RANGELAND TREND RATING: (Toward or away from historic climax plant community)

Circle One:

TOWARD (AVE > 3.6) **NOT APPARENT (AVE 2.6 - 3.6)**

AWAY FROM (AVE < 2.6)

Rangeland Health Worksheet

What is Rangeland Health?

- The degree to which the integrity of the soil, vegetation, water, air, and ecological processes of the rangeland ecosystem are balanced and sustained.
- Rangeland health looks at three broad categories of ecosystem function:
  - ✓ Soil/Site Stability
  - ✓ Plant/Biotic Integrity
  - ✓ Watershed Function

Why Do We Measure Rangeland Health?

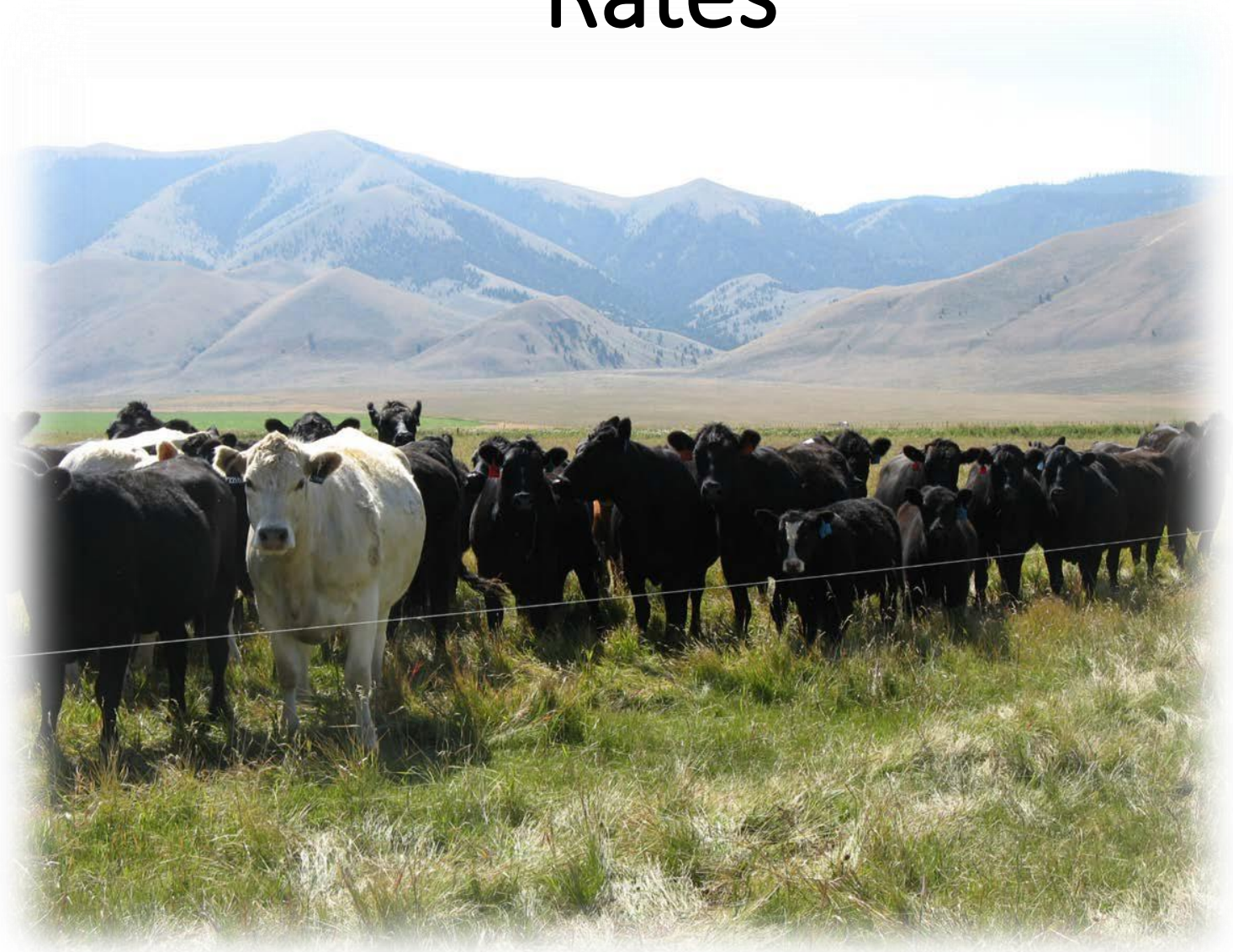
- To evaluate the rangeland ecosystem to see if it is healthy and sustainable.
- To be aware of warning signs that indicate the rangeland is declining in health.
- To help us see if we are meeting our goals.

TABLE 1: A CHECKLIST OF USEFUL INDICATORS FOR JUDGING RANGELAND HEALTH. (Prepared by Jeff Mosley, Extension Range Management Specialist, Montana State University, Bozeman, 8/97.

	YES	NO
1. Are desirable forage species abundant?		
2. Are noxious weeds rare or absent?		
3. Is there a variety of species of perennial plants?		
4. Are the plants well distributed across the site?		
5. Is mulch present and well distributed across the site?		
6. Are all age classes of plants (seedlings, young, mature) present?		
7. Are preferred forage species accessible to grazing/browsing animals?		
8. Do preferred forage species have adequate residue remaining after grazing?		
9. Are lowly palatable plants grazed lightly or not at all?		
10. Is gully erosion minimal or absent?		
11. Is soil movement minimal?		
12. Is at least 70% of the ground covered by a combination of plants, mulch, and rock?		
13. Are plant pedestals rare or absent?		
14. Do lichen lines on rocks extend to the soil surface?		
15. Is the mulch becoming incorporated into the soil?		

If you answered "Yes" to most of these questions, your rangeland exhibits good rangeland health.

Utilization and Stocking Rates



Range Utilization

This material has been developed to complement the range utilization portion of the Utilization/Stocking Rate workshop. It will not be covered in detail at the MRD workshop. ***You will only be tested on determining percent utilization at the Montana Range Days Contest.***

A basic outline of the section is provided below:

A summary of plant growth and development…

What are plants?

Plant growth factors:

- Photosynthesis
- Respiration
- Moisture
- Temperature (growing season)
- Annual growth cycle/Carbohydrate storage

Anatomy of plant growth

Plant growth structures:

- Growth points
- Buds
- Rhizomes
- Stolons

Plant parts associated with growth and development

- Tillers
- Phytomers
- Leaves
- Roots
- Crowns

Major differences in types of grass plants and management implications

- Growth type:
    - Bunchgrass
    - Sod-forming
- Season of growth
- Growth curves
- Growing degree days
- Location and elevation of growth points
- Percent reproductive tillers
- Energy allocation to shoots and roots
- Special physiological adaptations

What happens when a plant is grazed?

- Results of removal of leaf material and growing points
- Effects of grazing
- What factors of grazing can we control?
    - Grazing intensity
    - Grazing frequency
    - Timing of grazing
    - Fall/Winter grazing
- What about no grazing?

Monitoring grazing utilization

- Key species and key areas
- Determining % use
- Guide to degree of use
- Plant residue
    - Stubble
    - Litter
- Effects of grazing utilization on water conservation
- Runoff

A summary of plant growth and development…

Plant growth is fueled by photosynthesis. The carbohydrates produced during photosynthesis feed plant shoots and leaves while they are growing. Extra carbohydrates are stored in the crown area and/or utilized by roots for expansion and maintenance.

Range plants do not die during the winter. The plants continue to slowly respire (breath). Note that over-winter respiration requires approximately 10% of the energy stored in plant crowns and roots. In the spring, as the soil warms to about 40-41 degrees, range plants wake up but do not have any leaves. The plant utilizes the small amount of energy stored in plant crowns to activate dormant, adventitious buds. These buds were formed at the base of tillers the previous fall. The buds transform into brand new tillers and leaves. New leaf material photosynthesizes rapidly and can usually generate enough energy for additional tillers and leaves to grow. Later in the growing season, tiller and leaf growth slows. At this time, any additional food that is produced is allocated to plant crowns and roots. Some energy from plant crowns is utilized to form and maintain buds for next year's tillers. The roots store energy to maintain and expand existing roots and replace old roots.

What are plants?

Plants are **autotrophs**. Autotrophs make their own food by photosynthesizing.

What is photosynthesis?

Photosynthesis can be summed up in different ways:

- "to make something out of light"
- "to make order out of disorder"

During photosynthesis, plants utilize the sun's energy along with carbon dioxide (CO_2) and water to make chemical energy in the form of carbohydrates ($C_6H_{12}O_6$ - glucose) and Oxygen (O_2).

Plants utilize the simple sugar called glucose to build new plant material. Animals breathe the oxygen produced by plant life.

Plants can photosynthesize because they have structures called chloroplasts within the cells of their tillers (primarily the leaves). The chloroplasts contain chlorophyll, which allows the chloroplasts to capture the sun's energy for transformation.

The formula for photosynthesis is

$$\text{Carbon Dioxide + Water} \xrightarrow{\text{Light}} \text{Carbohydrates + Oxygen}$$

$$CO_2 + H_2O \xrightarrow{\text{Light}} C_6H_{12}O_6 + O_2$$

Respiration

Plants respire during the day and night. Respiration is the opposite of photosynthesis. Plants make food during photosynthesis. Respiration is the process by which plant cells break down food to release energy. The plants use oxygen from the air and carbohydrates (glucose) to make carbon dioxide and water. Extra carbon dioxide is released and oxygen is taken-in. Small openings in plant leaves called stomata allow these chemicals to diffuse in and out of plants.

Plants continue to respire during winter dormancy. This respiration process uses up approximately 10% of stored carbohydrate reserves.

Moisture

Water is extremely important to photosynthesis and resulting plant growth. Roots supply the plant with water from the soil profile. During photosynthesis, water is split into Hydrogen and Oxygen by the sun's energy. The resulting Hydrogen is used to make Carbohydrates while the Oxygen is released into the atmosphere.

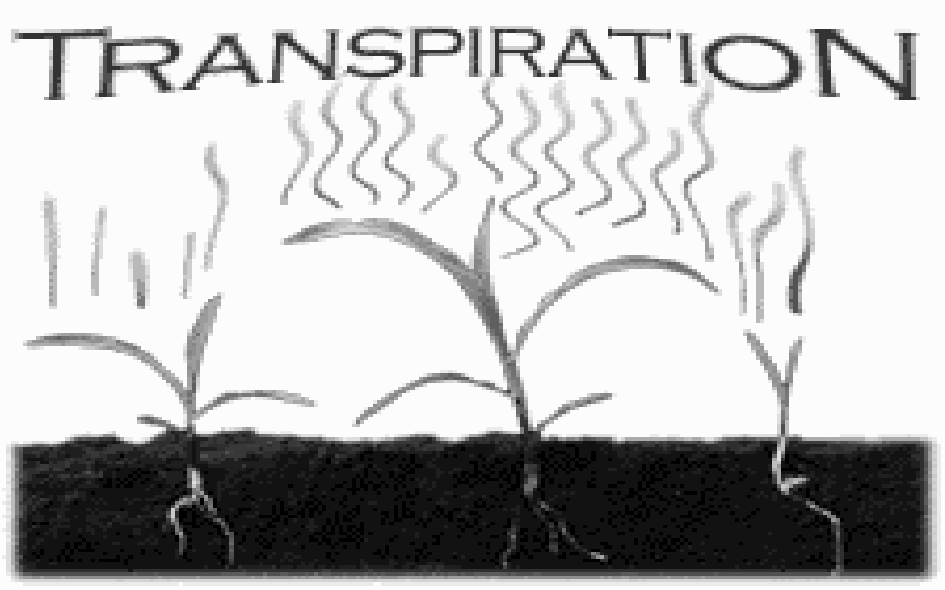
Water helps the plant maintain its shape and firmness. It also helps plant cells to grow.

Water dissolves minerals in the soil, where they are taken-up and transported through the roots to other parts of the plant, to help build and maintain plant tissues.

Too much water is not a good thing. An over-abundance of water does not allow the plant to take in oxygen or respire effectively.

Plants also release water, through openings on their leaves called stomata. This is called **transpiration.** Transpiration allows water to:

- travel through the plant
- transport minerals
- cool the plant
- re-allocate food and chemicals
- maintain pressure inside the plant cells



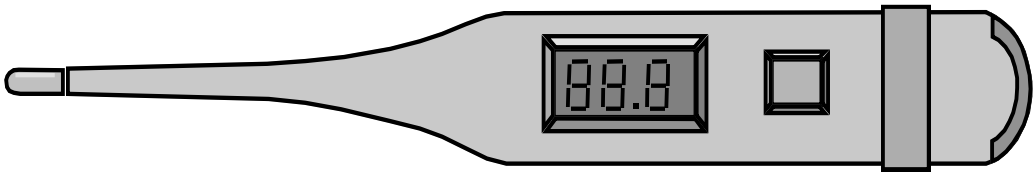
Temperature - Growing Season

Plants grow when soil and air temperatures warm-up in the spring. Soil temperatures need to reach 40-41 degrees F in order for plants to begin growth. Plants quit actively growing in the fall, when temperatures cool. This period of growth is called a **growing season**. Across the state of Montana, the growing season varies, but generally occurs between May 1st and October 1st, approximately 5 months.

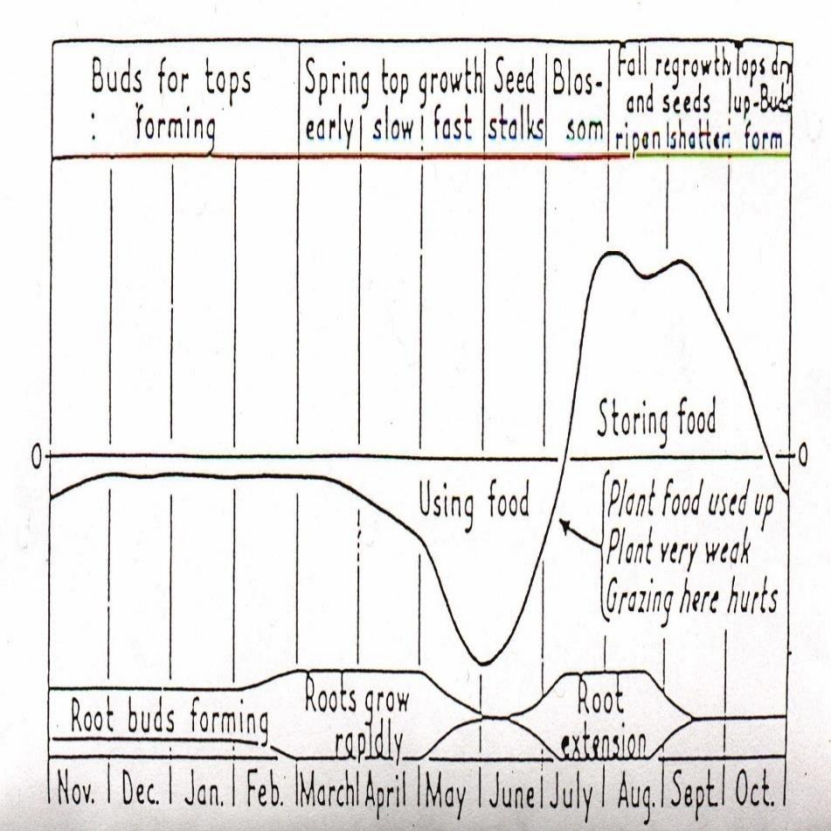
You can find climate summary information for your area at www.mtmastergardner.org/climate_data.html. All of the information is approximate. Expect the actual growing season to vary by plus or minus 2 weeks from year to year. Actual site conditions also play an important role in growing season characteristics. Expect a frost in every month.

For many Counties in Montana:

average date of last killing frost	first week of June
average date of first killing frost	first week of September
average growing season	90(+/-) days
average annual precipitation	11"-14"



Annual growth cycle – Use and storage of carbohydrates



This diagram shows major physiological events during the year in a typical range grass plant for an area with a cold winter and a dry summer.

The diagram illustrates three things that happen in a plant during the year. The top line of the diagram is top-growth. The second line is the rate at which the plant uses or stores food that it makes (the heavy curved line). The third line is root growth. The rate of root growth is shown by the width of the strip just above the months of the year.

Plants are most easily injured by grazing when their food storage is used up in the building of tops and roots. (Source: Parker 1969)

Anatomy of Plant Growth

(Photo courtesy of Phillips County Range Committee)

Plant Growth Structures

All plants have growth points and buds that provide for growth. However, individual plants may not have rhizomes or stolons.

1. Growth points or meristems
2. Buds
3. Rhizomes
4. Stolons

Growth points:

Plant growth points are made of "meristematic" tissue. The cells in this type of tissue can expand (grow wider) and elongate (grow taller). Growth points eventually develop and change into the different parts of a plant: roots, leaves, stems, buds, rhizomes, stolons and with the right conditions, seed heads.

There are several different types of growth tissue.

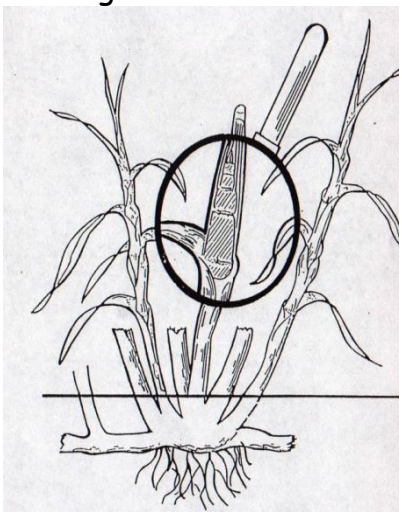
1. **Apical**
2. **Axillary**
3. **Intercalary**

(Photo from UIS Prairie Restoration website)

Apical meristems:

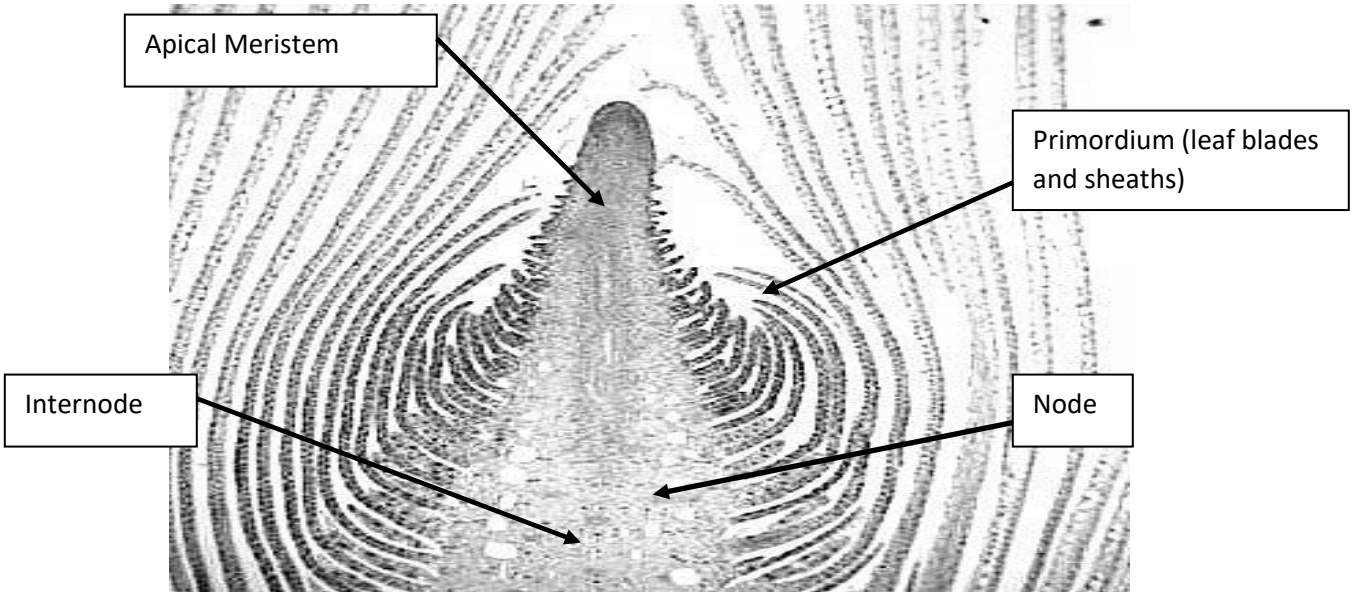
Apical meristems are dominant or the first to grow. Shoots and roots both have apical meristems.

At the start of the growing season, shoot apical meristems are located in the buds at the base of a grass plant. In some grasses, the apical meristem will eventually be pushed up above the ground surface, where it can be removed by grazing animals or lawn mowers. For example, when a wheat plant is in the "boot", the swelling in the stem is actually the elevated apical meristem.



Anatomy of apical meristems

The apical meristems are formed of nodes and internodes. Using energy from photosynthesis, the apical meristem expands and pushes new leaves and stems up, which causes the plant to grow in height and width.

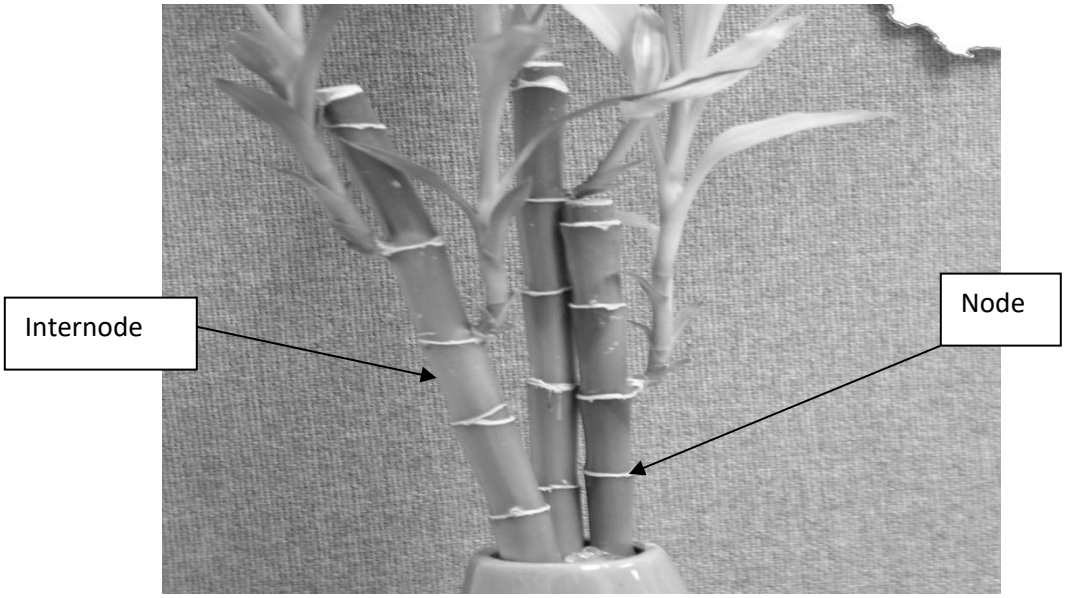


(Photo from Ohio State University, Lima Website)

Nodes/Internodes

Nodes: The nodes are points along the plant stem where the leaves emerge.

Internodes: An internode is an area between two nodes. Internodes elongate with the help of intercalary meristems and form the stem of a plant.

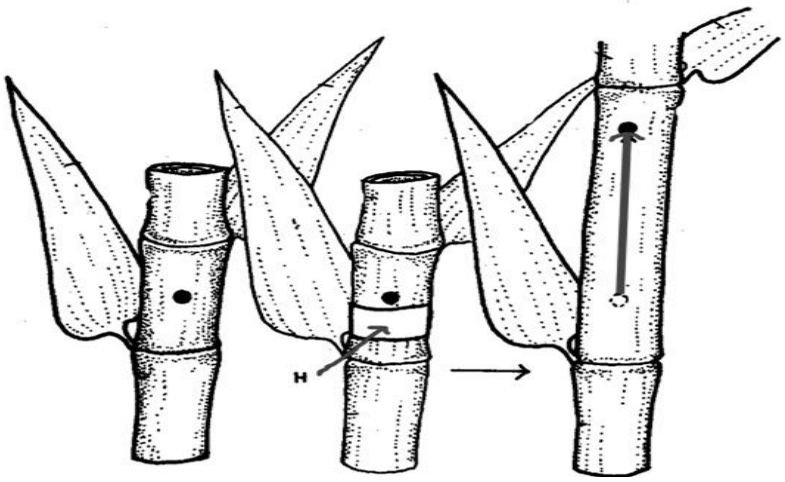


Intercalary meristems:

Intercalary meristems are formed in the bases of developing leaf blades and sheaths. The intercalary meristems are pushed upward, as the apical meristem expands.

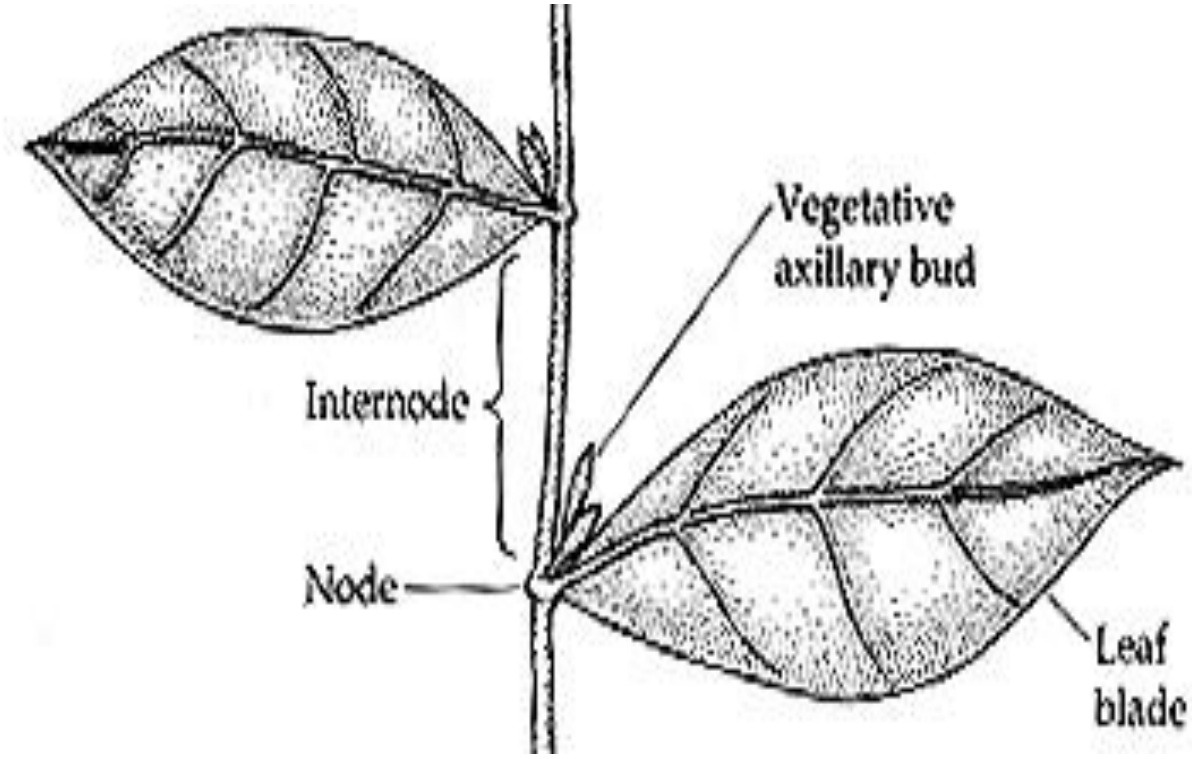
Growing cells in the intercalary meristems allow for leaf expansion. You may have noticed that leaves continue to grow if the tips are removed by grazing or mowing. This is because the expansion of leaf tissue is occurring at the base of the leaf in the intercalary meristem.

These meristems also cause internodes to elongate to create the stem of the plant.



Axillary meristems

Axillary meristems are located in axillary buds that form at the base of each leaf. Fortunately for the plant, axillary meristems are activated if the apical meristem is removed. The axillary meristems then provide for plant re-growth.



Buds

Buds are structures that contain and protect growing points. There are many different names for buds, which makes for some confusion.

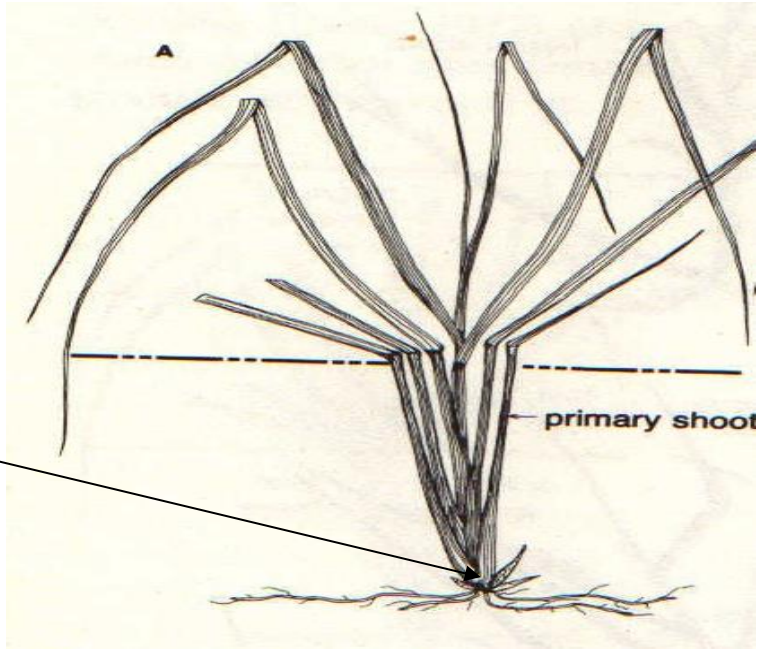
In grasses, adventitious buds are located at the plant base or crown, and are often called basal buds. Axillary buds are located in leaf axils or below the nodes on plant stems.

Buds can be dormant or active. Buds are activated by hormones in the plant.

Adventitious (Basal buds)

Basal buds form on the mature tissue at the base of a primary tiller at the crown of the plant, or on underground stems (rhizomes). These buds contain apical meristems, which expand and develop into a series of leaves called tillers.

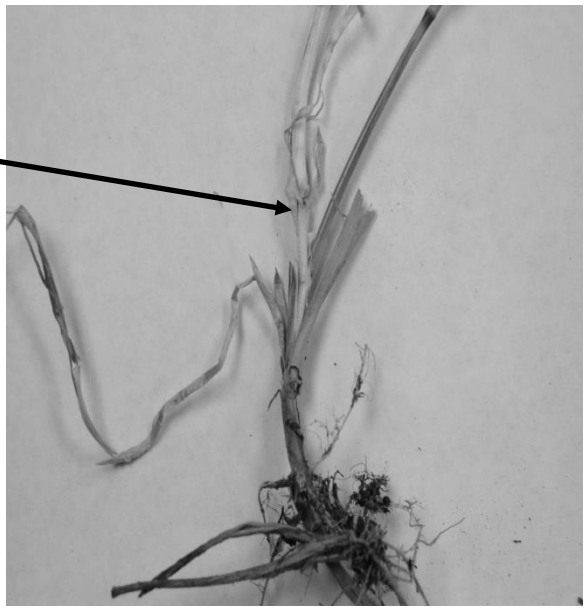
Note that this year's grass crop was actually determined by the number of basal buds the plant was able to form last fall and how well the buds survived the winter.



Adventitious bud

Axillary Buds

Axillary buds are formed at the base of leaves, and are a safety feature. If the apical growth point of a tiller is grazed off, the growth points in axillary buds can provide for new leaf and tiller growth.



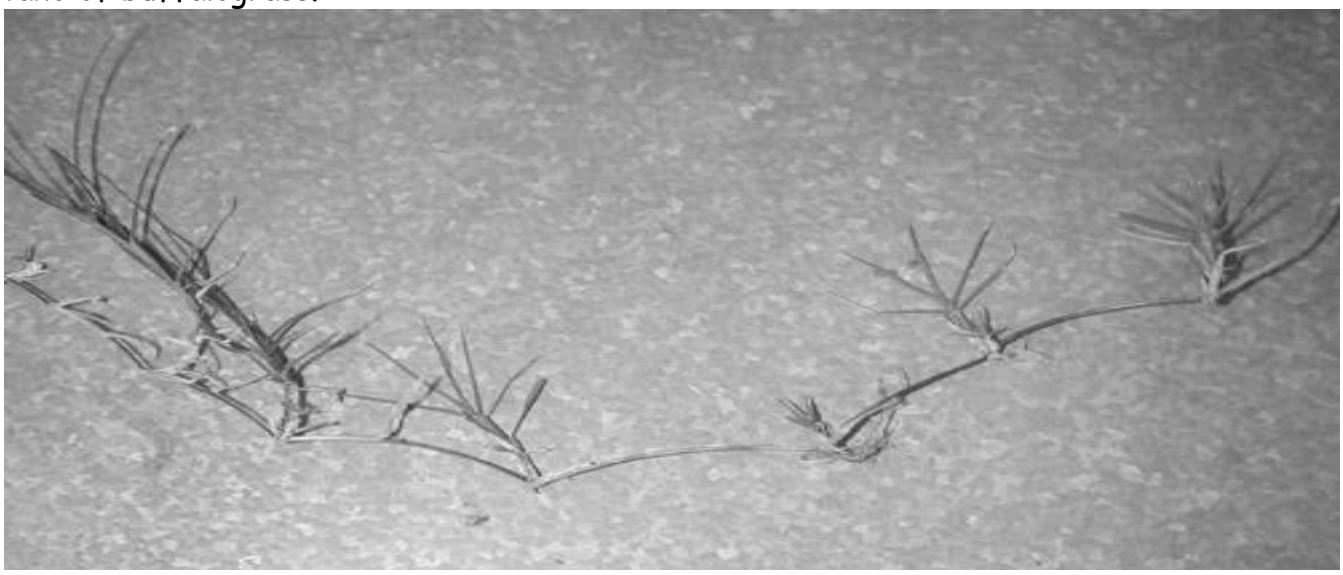
Axillary bud

Rhizomes

Rhizomes start from growth points in the plant crown and develop into stems that run sideways or laterally underground. Rhizomes consist of nodes and internodes. New roots originate at the nodes of rhizomes and then a new shoot (daughter plant) can grow from the stem.

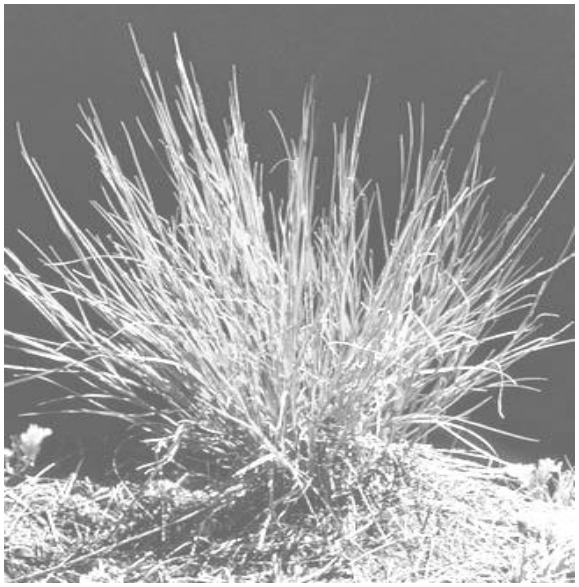
Stolons

Stolons also develop from meristematic tissue. Stolons are stems that run sideways above ground. Similar to rhizomes, stolons can form new roots and shoots at the nodes along the lateral stem. A stolon is often called a runner. You can observe stolons in a strawberry bed or in a stand of buffalograss.



Plant parts associated with growth and development

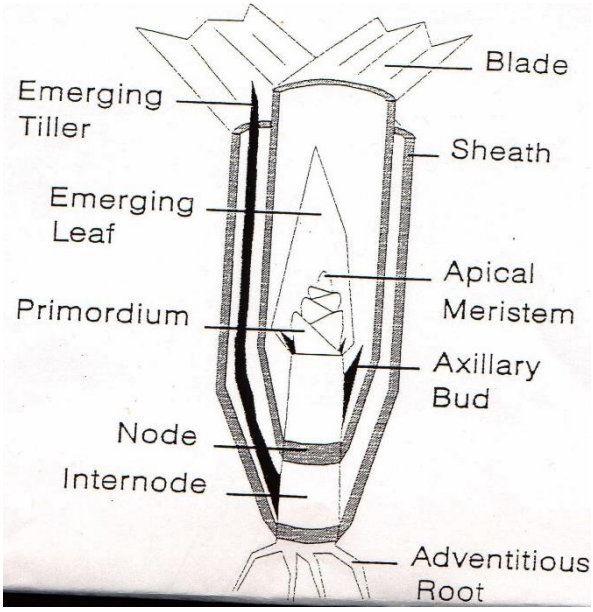
Tillers Phytomers Leaves Roots Crowns



(Photos from Selected Range Plants of North Dakota and Minnesota.)

Tillers:

A developing tiller is shown below. Tillers develop from apical meristems in plant buds and consist of phytomers. A phytomer is a fancy name for a leaf sheath, leaf blade, node, internode and bud. Tillers look like folded-up toy telescopes, with many layers of developing phytomers surrounding and protecting the growth point. Tiller development depends on the number and length of the phytomers that make up a tiller.

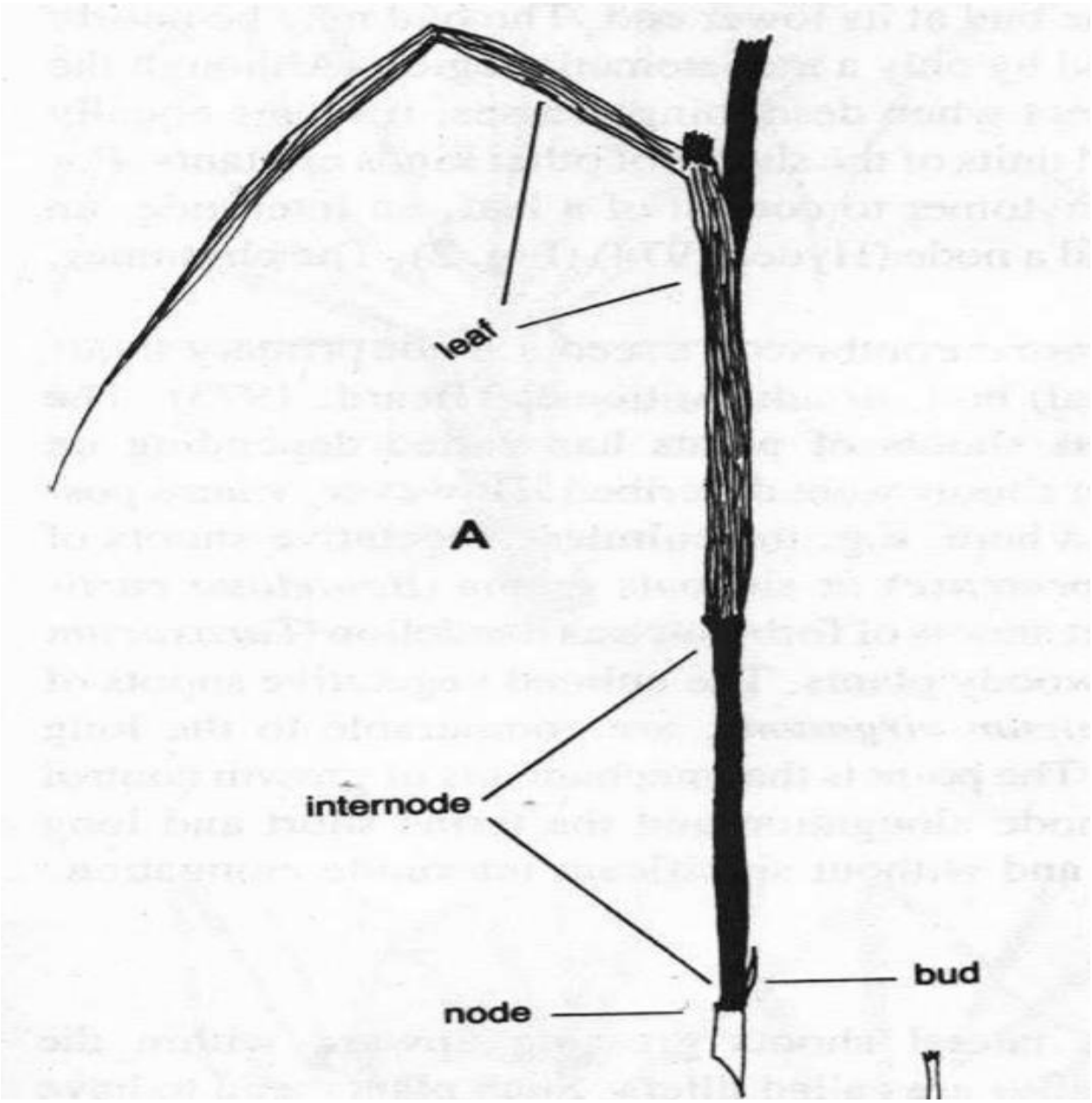


(Developmental Morphology and Physiology of Grasses – D.D. Briske)

Phytomers

Phytomers consist of a leaf blade, sheath, node, internode and axillary bud.

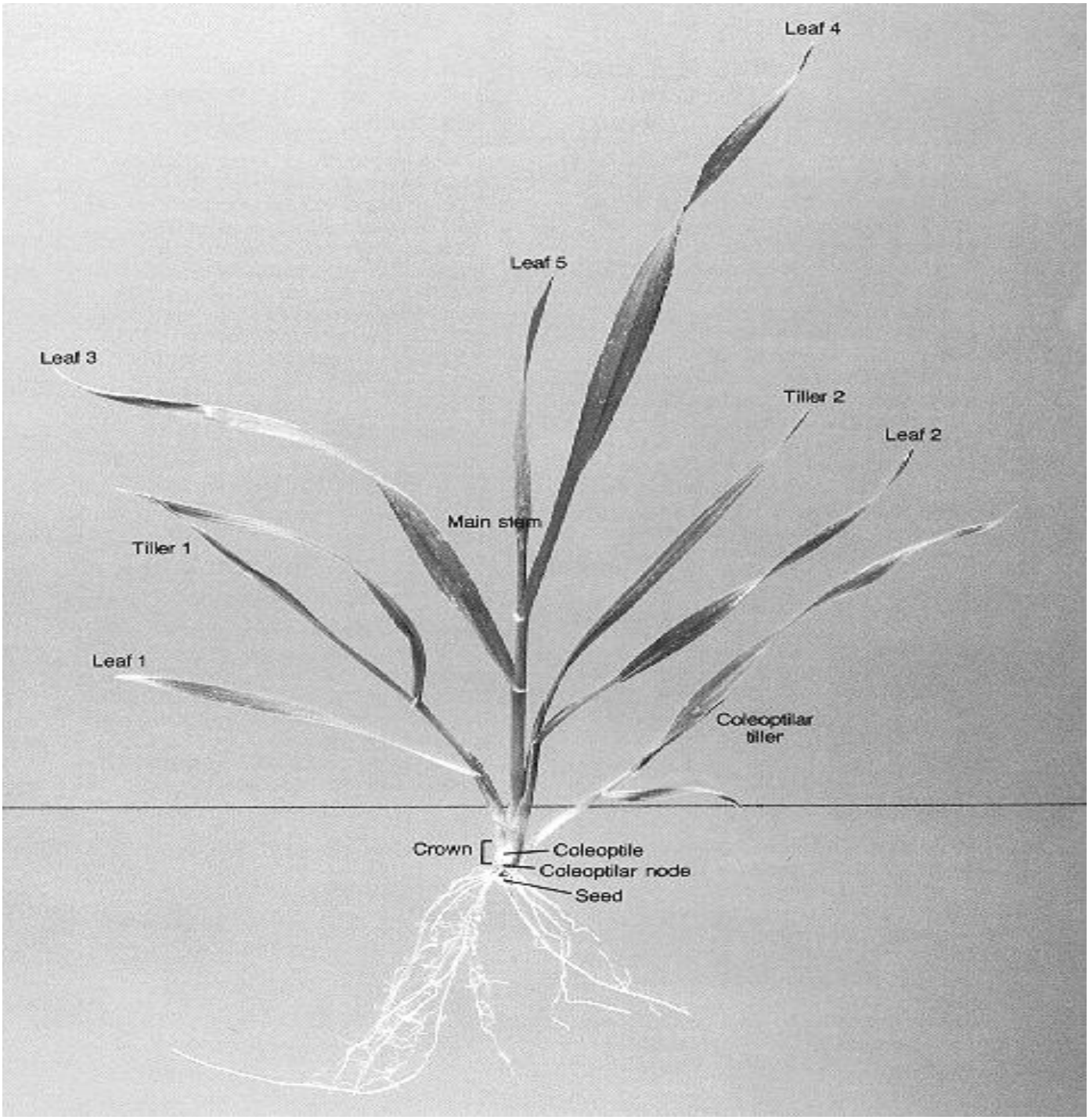
The growth of a phytomer starts in the apical meristem or growth point. The newly formed leaf blades and sheaths are called the leaf primordium. The primordium grow from the node of the growth point. (See the illustration on the previous page). Once the leaf blades and sheaths are formed, an axillary bud will also be made at the base of the leaf.



(Illustration from SRM Rangeland Plant Physiology – Range Science Series, NO. 4, 1977)

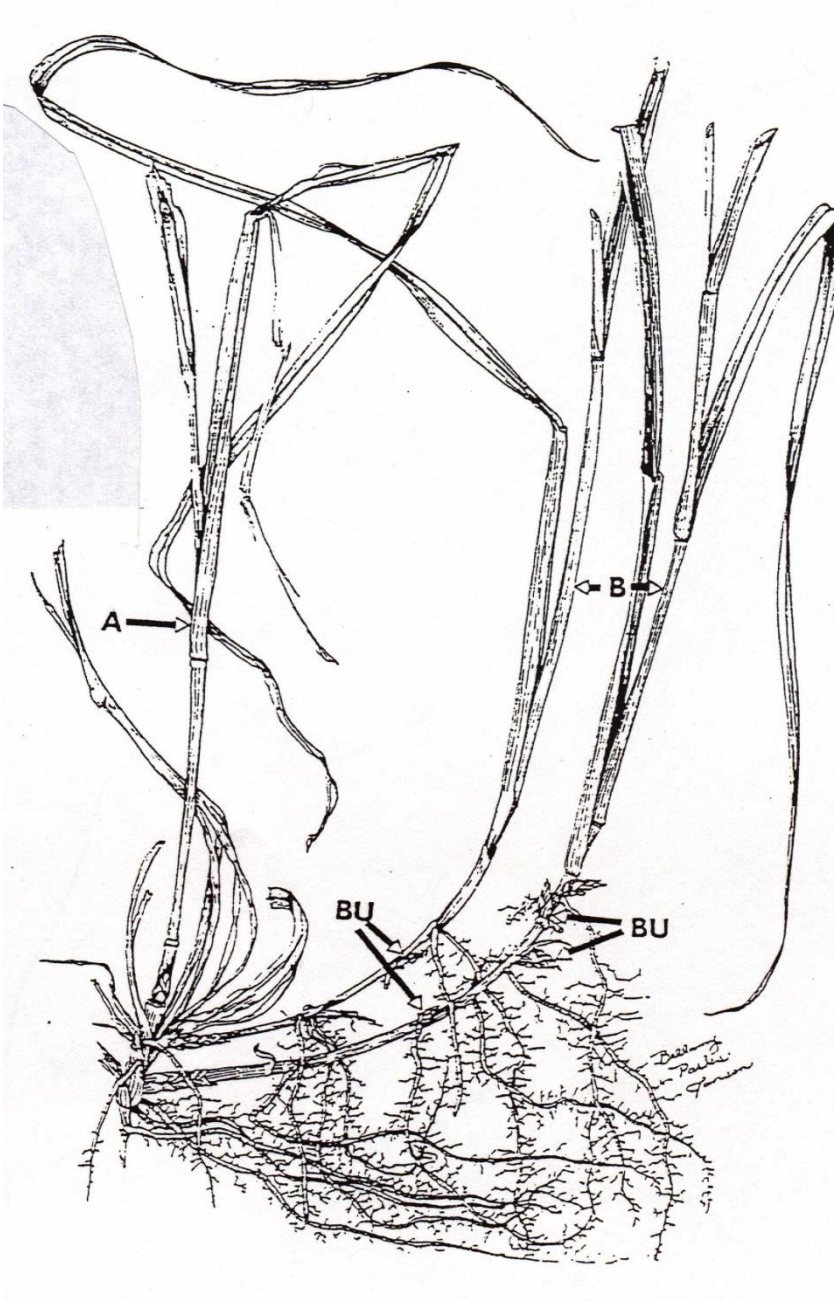
Secondary tillers

If conditions are good, a mature tiller can also form extra tillers from the axillary buds. An example of this is when a wheat plant "stools" out.



(Photo from University of Wisconsin website)

If you are in a pasture this summer, observe the grass tillers around you. You might find something like this…



A = Last year's tiller

B = Current year's tiller

BU = Buds on rhizomes which will become next year's tillers

Kinds of tillers

All tillers start out vegetative. The job of vegetative tillers is to grow leaves for photosynthesis. When tillers are in the vegetative stage, leaf sheaths and internodes do not expand. Growth points stay low to the ground. How low depends on the species of grass.

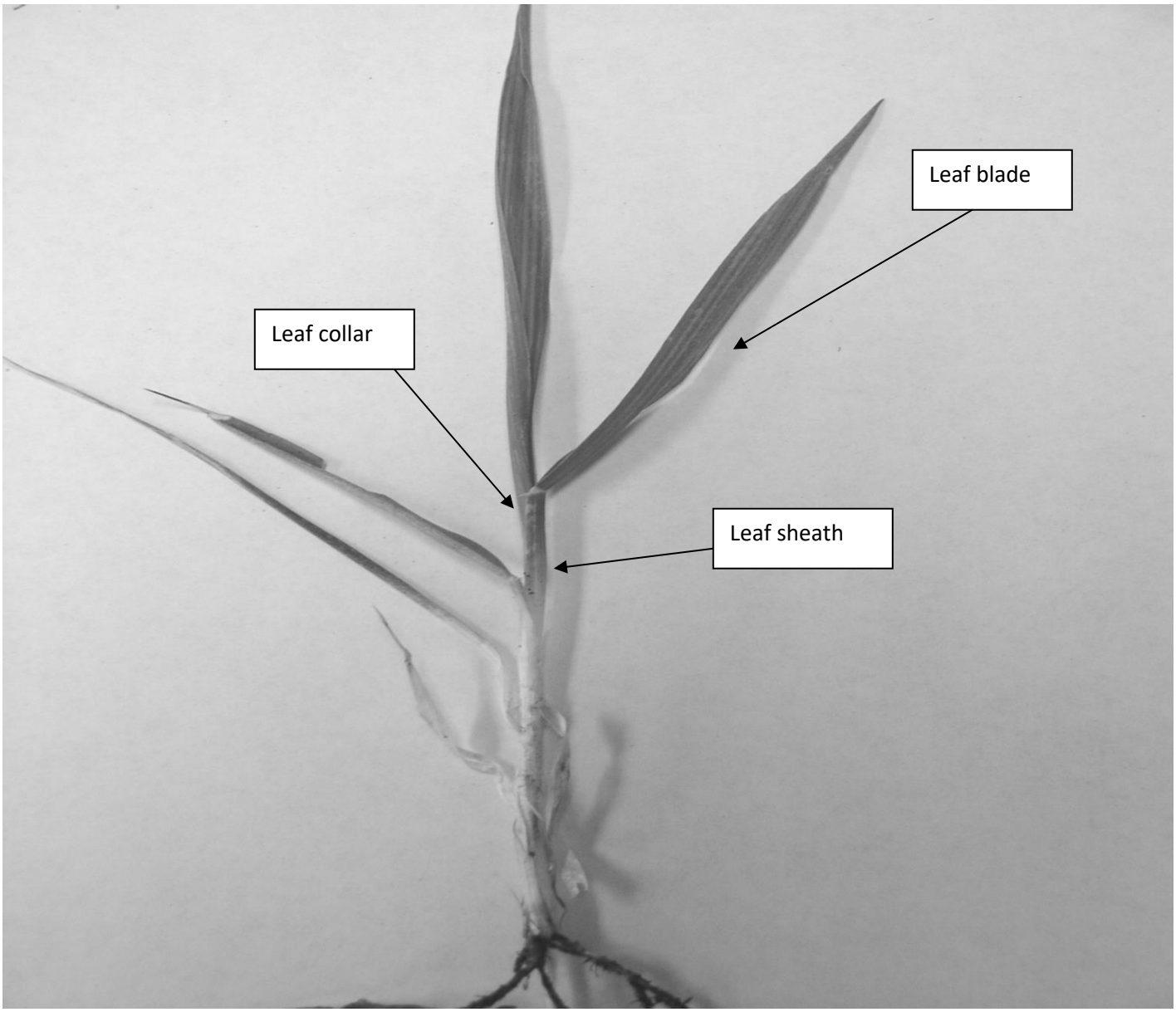
However, the plant also has to reproduce. So, in response to temperature patterns, day length and leaf development, vegetative tillers may change into reproductive tillers. Reproductive tillers elevate their stems and growth points, so that seed heads can be produced. Reproductive tillers do not have many leaves or buds so they are not able to re-grow quickly following a grazing event

Leaves

Leaves are part of phytomers. Leaves emerge from nodes and grow in a sequence. Leaf blades grow first (from the bottom up – not the tip down), followed by leaf sheaths. After leaf sheaths expand, the internode elongates.

Leaves provide green tissue and surface area so that plants can effectively photosynthesize.

More leaves, large leaves and new leaves equal more photosynthesis and therefore more energy available to plant tillers, crowns and eventually roots.



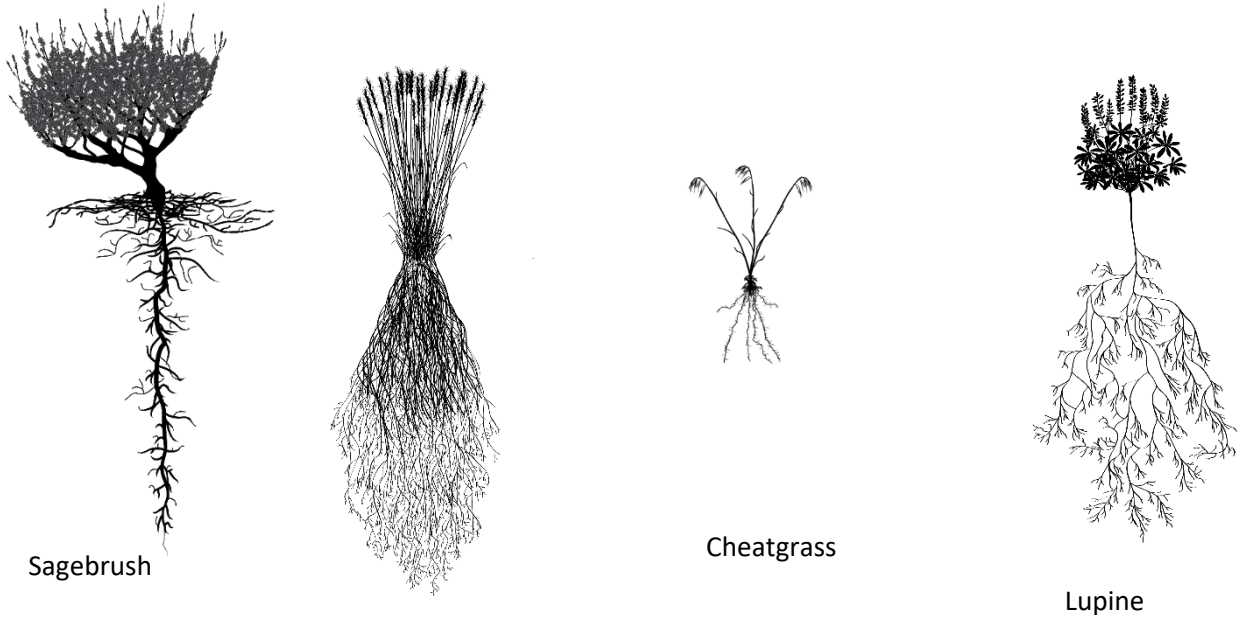
Roots

Plant roots also originate from growth points beneath the soil surface. Roots provide water and dissolved minerals to stems and leaves.

In order to be successful, roots must continuously expand through the soil profile. Since roots don't live very long, the system must also replace itself periodically.

Photosynthesis supplies energy, in the form of carbohydrates, for root growth and development. The veins of the plant transport carbohydrates from the leaves to the roots.

Research indicates that the carbohydrates stored in plant roots are utilized primarily for root growth and maintenance, not as reserve for stem or leaf growth.



Sagebrush

Bluebunch Wheatgrass

Cheatgrass

Lupine

Conserve our Western Roots Native Plant Drawings
From the Sage Grouse Initative website
Credit: Jeremy Maestas and Maja Smith

Plant Crowns

The crown is the persistent base or the lower portion of the shoot of a perennial plant. Although we don't think about them very much, plant crowns are very important.

Crowns:

- *store energy to activate buds for new growth in the spring*
- *store energy to grow new leaves following defoliation*
- *are the areas where the buds for next year's tillers are formed, maintained and protected through the fall and winter*

(Photo from Tarleton State University website)

Crowns are susceptible to damage during the winter, drought and overly-wet conditions.

If there is not enough residue left around the plant crown in the fall, the crown will be over-exposed to extreme winter weather.

When the soil is hot and dry, plant crowns loosen. While crowns are loose, grazing animals can cause damage by pulling out or trampling the plant. The same is true for overly-wet conditions, when soils are also fragile.

Differences in grass plant growth and development

Grass plants grow and develop differently. These basic differences affect how plants respond to grazing. The differences we will cover in this section include:

Bunchgrass vs. sod-forming
Cool-season vs. warm-season
Growth curves
Location and elevation of growth points
Percentage of reproductive (flowering) tillers
Energy allocation to shoots and roots
Physiological adaptations

(Photo courtesy of USDA-NRCS)

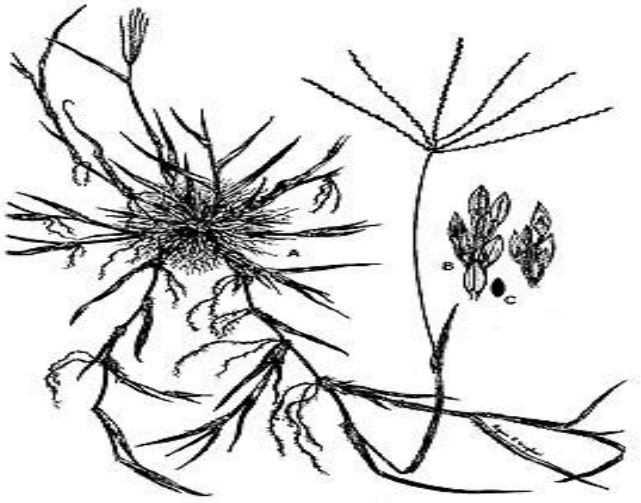
Bunchgrasses

Bunchgrasses *do not* produce rhizomes or stolons from adventitious buds. New shoots emerge upright, within neighboring leaf sheaths. Therefore, bunchgrasses have a tufted habit, and don't spread outward. Examples are little bluestem and bluebunch wheatgrass.

(Photo courtesy of UIS Prairie Restoration Project website)

Sod-forming grasses

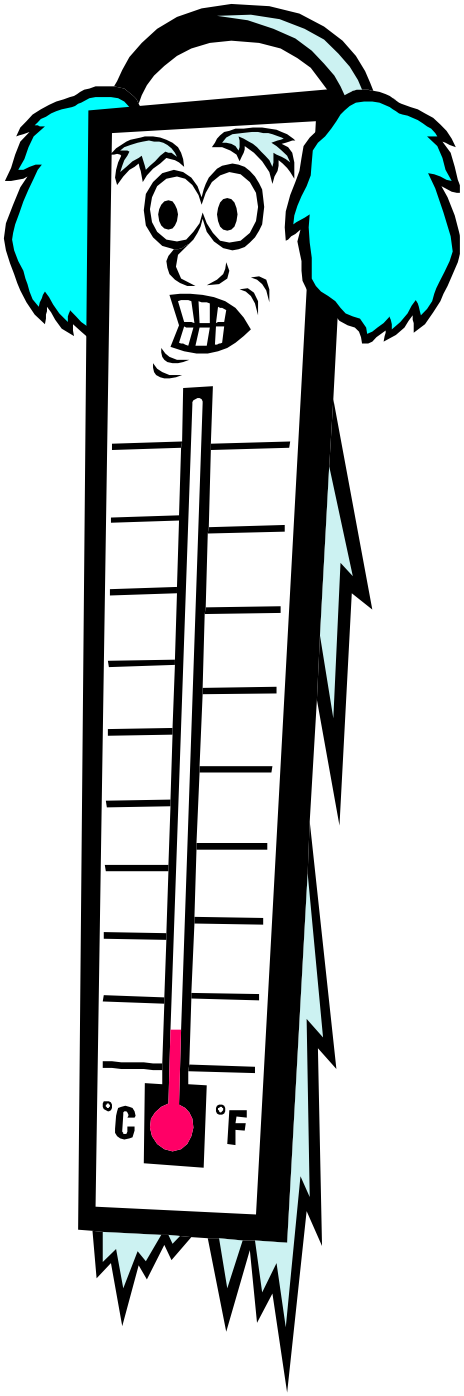
These grasses produce lateral stems in the form of rhizomes or stolons from adventitious buds that form in plant crown tissue. In most sod-forming grasses, new shoots emerge through the sides of neighboring leaf sheaths. This allows for the plant to spread-out instead of grow upright. Examples are crabgrass and stinkgrass.



Season of Growth

Plants are split into two very basic groups, based on when they grow during the growing season. Cool-season and warm-season plants have different leaf anatomy. Therefore they photosynthesize differently.

Cool-season



C3 photosynthetic pathway.

Cool-season plants originated in cooler regions of the earth.

Cool-season plants like to grow at temperatures of 65-75 degrees.

Cool-season plants are less efficient at gathering carbon dioxide and using water.

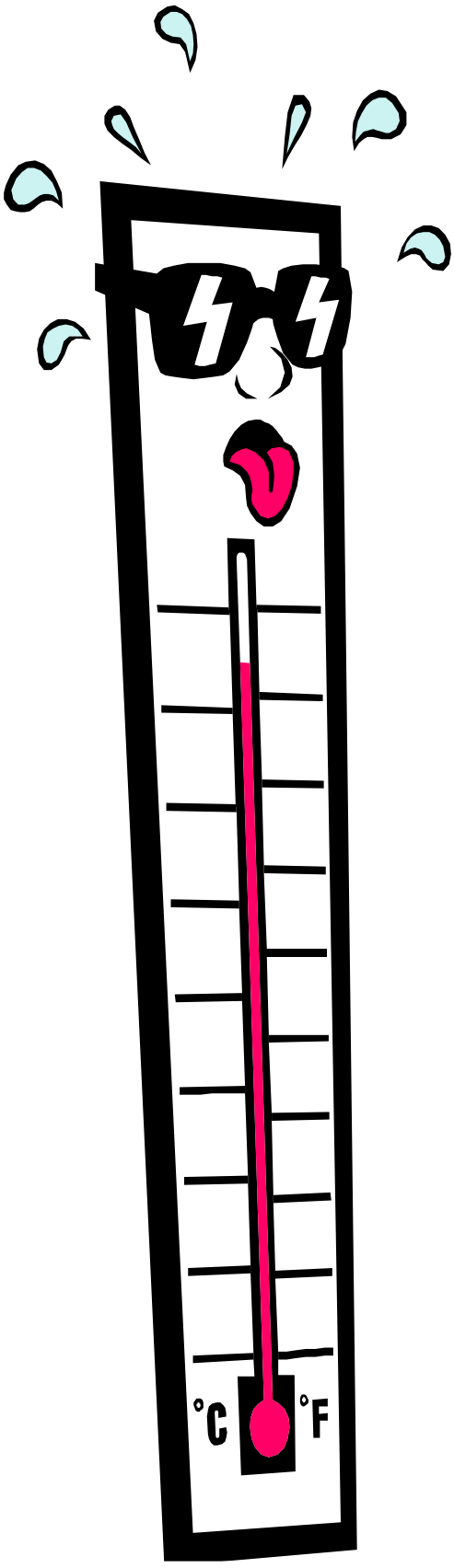
They green-up and bloom early in the spring, when there is more moisture. They occasionally green-up again late in the fall with adequate moisture.

Cool-season plants require short days and/or low temperatures in the fall or early spring for reproductive tillers to form.

These plants are generally more palatable (easier to eat) than warm-season plants. The cell walls of cool-season plants are digested faster.

Idaho fescue, western wheatgrass, green

Warm-season



C4 – photosynthetic pathway.

Warm-season plants originated in the tropics, and are efficient at gathering and processing carbon dioxide and water.

They grow and flower during the summer months and reach peak production about one month later than cool season plants. They grow best when temperatures are 90 to 95 degrees F.

Warm-season plants use soil moisture efficiently and are drought tolerant. They have more lignin and fiber than cool season plants and are not as palatable to grazing animals. However, warm-season plants are green when cool season plants are mature, so grazing animals may select for the fresher plant growth.

Warm-season plants do not have as much protein as cool-season grasses, but the protein is utilized better by grazing animals.

Blue grama, little bluestem, prairie sandreed, big

Growth Curves

GROWTH CURVES: Different plants grow at different times within the growing season. Each species of plant has a unique growth curve. Kids in your class at school grow differently. Some grow more than others. Some grow sooner than others. Plants behave in much the same way. Each species of plant begins and ends its growth at a slightly different time than a neighbor of a different species.

Growing Degree Days:

Following a period of rapid growth and ideal spring conditions, plants need time to grow numerous, large leaves before they are utilized again by grazing animals. Plants usually need to grow 3-4 leaves to adequately feed additional tillers and leaves.

To achieve this much leaf growth, plants need a certain number of growing degree days.

GROWING DEGREE DAYS:

Each plant species needs a certain number of heat units from the sun (growing degree days) to grow 3 to 4 leaves.

Crested wheatgrass may have four leaves ready by May 1st. Prairie junegrass and needleandthread might be ready near the end of May. Green needlegrass would grow to the four-leaf stage in early June. Blue grama, a warm-season grass, would take significantly longer to grow four leaves, perhaps until the first of July.

Since weather conditions can vary so much year to year, it is important to monitor grasses annually to observe stages of growth or re-growth.

Low growth points (non-jointed/culmless stems)

Annual grasses and many perennial grasses produce short tillers/shoots. The internodes of these tillers do not lengthen during vegetative growth, so growing points stay close to the ground longer and are protected from grazing. Some of the plant's growth points will eventually elevate as the plant produces seedheads. Then, the growth points may be removed by grazing.

Management implications: These grasses can tolerate more intensive grazing. Since their growth points are low and protected, they do not have to expend energy to initiate new bud and tiller growth following grazing. However, during periods of drought or long rests, species such as Kentucky bluegrass will also elevate growth points on vegetative tillers, making them susceptible to grazing during this time.

Examples:

Kentucky bluegrass, blue grama

(Photos from Selected Range Plants of North Dakota and Minnesota.)

High growth points (jointed/culmed stems)

Other grasses lengthen internodes and raise growth points early in the growing season. Some elevate growth points early because they produce many reproductive tillers compared to vegetative tillers (little bluestem). However, some species also elongate the internodes and apical meristems of vegetative tillers, without these tillers ever becoming reproductive (bluebunch and western wheatgrass).

Management Implications: Grazing animals can remove growth points located higher on the stem/culm. If the apical and intercalary meristems are removed, there is no potential for re-growth. Then the plant has to activate buds at the base of the plant or in the axils of the remaining leaves to grow new leaves and tillers. This process takes time and energy.

Plants that elevate growth points should be grazed early, before meristems are elevated, or in later stages of growth, when the axillary buds are ready to initiate new tillers.

Example: bluebunch wheatgrass

(Photos from Selected Range Plants of North Dakota and Minnesota.)

Percentage of Reproductive Tillers

Some grasses produce many reproductive tillers, compared to vegetative tillers.

Management Implications: Reproductive tillers elevate their growth points, and don't produce as many leaves. They are intended to produce seed, not to endure grazing. If the tillers are grazed, their primary growth points will be removed and there will not be as much leaf material available to photosynthesize and help the plant re-grow.

The seedheads of some grasses do not seem be very palatable. You may notice that grazing animals avoid grazing these plants as the reproductive tillers mature. They may continue to graze the leaves around the base of the plant.

Some years the conditions are not right to trigger reproductive tiller development. During such growing seasons, grazing animals will utilize these plants more throughout the duration of the growing season.

Examples:crested wheatgrass and little bluestem

(Photo from UIS Prairie Restoration Project website)

Energy allocation to shoots and roots

Plants differ in allocation of carbohydrates. Some species provide much more energy to above ground shoots. Other plants funnel much of their energy below ground to extensive root systems.

Management Implications: Energy allocation often affects the way a plant re-grows or recovers following a grazing event. An introduced grass like crested wheatgrass will re-grow quickly, because energy will be directed toward tiller re-growth. Native bunchgrasses, like bluebunch wheatgrass, may quit growing and just allocate any additional energy to root growth and maintenance.

(Photo from Tarleton State University website)

Special physiological adaptations

Over the years, plants have developed specialized anatomical features that discourage livestock grazing. *Red threeawn*, for example, has both awns and high silica content. The awns and silica irritate the mouths of livestock.

(Photo from the Rocky Mountain Arsenal National Wildlife Refuge)

Other examples of physiological adaptations include:

Hair
Spines (cactus)
Thorns (buffaloberry)
Lignin content (warm-season grasses)
Latex (leafy spurge)
Etc.

Now that you know how plants grow, you can better predict how plants might be affected by grazing use.

What happens when a plant is grazed?

- *leaf material is removed*
- *growing points may be removed*

(Photo courtesy of USDA-NRCS)

The removal of leaf material and growing points will result in:

- Less leaf area for photosynthesis.
- Decreased carbohydrate production and storage in plant shoots and roots.
- Reduction in root growth.
- Decrease in water and nutrient availability.
- Activation of dormant or axillary buds, which draw on stored energy reserves to grow.

(Photo courtesy of Rebecca Wolenetz)

The effect of grazing on a plant depends on the following factors:

- Season of use/growth stage
- Grazing intensity (how much leaf material remains)
- How often plants are grazed and re-grazed
- Type of plant (growth form, season of growth)
- Availability of growing points and new buds
- How many carbohydrates are available in the plant shoots
- Size and health of root systems
- Physical grazing effects (for example, trampling, trailing)

(Photo courtesy of USDA-NRCS)

What factors of grazing can we control?

- ***Grazing intensity:*** *The size of the leaf area remaining following a grazing event.*
- ***Grazing frequency:*** *How often a plant is grazed/re-grazed.*
- ***Timing of grazing:*** *When the field is grazed.*

(Photo courtesy of USDA-NRCS)

Grazing intensity

Facts and guidelines

- If *greater than 50%* of the leaf material of perennial grasses is removed, *root growth is reduced.*
- Utilization of 80-90% of leaf tissue stops grass root growth for 12-18 days. .
- Heavy utilization levels (>75%) reduce the ability of grass shoots (tillers) to re-grow.

Note that all plant types are affected by grazing use.

- **Remember….if grazing use is more than 50-60% during the growing season, plants need extra time to rest and recover before another grazing event.**

(Photo from Canadian Research Station)

Grazing frequency

Grazing and re-grazing the same plants throughout a growing season will reduce plant shoots, buds and roots. This applies to all plant types.

The plants will use stored energy in plant crowns to make new leaf material, or activate new buds. Plants grazed and re-grazed early in the growing season, before they have grown enough leaves to support themselves photosynthetically, may experience an energy shortage.

It is important to rotate grazing animals, so that plants that have been grazed have a chance to re-grow leaf material and replenish carbohydrate reserves via photosynthesis.

(Photo courtesy of USDA-NRCS)

Timing of grazing

Determine a key species for a range site or a pasture and then *determine grazing dates based on the growth habits, growing season, growth curve and season of growth for that particular plant or plants.*

Don't forget to consider how much and when the plant was utilized the year before.

Remember that animals have to graze all of the time, so some plants will be grazed at a susceptible time each year. These plants may need extra rest and a change in season of use the following year.

(Photo courtesy of USDA-NRCS)

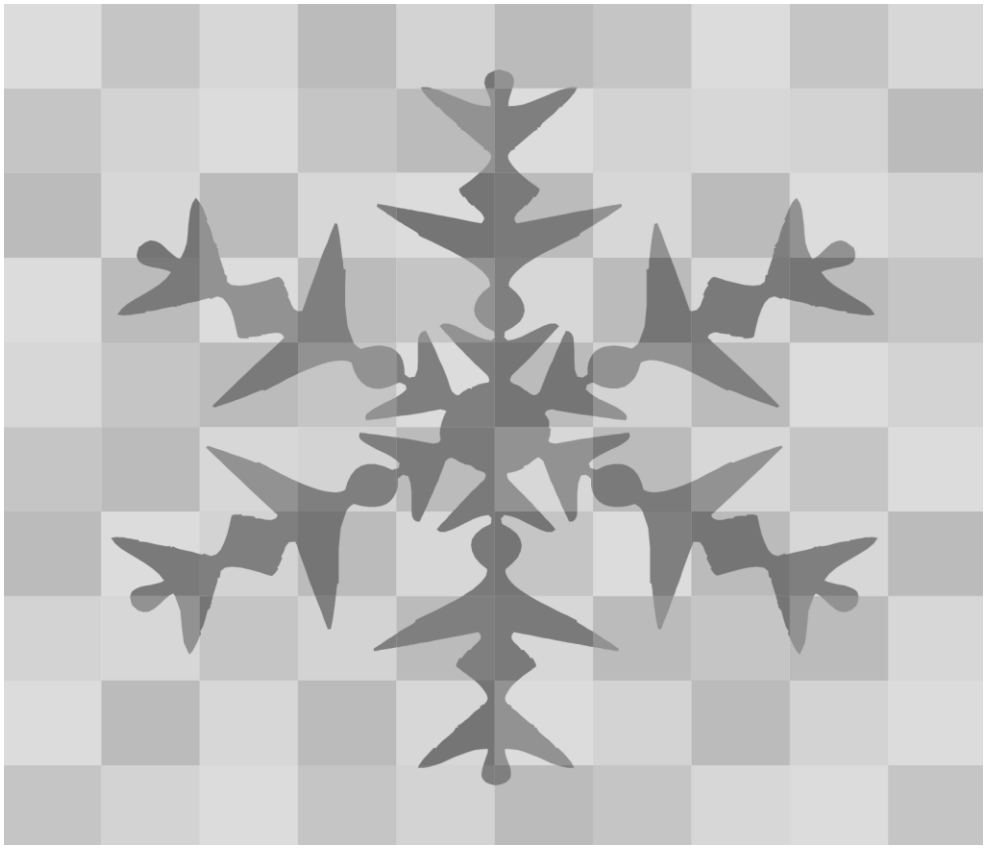
Fall/Winter grazing:

In the fall, before dormancy, cool-season plants may green up and photosynthesize again for a short while to store additional carbohydrate reserves. It is tempting to use pastures in the fall, because the new growth is nutritious for grazing animals. The re-growth process uses energy reserves, which might otherwise be used to maintain crowns and buds for next year's tiller crop. Fall grazing may also result in buds being trampled.

Buds and crowns may also be damaged by close grazing and trampling in the winter. Plant should not be grazed more than 65% during winter use.

Enough litter should be left on rangelands to break the wind and collect snow. The litter will protect plant crowns and buds from extreme cold. The collection of snow will result in additional moisture for the plant the following spring.

If dormant crown buds survive to the following spring, they will use energy reserves in the crown to initiate growth when soil temperatures reach 40-41 degrees.



What about no grazing?

If plants are not grazed at all, the current year's leaves age and die. The plant is not stimulated to activate new buds and grow additional leaves. Dead leaf material is not capable of photosynthesis. Old leaves cannot photosynthesize very much. ***Therefore, no grazing can also result in reduced plant health and vigor.***

(Photo courtesy of Rebecca Wolenetz)

Monitoring grazing utilization

Percent utilization is figured on the ***current year's forage production for an entire pasture.*** Measuring and mapping-out grazing utilization over an entire pasture or pastures will provide valuable information regarding percent utilization and livestock grazing patterns.

For example, you may find that one area of a pasture is over-utilized (ex. 80%) while another area is utilized lightly (ex. 15%). If this pattern is consistent year to year it would indicate a livestock distribution problem. You might need to plan and apply a conservation practice to modify livestock distribution patterns. You may find that the entire pasture is over-utilized, and you need to adjust stocking rates. Maybe the animals are over-utilizing certain plant species. If so, timing of grazing may need to be adjusted, so that grazing animals will select different plants.

(Photo courtesy of USDA-NRCS)

Key species and key areas

Taking technical, precise measurements of use throughout an entire pasture is not always practical, especially when monitoring utilization over large acreages. Therefore, ***key species in key areas*** are often specifically identified and monitored.

Just remember that you may not be seeing the big picture, when using key species and key areas to measure use.

(Photo courtesy of USDA-NRCS)

Key species

1. Are generally preferred by grazing animals.
2. Provide more than 15 percent of the available forage in a key grazing area.
3. Are important to the management of the plant community.
4. Are usually perennials.

(adapted from the NRCS National Range and Pasture Handbook)

(Photo from Selected North Dakota and Minnesota Range Plants)

Key areas

1. provide a significant amount of the available forage in a grazing unit.
2. are easily grazed because of even topography, available water, etc. Note that key areas should not be located in areas of natural congregation such as watering sites or salt tubs
3. usually consist of one ecological site
4. may be areas of special concern
5. are usually limited to one per grazing unit.

Key areas should be selected after carefully evaluating grazing use and considering management objectives. Key areas may need to be changed if grazing ditribution changes.

(Photo courtesy of USDA NRCS)

Determining % use

(Photo courtesy of Phillips County Range Committee)

- Find an ungrazed key species in a key area.
- Cut the plant off at ground level.
- Balance the plant on your finger to determine the 50% weight point.
- Holding the lower portion, snip off the upper half at the 50% weight point.
- The remaining portion is the amount left at a 50% utilization level.
- Use this "sample" height to determine the average degree of use of the key species.

Guide to degree of use

SLIGHT 	**1 TO 20%**	USE TO IMPROVE POOR AND FAIR RANGE CONDITION. *Key areas are practically undisturbed. There is light use on key species in choice areas. Some key plants are not grazed.*
MODERATE 	**21 TO 40%**	BEST FOR EARLY GROWING SEASON USE AND IMPROVING RANGE IN FAIR CONDITION. *Plants accessible to livestock are grazed. Use levels are low on less desirable plants.*
FULL 	**41 TO 60%**	THE DESIRED USE LEVEL ON RANGELAND IN GOOD AND EXCELLENT CONDITION. *All accessible plants have been grazed. Most key species are used fully. Increaser plants are also utilized. Less than 10% of the total plant population is used more than 60%.*
CLOSE 	**61 TO 80%**	PLANTS SHOULD NOT BE GRAZED TO THIS LEVEL EXCEPT DURING THE DORMANT SEASON (65%). *All accessible plants have a cropped appearance. Key species have been utilized 50% or more. Use is evident even on less desirable plants. Choice areas are overused.*
SEVERE	**81 TO 100%**	DO NOT UTILIZE PLANTS TO THIS LEVEL. SEVERE UTILIZATION IS HARMFUL TO PLANTS, WILDLIFE AND LIVESTOCK. *Key forage species are almost completely used. The less desirable plants are now carrying the grazing load. Livestock trampling and trailing is clearly evident. Plants are in poor health and lack vigor.*

Look at the example utilization plot that your instructors have clipped. Determine % use using the definitions above. Put your answer here. _____

Plant residue

The plant residue (material) remaining after a grazing event is very important to rangelands.

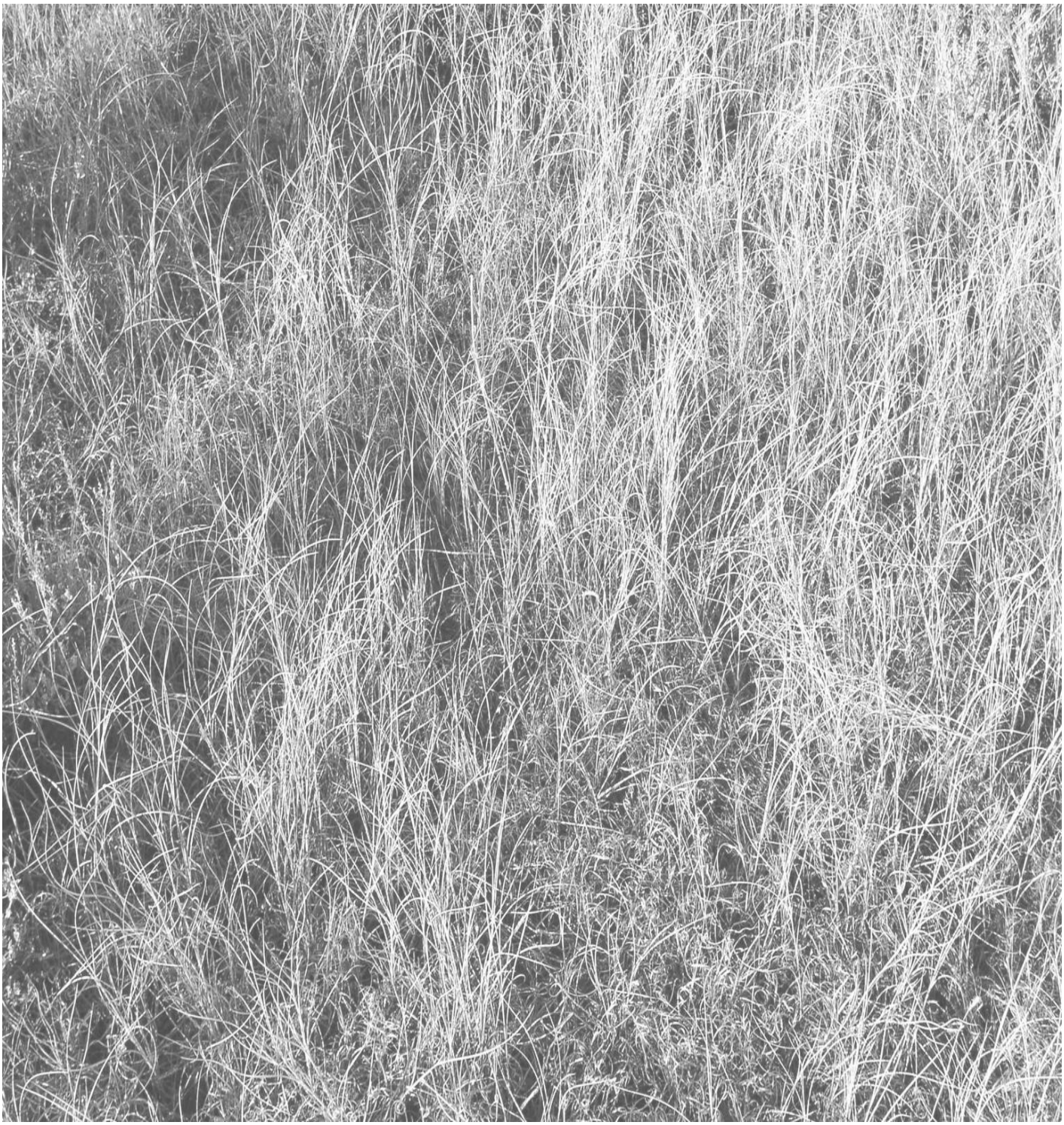
There are two types of residue that are commonly evaluated.

- *Stubble*
- *Litter*

(Photo courtesy of Rebecca Wolenetz)

Stubble

Standing plant material is called stubble. Stubble height is evaluated to determine percent utilization of key species.



(Photo courtesy of Ekalaka NRCS)

Litter

The plant material lying on the ground is called litter.

Range managers carefully observe the quantity and placement of litter on soil surfaces. Litter is one factor used to evaluate long-term range trend and/or range health.

(Photo courtesy of Ekalaka NRCS)

Effects of grazing utilization on water conservation

Water is a limiting factor on western rangelands.

(Photo courtesy of USDA - Natural Resources Conservation Service)

Stubble and litter help the water cycle by:

- Slowing the velocity of water flowing over the surface of the soil. Reduce water erosion.
- Allowing more water to infiltrate the soil surface and percolate through the soil profile.
- Adding organic matter to the soil profile. Organic matter acts as a sponge to capture and hold water in the soil profile.
- Shading and thus cooling the surface of the soil.
- Slowing the rate of water evaporation from the soil profile.

Runoff

When there is enough rain to cause "runoff," grazing makes a difference!!!

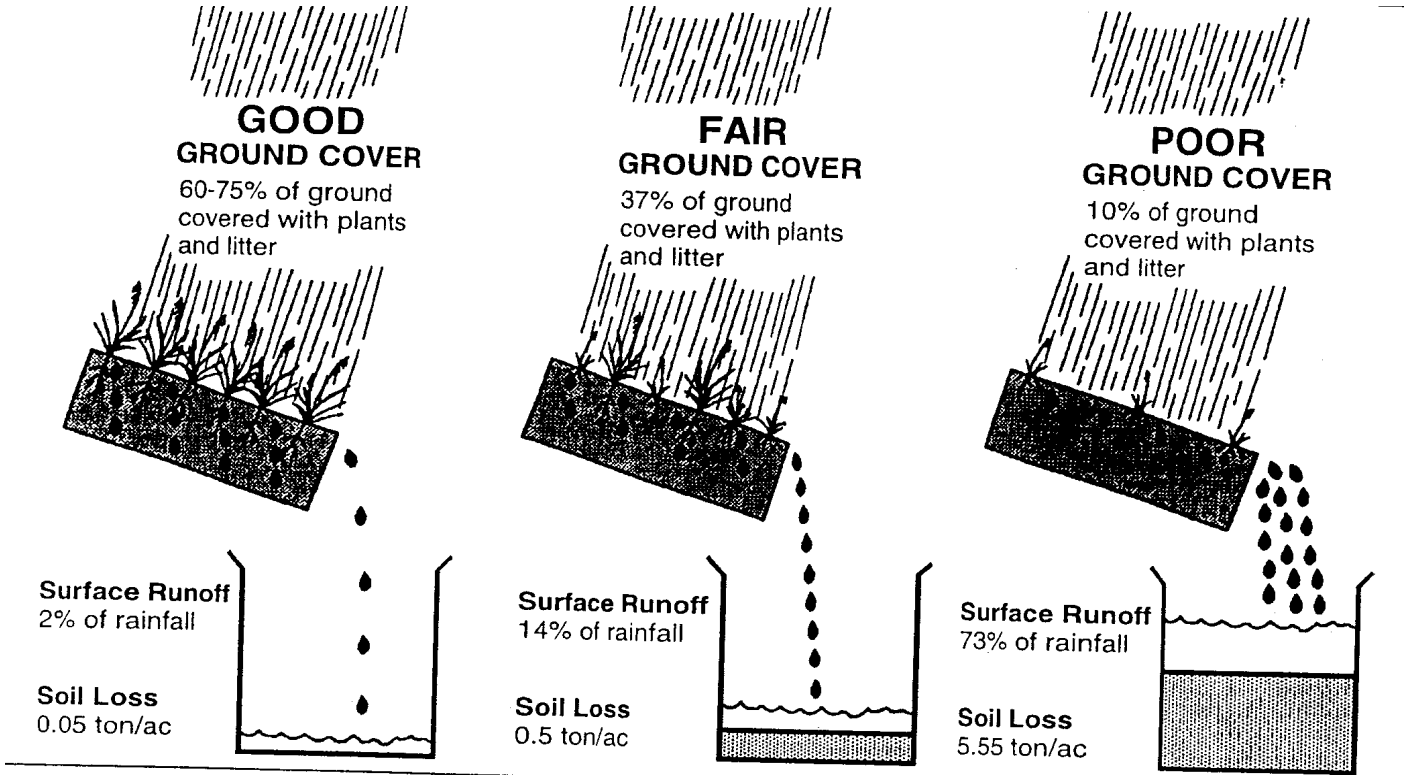


Figure 3. Good ground cover means less runoff and erosion and better water use efficiency. (Adapted from R.W. Bailey and O.L. Copeland Jr. 1961. Low flow discharges and plant cover relations on two mountain watersheds in Utah. International Association of Science Hydrology Publications 51:267-278.)

Feed and Forage Balance

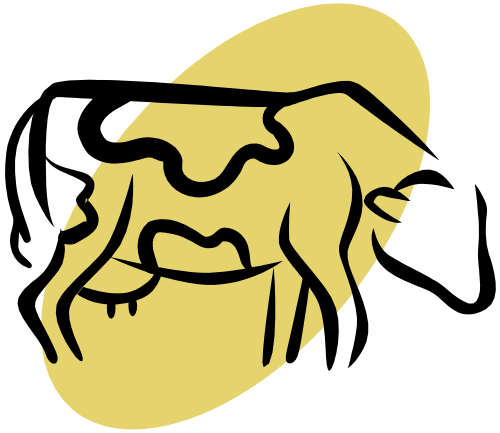
Grazing management relies on balancing the amount of forage produced on a ranch with the amount of forage harvested by grazing animals. Each ranch has a ***grazing capacity***…an amount of forage available to grazing animals.

Depending on the ranch goals this estimated grazing capacity can be translated into a certain number and kind of grazing animals that can live on the ranch long-term without permanently damaging the rangeland. This is often called the "carrying capacity" of a ranch, for example, "This ranch has a carrying capacity of 200 cows".

Grazing capacity is best calculated by inventorying forage resources before they are harvested, on an average growth year. Inventories that are repeated for several years give a ranch manager valuable insight into sustainable range resource management.

Feed and forage inventory:

To inventory the forage resources on a place, you need to gather the basic information regarding land use, ecological sites, rangeland health, pasture and hayland species, health and productivity and crop aftermath availability. With this information you can begin to assign basic stocking rates and tie the stocking rate information to acreages.



What are stocking rates?

Stocking rates compare the total forage needed to support a grazing animal to the total area available to provide the forage. A stocking rate is usually expressed in AUMs per acre per year. A range manager can define the stocking rate more by specifying a certain number and type of animal; for example "40 AU's ewes with lambs, for 30 days".

What is an AUM?

An AUM or an Animal Unit Month is the amount of forage needed to support a 1000 pound cow with calf (less than 4 months of age) for 1 month. A 1000 pound cow with calf will consume approximately 30 pounds (air dry weight) of forage per day. Therefore, she would need approximately 915 pounds of usable forage for one month.

Stocking rate guidelines

Over the years, range scientists have developed stocking rate guidelines for various ecological sites and forage crops based on clipping data and cattle preferences. For example, a loamy ecological site on the Eastern Sedimentary Plains that has a similarity index of 65% would have a stocking rate of .3 AUMs per acre. *Table 1* and *Table 2* provide basic stocking rate information for a 13-19 inch precipitation zone in the Northern Rocky Mountain Foothills South.

NOTE: Specific stocking rate information is documented in the Montana NRCS Ecological Site Descriptions, found on the Montana NRCS website.

Table 1. Approximate stocking rates for native ecological (range) sites in the 11-14 inch precipitation zone in the Sedimentary Plains, expressed in AUM's/Ac.

AUMs per acre X acres of a ecological (range) site = total AUMs

	Range Sites	Subirr.	Overflow	Loamy	Loamy Steep	Droughty	Shallow to gravel	Limy	Limy Droughty
Similarity Index	(76-100%)	1.4	.6	.42	.55	.29	.26	.25	.24
	(51-75%)	1.0	.45	.34	.43	.22	.18	.19	.17
	(26-50%)	.6	.3	.25	.28	.12	.12	.1	.1
	(0-25%)	.2	.1	.1	.15	.06	.06	.06	.05

(Photo courtesy of Ekalaka NRCS)

Table 2. Approximate stocking rates for introduced pasture species, hay, hayland aftermath and crop aftermath, expressed in AUMs/Ac.

AUMs per acre X acres of a ecological (range) site = total AUMs

Species	AUMs per Acre
Crested wheatgrass	.7
Pubescent wheatgrass	1
Russian wildrye	.6
Hay (1.5 Tons per acre)	2.2 (This is an approximate figure.)
Hayland aftermath with regrowth	.4
Hayland aftermath without regrowth	.2
Crop aftermath (small grains)	.2

You may want to figure an actual stocking rate on a range site out in a pasture.

Technique for figuring an actual stocking rate:

Throw a 9.6 sq. ft. hoop out onto a representative area of a range site.

If cattle are the primary grazers, clip all the forage within the site that would be preferred or desirable to cattle (primarily grasses, some forbs and shrubs as indicated in the Ecological Site Descriptions).

Dry and then weigh the sample. (Remember that you can also estimate dry matter basis.)

(Photo courtesy of USDA-NRCS)

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Of the forage that cattle prefer or desire consider that….

- 50% of the forage should be left un-grazed
- 25% will be trampled by livestock, covered with manure, consumed by insects, etc.
- **25% of the forage can be utilized by grazing animals**

Example stocking rate scenario:

Ecological Site = Loamy - 500 acres
Grazing Animal Class = Cattle
Air dry weight **of preferred or desired forage sample** (clipped with 9.6 ft.^{2} hoop) = 100 grams

Stocking Rate Calculations:

- 100 grams X 10 (hoop conversion factor to convert grams to pounds/acre) = 1000 pounds/acre of forage.

- 1000 pounds/acre X .25 (25% usable forage) = 250 pounds/acre.

- It takes 915 pounds to feed 1, 1000 pound cow with calf for 1 month. Divide 250 by 915. The answer will be .27 AUMs/AC for that site.

If you know that there are 500 acres of that particular ecological site in approximately the same similarity index category, then you can figure the grazing capacity for the site.

- Multiply 500 Ac. X .27 AUMs/Ac. = 135 AUMs available on that site.

It sounds pretty simple, but there are factors other than formulas that also need to be considered when determining stocking rate and grazing capacity.

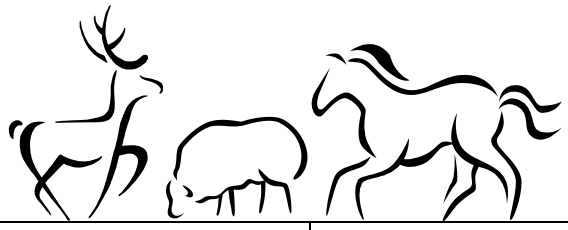
1. Animal Unit Equivalent – based on class of animal, animal size and maturity
2. Topography or steepness of terrain
3. Distance from water
4. Plant season of use – ex. warm or cool season
5. Grazing system utilized – ex. continuous, deferred rotation, intensive grazing
6. Growing season conditions – ex. drought, grasshoppers, hail, fire, etc.
7. Animal nutrition

(Photo courtesy of USDA-NRCS)

Animal Unit Equivalents

The Animal Unit Equivalent serves as a common denominator for calculating the forage requirements of different species of animals. The standard animal unit is a 1000 pound mature cow with a calf less than 6 months of age. The AUE of mature sheep is .2. This means that 1 mature sheep would eat 20% of the amount of forage required by 1, 1000 pound cow with a calf. 1 divided by .2 = 5. So, you could run approximately 5 mature sheep for every "standard" cow.

Since cattle size has increased, many planners do not work with the standard Animal Unit Equivalent anymore. They figure in an extra $^{1}/_{10}$ of an Animal Unit for each 100 pounds over 1000. For example, an 1100 pound mature cow would have an Animal Unit Equivalent of 1.1 instead of 1.0. Differences in mature size should be factored in to your stocking rate calculations. It really does make a difference.



Kinds/classes of animals	Animal Unit Equivalent	Forage consumed per day	Forage consumed per month
Cow, dry	.92	27.6	842
1000 lb. Cow, with calf	1.00	30	915
Bull, mature	1.35	40.5	1235
Cattle, 1 year old	.60	18	549
Cattle, 2 years old	.80	24	732
Horse, mature	1.25	37.5	1144
Sheep, mature	.20	6	183
Lamb, 1 year old	.15	4.5	137
Goat, mature	.15	4.5	137
Kid, 1 year old	.10	3	92
Deer, white-tailed, adult	.15	4.5	137
Deer, mule, adult	.20	6	183
Elk, mature	.60	18	549
Antelope, mature	.20	6	183
Bison, mature	1.00	30	915
Sheep, bighorn, mature	.20	6	183

Topography or steepness of terrain

Topography needs to be considered when figuring and adjusting stocking rates. The NRCS National Range and Pasture Handbook provides example guidelines for slope

Percent slope	Percent adjustment
0-15%	0%
15-30%	30%
31-60%	60%
>60%	100%

adjustments on rangelands in Table 3-12. These adjustments would only be made on the acreages with significant slopes, *not the entire pasture.*

(Photo courtesy of Ekalaka NRCS)

Proximity to water

In some situations, grazing animals cannot effectively utilize part of a pasture because it is too far from water. Therefore, the stocking rate on that acreage would need to be adjusted. The NRCS National Range and Pasture Handbook provides example guidelines for water distribution adjustments on rangelands in Table 3-13.

Distance (miles)	Percent adjustment
½ to 1 mile	0%
1 to 2 miles	50%
2 to 3 miles	75%

(Photo courtesy of Ekalaka NRCS)

Plant Season of Use

Some pastures are dominated by either cool-season or warm-season plants, but not both. Season of use affects stocking rates. For example, if you have a pasture that consists primarily of warm-season plants, you will have to adjust your stocking rates if you graze the field early in the spring, before the warm-season plants make their growth.

Grazing system utilized

As the number of grazing animals in a pasture increases, harvest efficiency increases. The animals will eat more and waste less. Rotational grazing systems generally apply higher stock densities to individual grazing units. The forage harvest efficiency within these systems may increase from the standard 25% (see page 6) up to 40%. Therefore, a rotational grazing system may allow for an increase in stocking rate.

Growing season conditions

Previous and current year growing season conditions need to be figured into grazing capacity projections. Moisture, temperature, wind, fire, hail, insects, etc. determine the amount of forage available each year. *These factors should be monitored and evaluated so that stocking adjustments can be implemented to protect the natural resources from long-term damage.*

Animal nutrition

Grazing animal's nutritional requirements always need to be considered when evaluating grazing capacity and stocking rates. Hypothetically you may have enough forage, but it might not be the right kind or the right amount to satisfy the nutritional needs of the animals. For example, animals grazing old, over-mature grass may not have enough protein in their diets. Therefore, it is important to monitor animal health throughout the growing season and provide dietary supplements if necessary.

(Photo courtesy of Rebecca Wolenetz)

Adjust!

If you calculate the grazing capacity of a ranch and the numbers do not match what you are seeing on the ground, make some adjustments. *Remember that stocking rates are just guidelines and should be used as such.*

STOCKING RATE ROUNDING RULES FOR CONTESTS:

1. *Round stocking rates to the nearest one hundredth. For example, .277 AUMs/acre would be rounded to .28 AUMs per acre.*

2. *If you are figuring numbers of animals, round to the nearest whole number because you cannot have a fraction of an animal. For example, in the scenario that follows, the number of yearlings is rounded from 333.3 to 333.*

3. *Round AUM calculations to the nearest tenth.*

4. *Round months to the nearest tenth.*

Example of a basic stocking rate scenario

You do a range inventory on the Lone Pine pasture. The inventory reveals that there are 1000 acres of loamy range with a similarity index of 40%. Using the AUM Factor Table, you determine that the stocking rate for a loamy site with a similarity index (SI) of 40% is .25 AUMs/acre.

- **HOW MANY AUM'S ARE AVAIALABLE IN THE LONE PINE PASTURE?**

  1000 acres X .25 AUM'S/acre = 250 AUM'S

You plan to run cow/calf pairs on the unit. Refer back to the Animal Unit Equivalent chart. A cow/calf pair is equal to 1 animal unit (AU).

- **HOW LONG (MONTHS) COULD YOU RUN 250 COW/CALF PAIRS ON THE LONE PINE PASTURE?**

  250 AUM'S/250 AU'S = 1 month

- **COULD YOU RUN 300 COW/CALF PAIRS THE LONE PINE PASTURE FOR 1 MONTH?**

  No. 300 AU'S X 1 MONTH = 300 AUM'S and there are only 250 AUM's available.

- **HOW MANY YEARLINGS COULD YOU RUN ON THE LONE PINE PASTURE FOR 1 MONTH?**

  250 AUM'S/.75 AU/1 month = 333 yearlings

- **HOW MANY YEARLINGS COULD YOU RUN FOR 1 MONTH ON THE LONE PINE PASTURE IF THE RANGELAND HAD A SI OF 60%?**

  1000 ACRES X .3 AUM'S/acre = 300 AUM'S/.75 AU/1 month = 400 yearlings

Practice problem - basic stocking rate scenario

- **HOW MANY SHEEP COULD YOU RUN FOR 2 MONTHS IN A 640 ACRE PASTURE THAT CONSISTS OF:**

  200 ACRES OF LOAMY STEEP RANGE SITES (35% SLOPES); SI OF 65%
  440 ACRES OF SANDY RANGE SITES WITH A SI OF 50%?

- **THERE ARE 640 ACRES (1 SECTION) IN THE NORTH PASTURE. THE PASTURE CONSISTS OF LOAMY RANGE SITES WITH A SI OF 64%. ½ OF THE LAND IN THE PASTURE IS LOCATED MORE THAN 1 MILE FROM WATER. HOW MANY DAYS COULD YOU RUN 250 COW/CALF PAIRS IN THIS PASTURE?**

Keep practicing calculating stocking rates by making up your own scenarios. Try to figure in some adjustments for topography, distance from water and types of grazing animals also.

Sometimes the math is easier if you set up the equations in cross-multiplication format and then cancel units as you work through the problem.
FOR EXAMPLE:

$$\frac{400\ \text{~~AU~~M'S}}{250\ \text{~~AU'S~~}} = 1.6\ \frac{\text{~~months~~}}{1\ \text{~~month~~}} \times \frac{30\ \text{days}}{} = 48\ \text{days}$$

Range Planning

Range planning includes:

- ***PROBLEM IDENTIFICATION***
- ***GOAL SETTING***
- ***INVENTORY***
- ***ALTERNATIVES***
- ***MONITORING***

(Photo courtesy of USDA-Natural Resources Conservation Service)

PROBLEM IDENTIFICATION

SYMPTOMS VS. CAUSE

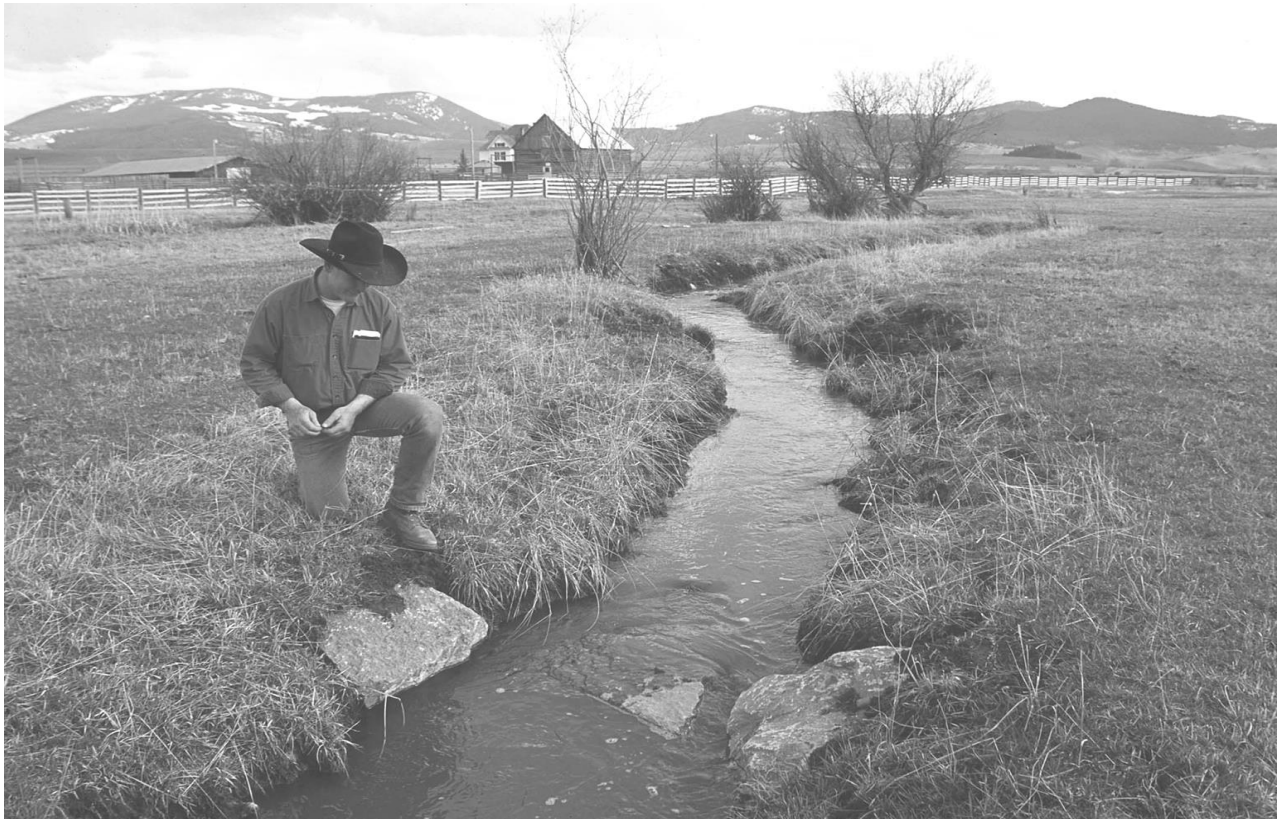
DEFINITIONS:

PROBLEM: 1: a question raised for consideration of solution; 2: an intricate unsettled question; 3: a source of perplexity or vexation.

CAUSE: 1: Anything producing an effect or result. 2: a person or thing acting voluntarily or involuntarily as the agent that brings about an effect or result.

SYMPTOM: 1: A change in an organism indicative of disease or abnormality; 2: A sign or indication.

*******ADDRESS THE CAUSE NOT THE SYMPTOMS*******



(Photo courtesy of the USDA – Natural Resources Conservation Service)

DETERMINE "CAUSE" IN THE FOLLOWING EXAMPLES:

SOIL EROSION

There are three major types of soil erosion: wind, water and geologic. We have no control over geologic erosion. The Grand Canyon is an example of geologic erosion.

The hay patch you plowed, packed and planted last spring is still blowing. Why?

During a heavy rainfall event, the draws in the summer pasture start to erode. Why?

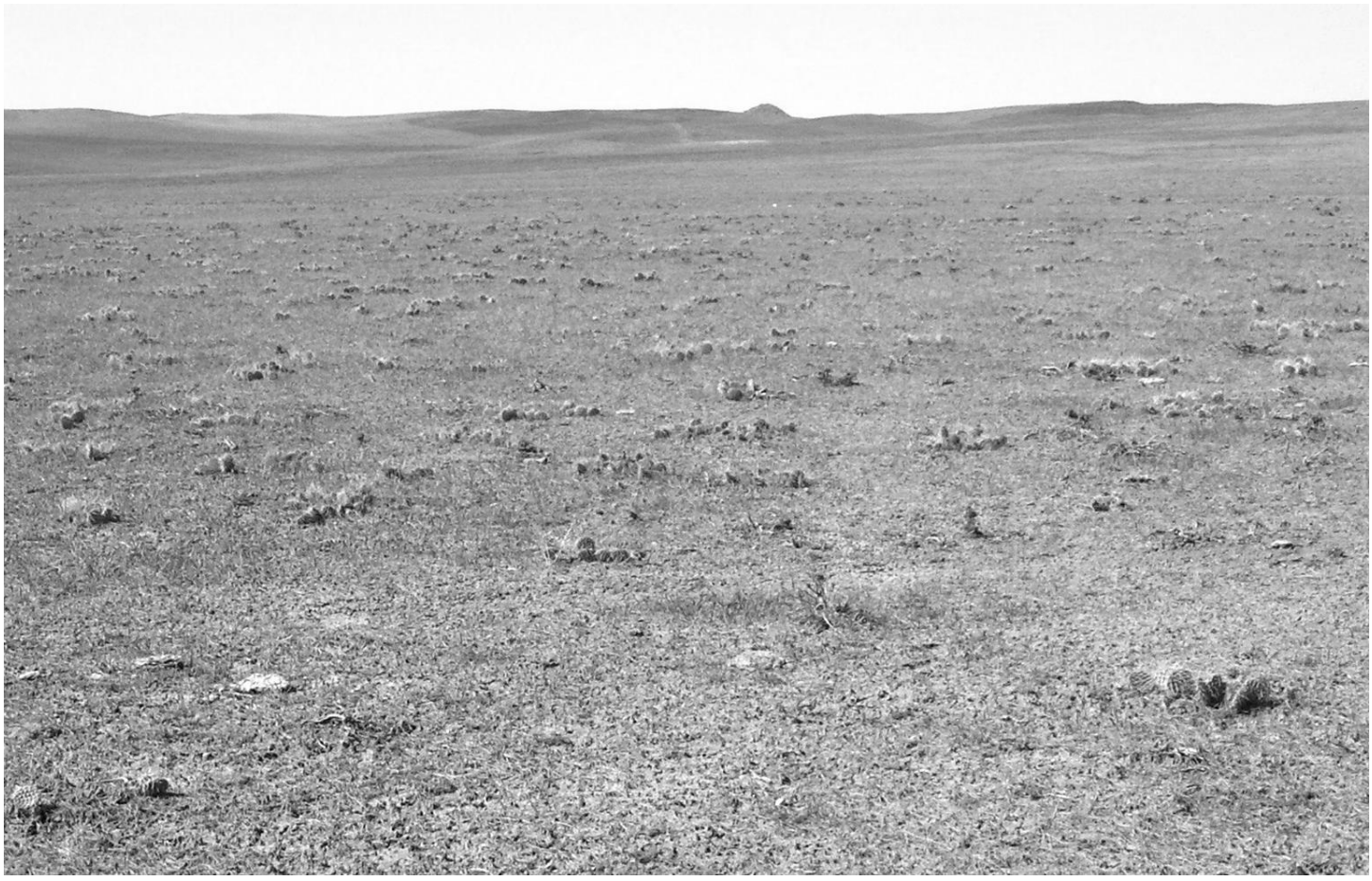
(Photo courtesy of USDA-Natural Resources Conservation Service)

OVERGRAZING

Overgrazing manifests itself in many ways: soil erosion, low plant vigor, low forage production, invasion of undesirable species.

A pubescent wheatgrass field is not producing to its potential. Why?

The clayey sites in the summer pasture are dominated by prickly-pear cactus. Why?



(Photo courtesy of Ekalaka NRCS)

POOR CONCEPTION RATES

Conception rates are influenced by a number of factors: breed characteristics, animal nutrition and health, bull/cow ratios, availability of water and the size and topographic features of pastures.

The vet came out and preg-checked the cow herd. The conception rate was only 63%. Why?

(Photo courtesy of Rebecca Wolenetz)

HIGH NITRATE LEVELS IN WELL WATER

Sources of nitrates include commercial fertilizers, animal wastes and natural geologic material (ex. coal veins).

You recently sent in a water sample. The lab results confirm high nitrate levels. Why is the well contaminated?

DEFINITION OF A GOAL:

aim; purpose; planned destination

WHY ARE GOALS IMPORTANT?

"YOU CAN'T GET ANYWHERE IF YOU DON'T KNOW WHERE YOU ARE GOING OR HOW TO GET THERE!!!"

Goal setting is a critical component of successful resource planning.

REMEMBER..

- Goals need to be realistic & achievable.
- Goals are easier to achieve if accepted by everyone involved.
- Both long term (10-50 years) and short term (1-5 years) goals should be considered.
- Goals are limited by land and economic resources.

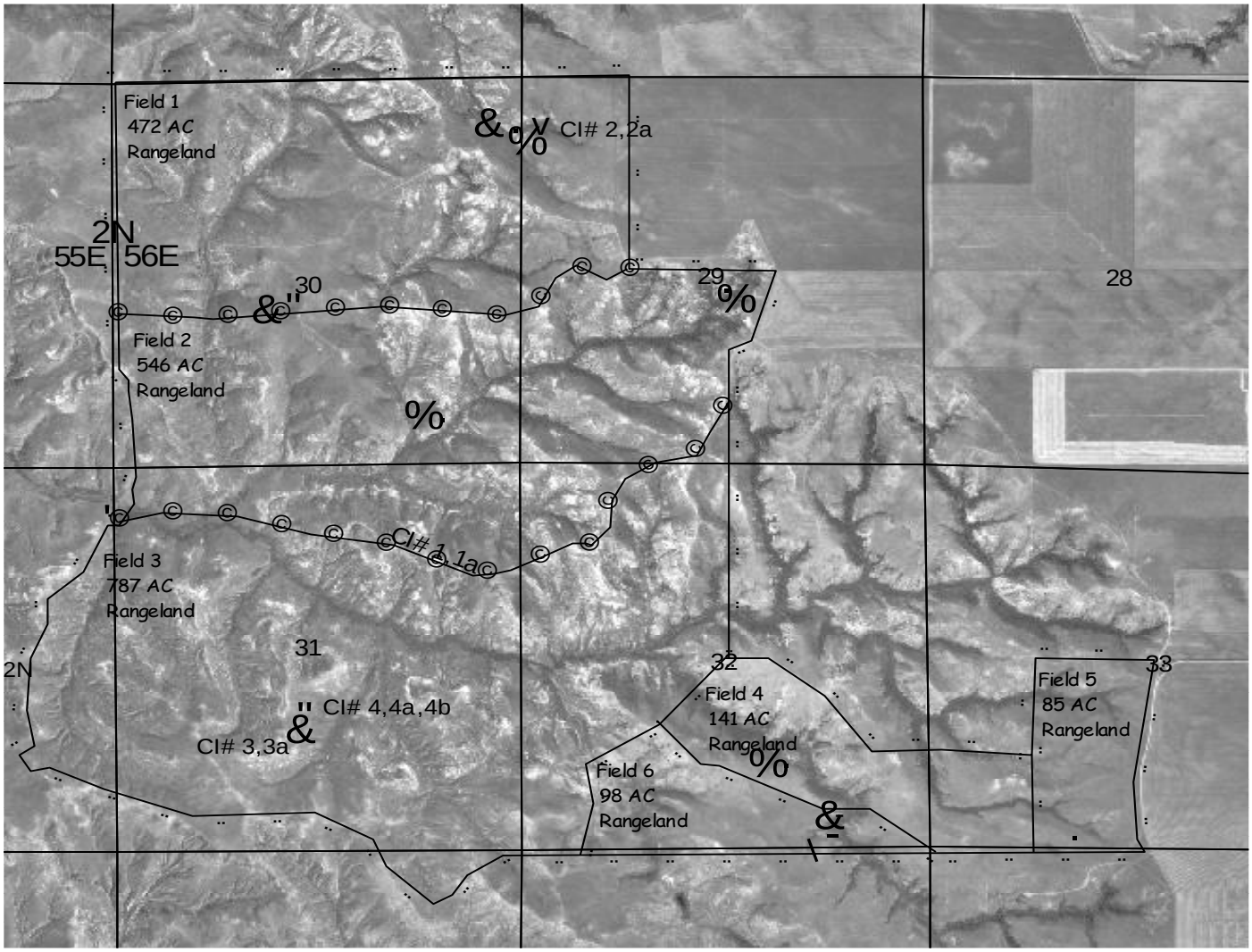
RESOURCE INVENTORY

A resource inventory accurately documents natural resource conditions and trends, existing natural and artificial features and economic and social considerations. This information is critical to the planning and decision making processes. Ultimately, over time, ***inventories serve as "baselines" to evaluate the success or failure of plans.***

(Photo courtesy of Rebecca Wolenetz)

PLAN MAPS

A plan map is an important component of a resource inventory. The map provides a "big picture" of the resources.



MEDIAS

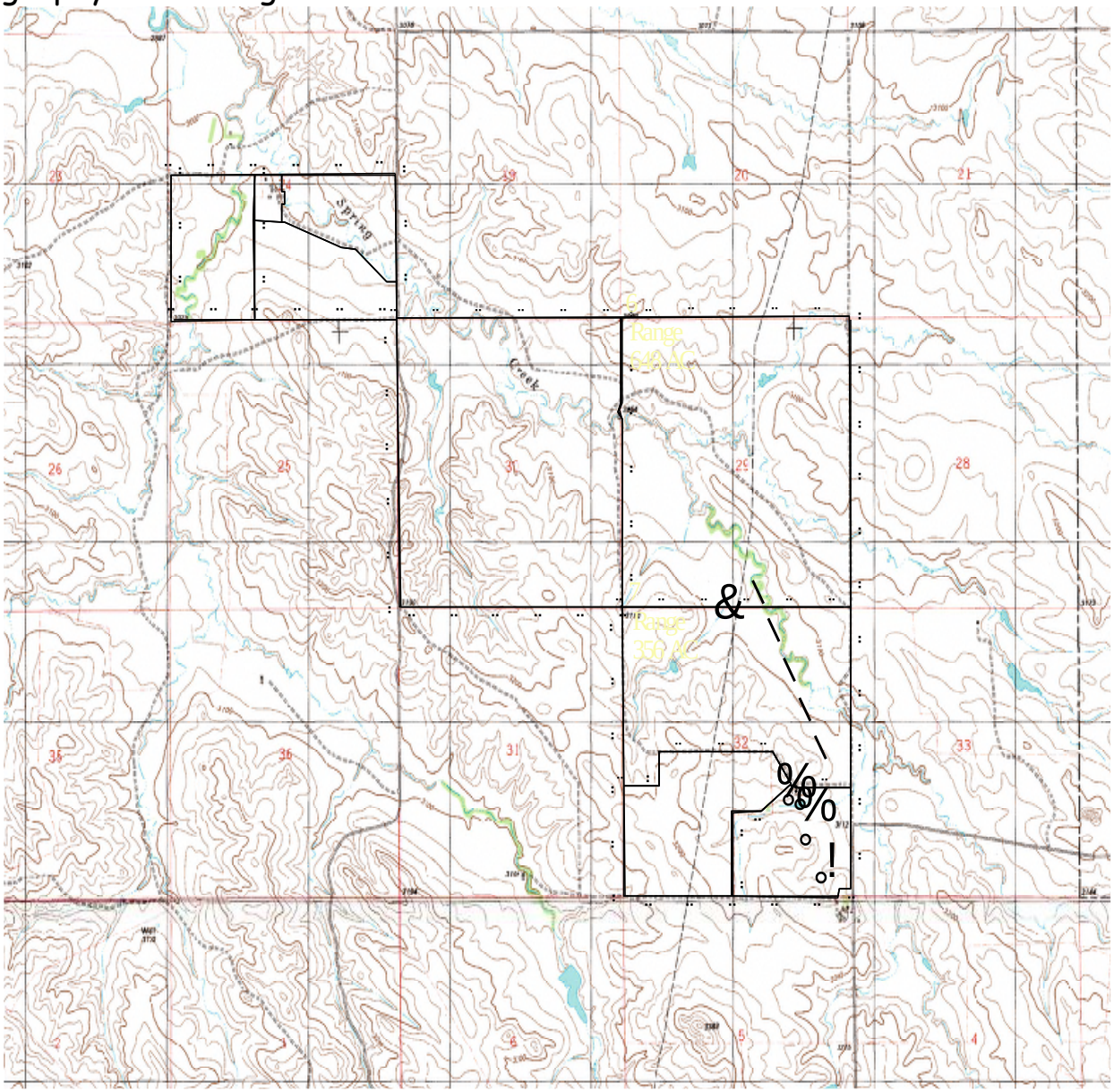
A variety of medias can be used to create a plan map.

EXAMPLES INCLUDE:

- *USGS Quad maps (topographic map)*
- *NRCS Soil Survey maps*
- *aerial photographs*
- *ARCVIEW*

USGS Quad maps (topographic maps)

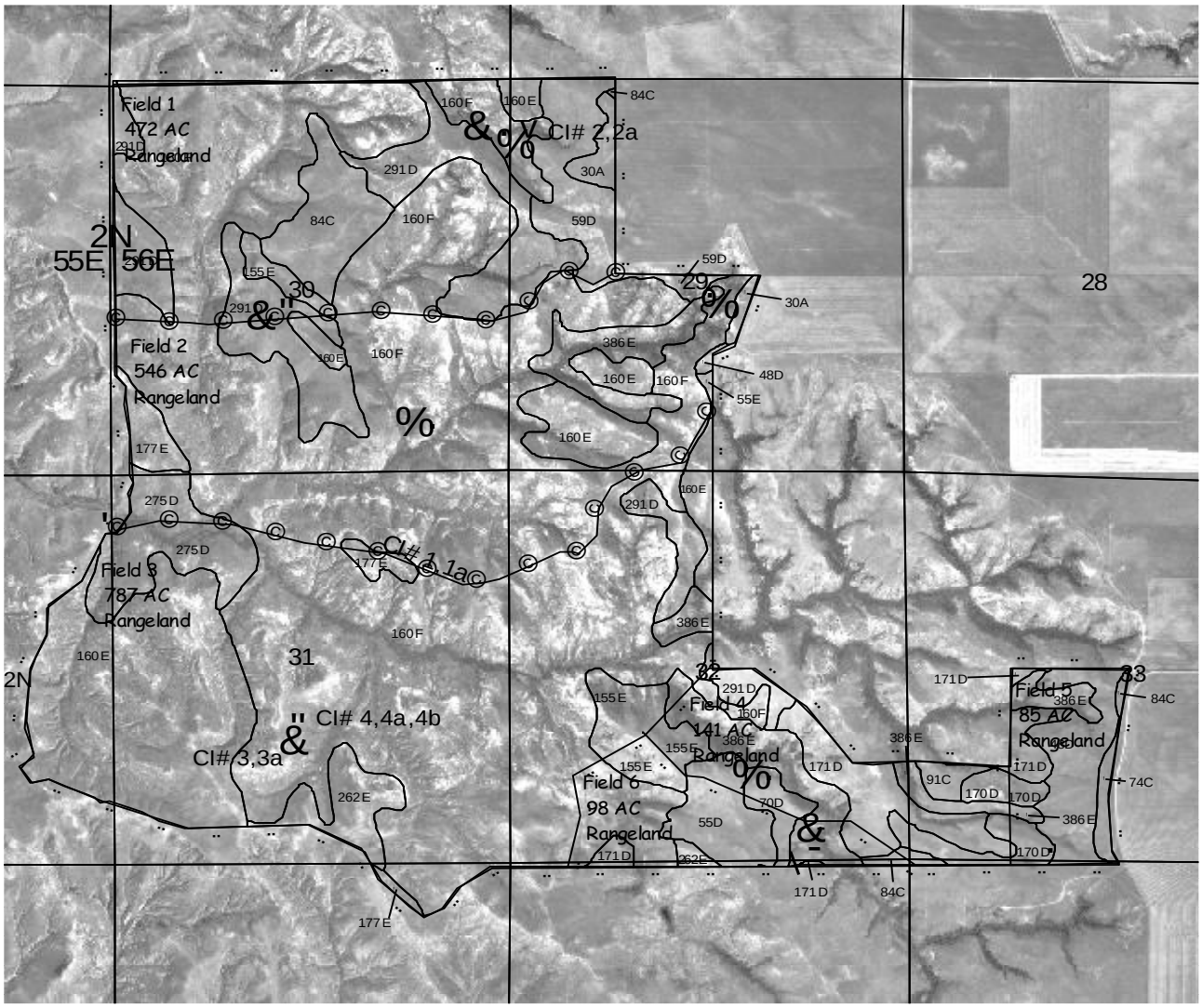
USGS Quad maps are mapped, edited and published by the Geological Survey. Although these maps may have different scales, many versions are scaled at 1:24,000. At this scale, 1 mile = 2.65 inches. Topographic maps consist of basic landscape features and contour lines indicating elevation changes, typically of 20 Feet. If the contour lines are space close together, the elevation is changing rapidly. If the lines are space far apart, the topography is fairly flat. Note that the topographic map shown below does not have aerial photography as a background.



NRCS Soil Survey Maps

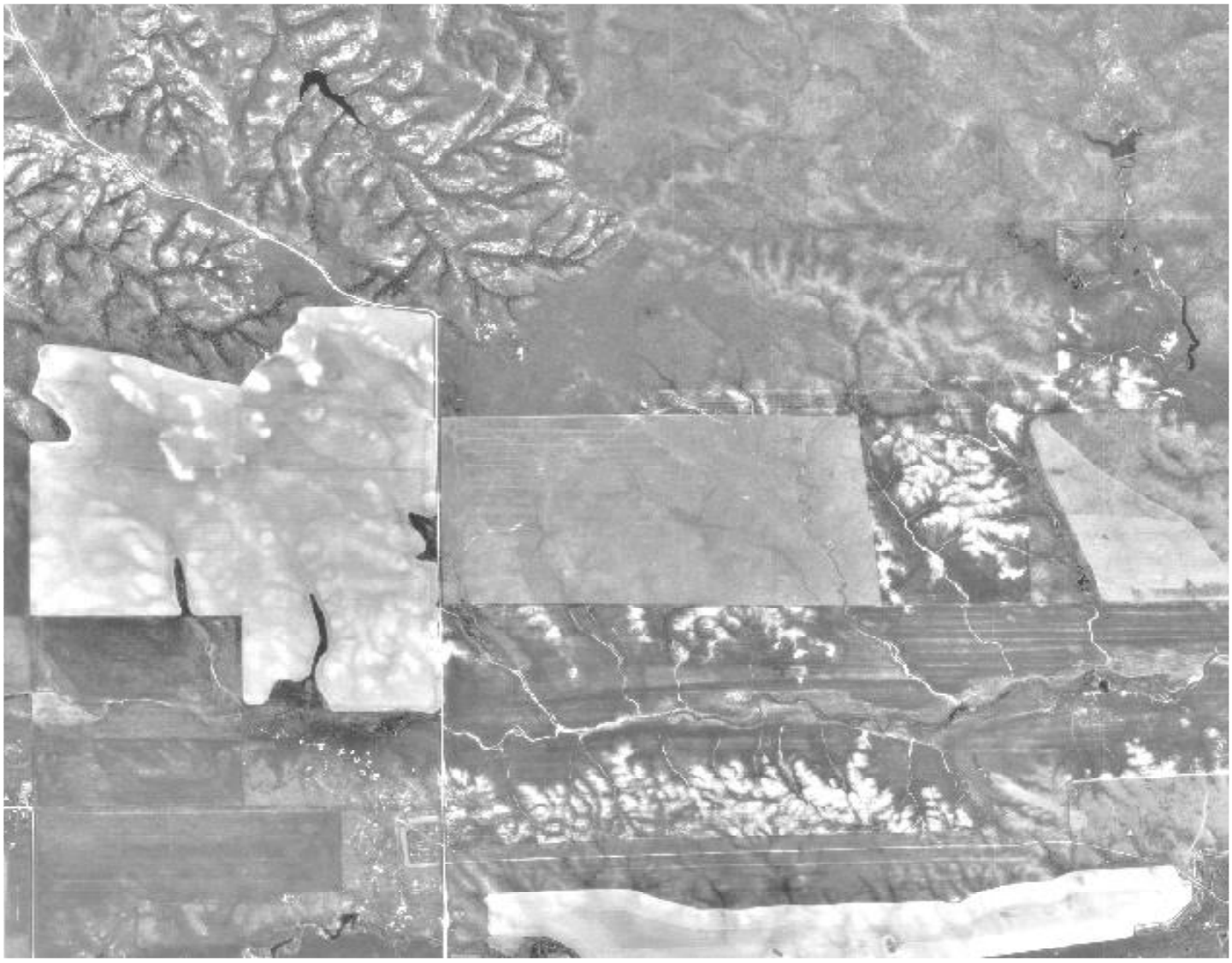
Soil Survey Maps were mapped, edited and published by USDA-NRCS. Soil maps delineate changes in soil types across a landscape. They are valuable references for understanding the productive potential of a farm or ranch, and for helping people select construction sites, etc. Soils are commonly mapped at a scale of 1:24,000 or 1 mile = 2.65 inches.

A soils map will list soils by symbol. It is important to obtain a map legend so that you can understand how to interpret the symbols. If your county has a published soil survey, you may be able to obtain a copy at your local NRCS office.



Aerial photography

There are different sources for obtaining aerial photographs. Aerial photographs provide an actual picture of a landscape. The picture is taken from a plane. The aerial photographs that you find in NRCS and FSA offices are usually scaled at 4 inches to 1 mile or 8 inches to 1 mile. When you first look at aerial photographs it may be difficult to recognize the differences between ridges and draws. If you look at a photo under a stereograph, you will get a better idea dimensionally of how the topography lies.

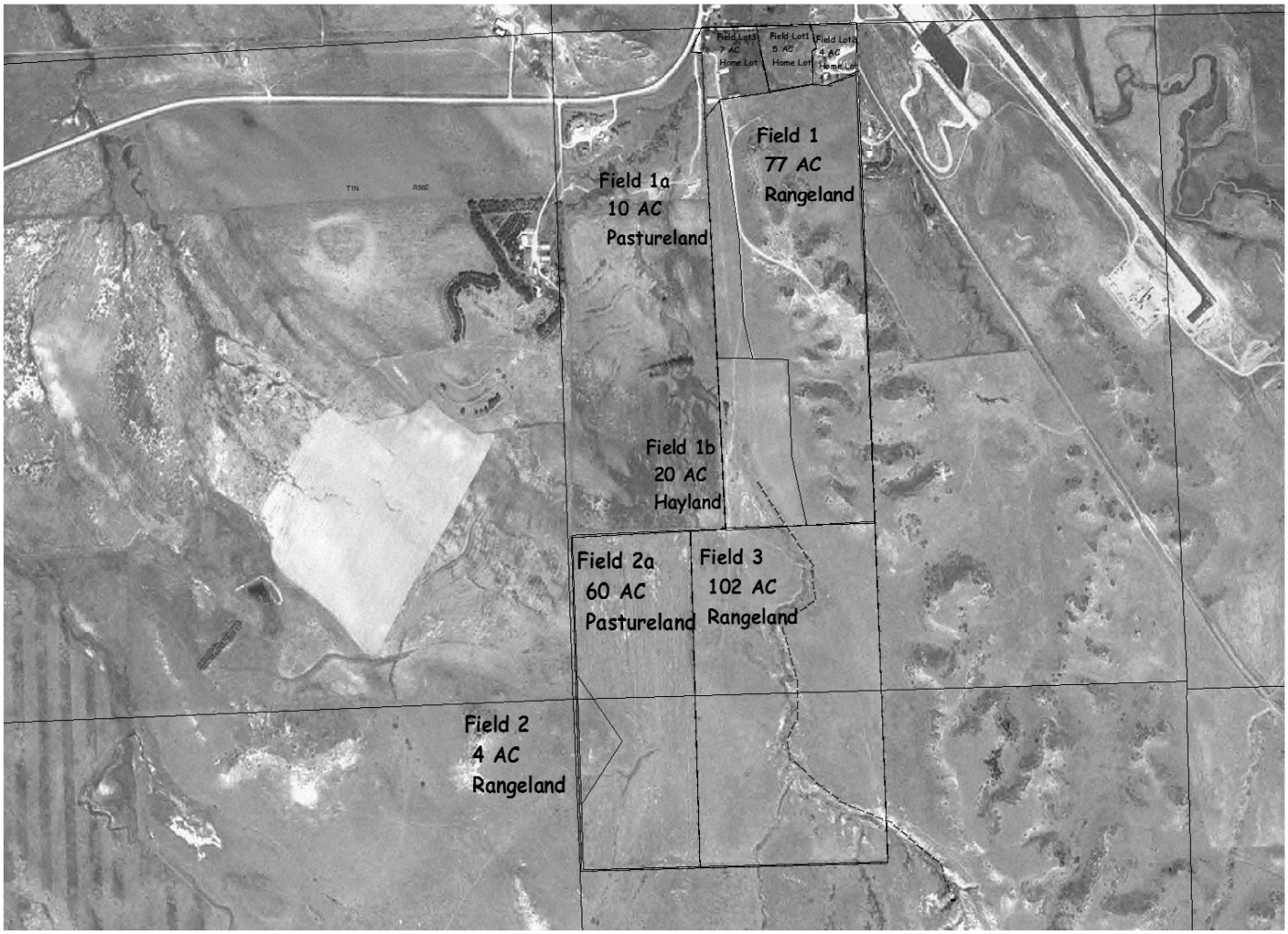


Clear mylar overlays can be used with aerial photography to illustrate problem areas, planned range improvements and management practices, without adding additional "clutter" to the original plan map. *Waterproof, fine-point markers should be used to draw features onto the mylar.*

ARCVIEW

Arcview, ArcGIS and similar computer programs generate custom maps. The maps use a variety of media and are often layered. For example, you could bring up an aerial photograph of your farm/ranch, draw in the boundaries, and overlay the soils information, water facilities, fences, etc. The end product is a professional-looking map that you can print at home or in the office.

Arcview can also incorporate GPS technology. You can GPS the perimeter of a weed infestation, download the information from the GPS into Arcview and add that data to the map. Obviously, there are some great applications for this program.

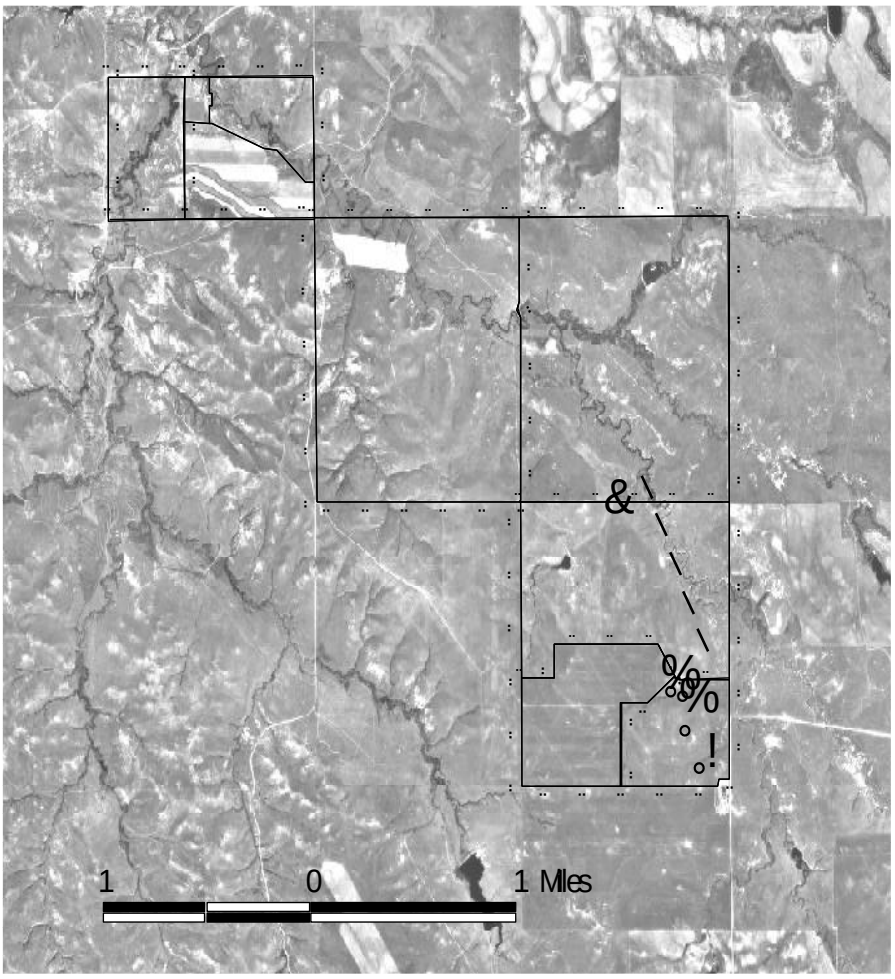


PLAN MAPS SHOULD IDENTIFY:

1. *ECOLOGICAL SITES*
2. *SIMILARITY INDEXES*
3. *NATURAL RESOURCE TRENDS*
4. *LIVESTOCK USE LEVELS*
5. *LIVESTOCK DISTRIBUTION PATTERN*
6. *NATURAL FEATURES: COULEES, STREAMS, CUTBANKS, NATURAL BOUNDARIES*
7. *ARTIFICIAL FEATURES: FENCES, TRAILS, WATER, SALT & BUILDINGS*

MAP SCALES

Maps come in many different sizes (scales). Map distances or scales are often expressed in inches to the mile. For example, an aerial photograph might have a scale of 4 inches to 1 mile. A soil map may have a scale of 2.65 inches to 1 mile. Always check the scale of your map, which is usually located at the bottom of the map.



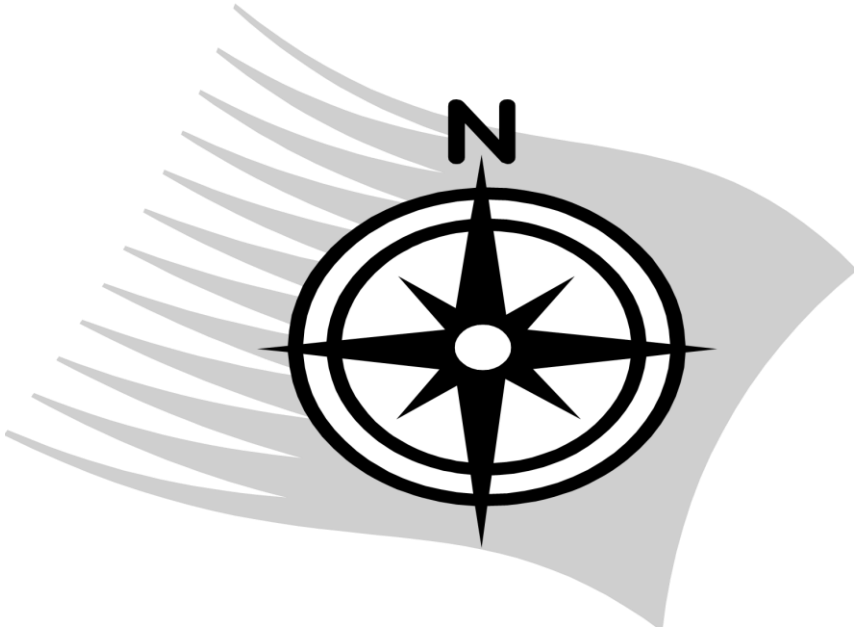
MAKING YOUR OWN MAP

Say that you would like to make a plan map of your place when you get home from Range Days. If you go to your county courthouse or to one of your local natural resource agency offices, you will find many different kinds of map medias available. BLM maps, Forest Service maps, aerial photographs, NRCS soil maps, USGS topographic maps, ownership maps.

You decide to use a USGS topographic map for your planning efforts. Since topographic or quad maps are very detailed they are printed at a larger scale (so that you can see the details). A larger scale means that there are less acres on one map.

A large scale map of an entire county would be absolutely huge! Not feasible to use by any means. Therefore, the county area is broken down into smaller map units. For example, there might be 80 USGS topographic maps to cover the land area for one county. Each map is identified with a name, for example, Blacktail Creek. There is a legend that identifies which Townships, Ranges and Sections are on the Blacktail Creek map.

If you provide a legal description, employees can determine from the legend which topographic map you need to look at. The same is true for soils maps and aerial photos.



LEGAL LAND UNIT DESCRIPTIONS

If you look at a map of your county, you will find that it is legally divided into Townships, Ranges and Sections.

This is an example of a legal land unit description.

Township 2 North, Range 55 East, Section 18

TOWNSHIPS:

Townships identify the horizontal position on a map. Townships are designated as either North or South.

Townships consist of 36 sections of land, numbered right to left and top to bottom. Section #1 would be in the upper right-hand corner of a township. Section 36 would be in the lower right-hand corner. Since the dimensions of a section are 1 mile wide by 1 mile long, a township would be six miles wide by six miles long. There would be 23, 040 acres in a township and 1,003, 622 square feet.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

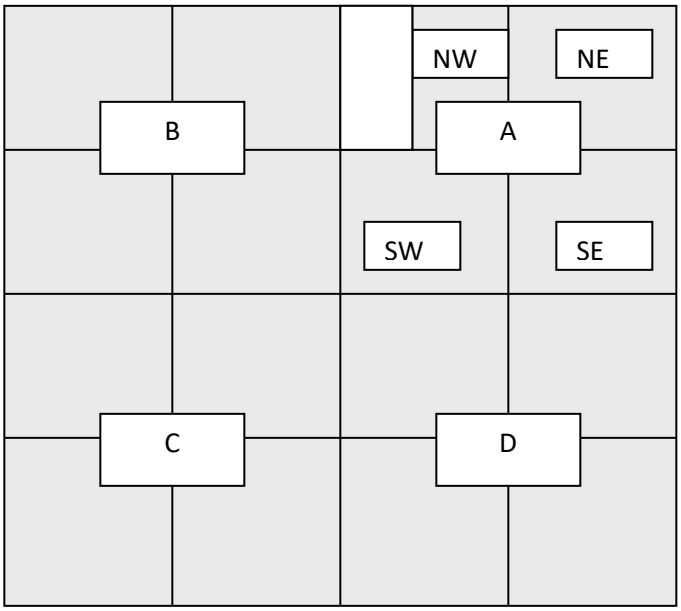
RANGES:

Ranges identify the vertical position on the map. Each range is the width of a Township, which would be six miles wide. A range runs lengthwise through the county. Ranges are designated as either east or west.

6	5	4	3	2	1	6	5	4	3	2	1
7	8	9	10	11	12	7	8	9	10	11	12
18	17	16	15	14	13	18	17	16	15	14	13
19	20	21	22	23	24	19	20	21	22	23	24
30	29	28	27	26	25	30	29	28	27	26	25
31	32	33	34	35	36	31	32	33	34	35	36

QUADRANTS AND FURTHER DIVISIONS:

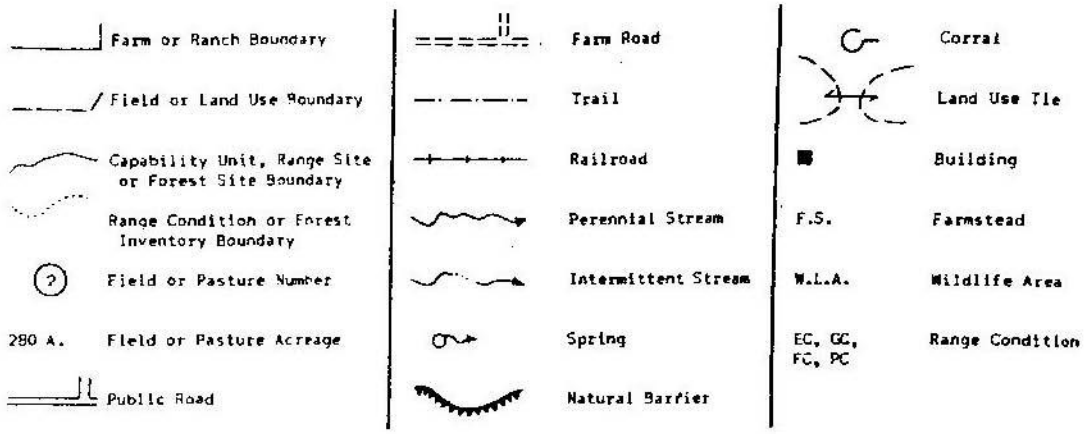
Each section is further divided into quadrants A, B, C, D. Each Quadrant is divided four times. A legal description within a section might read…the west $\frac{1}{2}$ of the NW $\frac{1}{4}$ of quadrant A in Section 8, Range 55 East, Township 2 North.

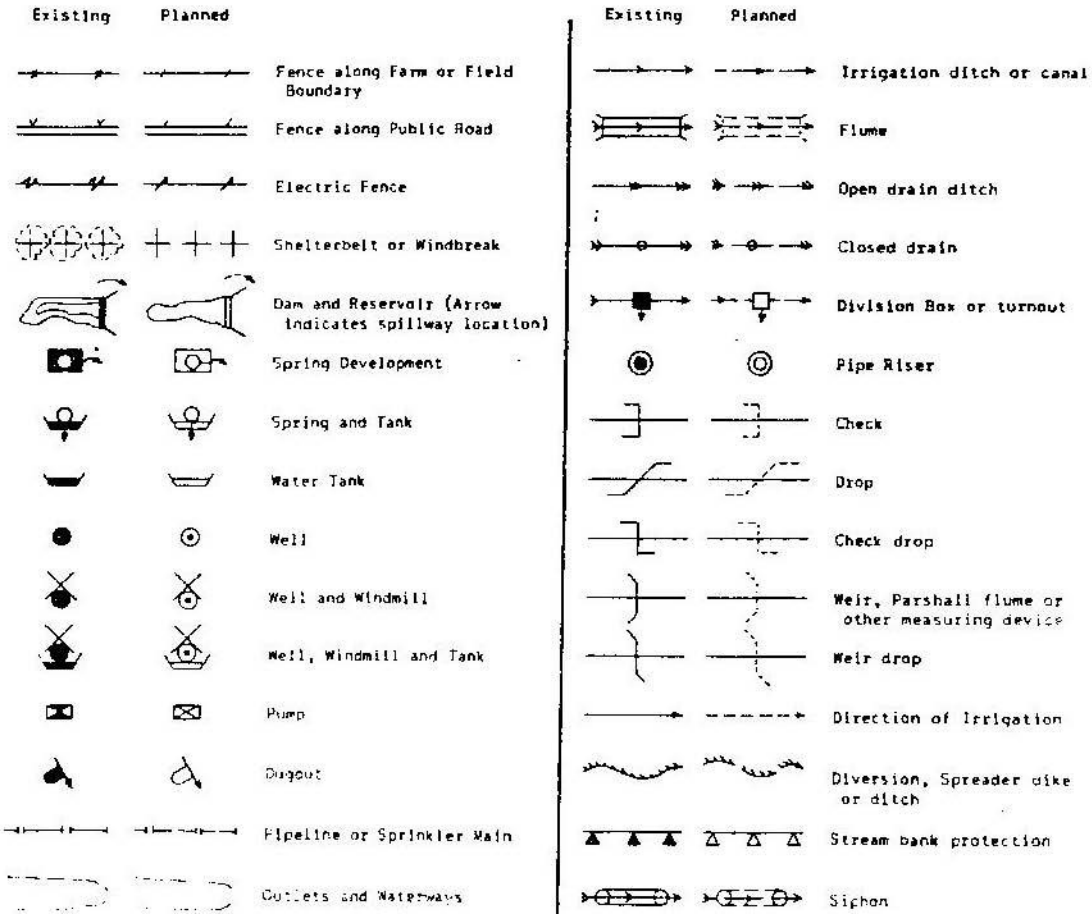


MAP LEGENDS

Legends are used to identify abbreviated symbols on maps. Plan maps, soil maps and topographic maps have their own unique legends.

EXAMPLES OF CONSERVATION PLANNING SYMBOLS USED ON PLAN MAPS:





RANGE IMPROVEMENT PRACTICES

Range improvement practices are planning alternatives used to improve or restore forage resources on rangelands. Goals, time, labor, economic constraints and natural resource conditions are considerations when selecting and planning range improvements.

Remember that practices applied to rangeland must benefit the physiological needs of the key plants to be considered a true range improvement.

(Photo courtesy of the Phillips County Range Committee)

CATEGORIES OF RANGE IMPROVEMENT PRACTICES:

1. VEGETATIVE MANAGEMENT PRACTICES

- Proper grazing use
- Planned grazing systems

These practices directly influence vigor, growth and use of range plants.

2. FACILITATING PRACTICES

- Stockwater development
- Fencing
- Salting
- Herding

These practices are applied with vegetative management practices to control and influence the movements of grazing animals.

3. ACCELERATING PRACTICES

- Brush management
- Weed management
- Mechanical range renovation
- Prescribed burning
- Fertilizing
- Range seeding

These practices are applied with vegetative management practices to achieve rapid changes in species composition and forage production.

PROPER GRAZING USE

Grazing use serves as a reference to evaluate the effects of grazing systems on desired plant communities.

HOW ARE PLANTS AFFECTED BY GRAZING USE?

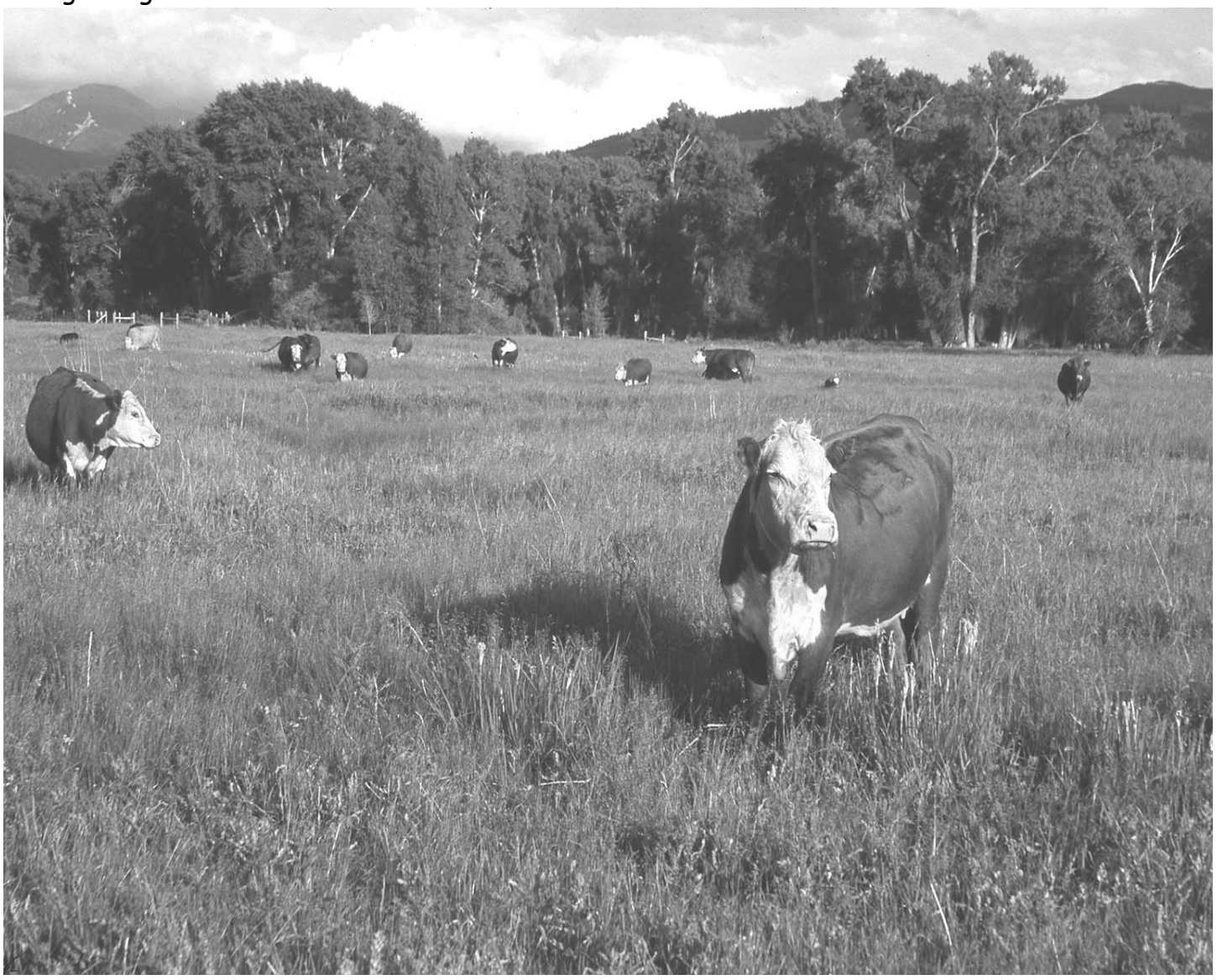
Repeated overgrazing will remove plant leaves and reduce root growth. Plants need green leaf material in order to photosynthesize. The products of photosynthesis (plant food) are allocated to both shoots and roots. If greater than 50% of the leaf material of perennial grasses is removed, root growth is reduced. In fact, utilization of 80-90% of leaf tissue stops grass root growth for 12-18 days. Therefore, *grass roots are larger and healthier on well managed rangelands.* Heavy utilization levels (>75%) also reduce the ability of grass shoots (tillers) to re-grow.

(Photo from a Canadian research station showing grass root growth in response to clipping)

MONITORING GRAZING UTILIZATION

Percent utilization is figured on the ***current year's forage production for the entire pasture.*** Measuring and mapping-out grazing utilization over an entire pasture or pastures will provide valuable information regarding % utilization and also livestock grazing patterns.

For example, you may find that one area of a pasture is over-utilized (ex. 80%) while another area is utilized lightly (ex. 15%). If this pattern is consistent year to year it would indicate a livestock distribution problem. You might need to plan and apply a conservation practice to modify livestock distribution patterns. You may find that the entire pasture is over-utilized, and you need to adjust stocking rates. Maybe the animals are over-utilizing certain plant species. If so, timing of grazing or stocking density may need to be adjusted, so that grazing animals will not be as selective.



(Photo courtesy of the USDA-Natural Resources Conservation Service)

PLANNED GRAZING SYSTEMS:

GRAZING SYSTEM: ***A grazing system is the arrangement of grazing and non-grazing periods during a grazing season.***

NOTE:

- A grazing system is only one management tool and cannot substitute for good livestock and forage management. Even well-designed grazing systems can fail when managed poorly.

- Grazing systems must be tailored to fit the package of resources you are working with.

A good grazing system....

1. ***Fulfills the producer's natural resource goals, as well as his/her goals for livestock and wildlife production.***

2. ***Maintains or improves range health by promoting vigor, production and reproduction and seedling establishment of the key desirable species.***

3. ***Increases grazing capacity and efficiency without harming the resources.***

4. ***Provides grazing animals with a constant forage supply throughout the grazing season.***

(Photo courtesy of the USDA-Natural Resources Conservation Service)

There are many different grazing systems. Grazing systems can be grouped into two basic categories:

1) CONTINUOUS

2) ROTATIONAL

CONTINUOUS GRAZING SYSTEMS

1. *Yearlong Seasonal Grazing*

- ✓ **Pastures are grazed continuously throughout the entire grazing season year after year.**

YEAR	ALL PASTURES
(ALL)	June through September

Continuous, yearlong seasonal grazing has few advantages in respect to rangeland health.

In a yearlong seasonal grazing system, grazing animal preferences and natural distribution patterns often create resource problems in areas of pastures where animals congregate, such as watering sources. This system is dependent upon stocking rates and water distribution. If stocking rates are well balanced to the resources, and water is ideally located, this system can work.

Continuous grazing requires minimal labor and inputs (fences, water developments. etc.). Sometimes this grazing system is the only option where water is difficult to develop and limits the ability of a producer to divide pastures with fences. *Continuous grazing systems promote high animal performance because livestock are able to selectively graze.*

2. *Repeated Seasonal Grazing*

- ✓ **Pastures are grazed at the same specific time in the grazing season year after year.**

YEAR	PAST. 1	PAST. 2	PAST. 3	PAST. 4
2000	June	July	August	September
2001	June	July	August	September
2002	June	July	August	September

A repeated seasonal grazing system incorporates rest (non-use), but does not consider the importance of *grazing deferment* to range plant health. For example, if a palatable cool-season plant in Pasture 2 is grazed each year in July, the developing seedhead may be grazed off every year, preventing the plant from producing seed.

A repeated seasonal grazing system is easy to implement because the rigidity of the system eliminates much of the on-site decision making. This type of grazing system requires more pastures, and watering facilities. Animal performance will be high, but associated costs will be higher.

ROTATIONAL GRAZING SYSTEMS

ROTATION: the movement of livestock from one pasture to another on a scheduled basis.

Grazing rotations provide plants with periods of non-use during the growing season.

ROTATIONAL GRAZING SYSTEMS USED IN MONTANA:

- ***COMPLEMENTARY***
- ***DEFERRED***
- ***RESTED***
- *INTENSIVE*

1. COMPLEMENTARY

Complementary grazing systems utilize a variety of forage resources to balance and extend the grazing season.

EXAMPLE OF A COMPLEMENTARY GRAZING SYSTEM:

SPRING GRAZING:	**FALL GRAZING:**
Crested wheatgrass or Smooth bromegrass	Russian wildrye *or* **Altai wildrye**
SUMMER GRAZING: *Native range:* Ex. Western wheatgrass, Green needlegrass, Needleandthread, Little bluestem, etc.	

Crested wheatgrass and Russian wildrye are cool season species commonly utilized for early spring and late fall grazing. Switchgrass is an example of a warm season grass that can be used as supplemental forage in late summer. These "complementary" species are usually fenced separately and then incorporated in the grazing rotation and provide rest to native range plants during critical periods in their growth cycle.

Cool season species such as crested wheatgrass and smooth bromegrass begin growing early in the spring, before most native plants break winter dormancy. These plants provide grazing animals with AUMs early in the season, giving slower growing native plants the opportunity to develop leaves and begin manufacturing food before a grazing event. Native, warm season range plants also need opportunities to grow and produce seed. Complementary forages, such as Russian wildrye or switchgrass can be utilized late in the season, while warm season pastures are rested.

A fall complementary grazing system may also benefit the nutrition of grazing animals. Late in the season, cool season grasses lose much of their nutritional value, while the nutritional requirements of a lactating grazing animal are still high. Some complementary forage species, such as Russian wildrye, keep their forage value into the fall and can be used to maintain the condition of grazing animals.

Complementary grazing systems require several pastures and additional management (monitoring/labor). Over time introduced stands will need to be maintained and/or improved.

(Photo courtesy of Rebecca Wolenetz)

2. DEFERRED

Deferred grazing systems provide for one or more pastures to be rested each grazing season until key desirable species have completed most of their annual growth and have set mature seed.

Deferred systems require two or more pastures so different pastures can be deferred each year.

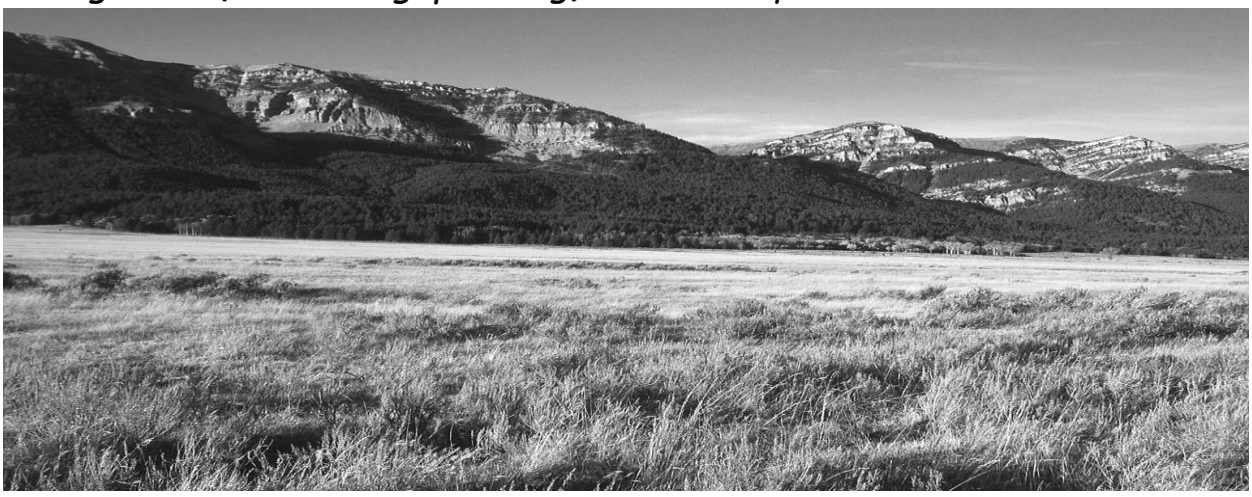
YEAR	PAST. 1	PAST. 2	PAST. 3	PAST. 4
2000	**June**	**July**	**August**	**September**
2001	**July**	**August**	**September**	**June**
2002	**August**	**September**	**June**	**July**
2003	September	June	July	August
2004	Start cycle over…			

In deferred grazing systems, no annual forage is left un-harvested.

A deferred grazing system increases seed production, enhances seedling establishment and decreases spring-time trampling and defoliation.

A moderate stocking rate should be utilized in a deferred grazing system. With moderate stocking, good animal performance is expected (equivalent to continuous systems).

Deferred grazing systems require several pastures, and more management(monitoring/planning). Labor requirements are moderate.



3. RESTED

This system incorporates a full year of rest for one or more pastures each year.

The cycle of rest is repeated on a regular basis. Within a cycle, the rest is rotated between pastures. Therefore, each year a different field is rested. In a four pasture scenario a quarter of the rangeland is rested each year. The rotation of the remaining grazing units is based on critical plant growth stages.

YEAR	PAST. 1	PAST. 2	PAST. 3	PAST. 4
2000	Spring	Summer	Fall	Rest
2001	Summer	Fall	Rest	Spring
2002	Fall	Rest	Spring	Summer
2003	Rest	Spring	Summer	Fall
2004	Start cycle over...			

A rest rotation grazing system requires more pastures, water facilities, and management (planning/labor).

(Rested pasture in Carter County - photo courtesy of Ekalaka NRCS)

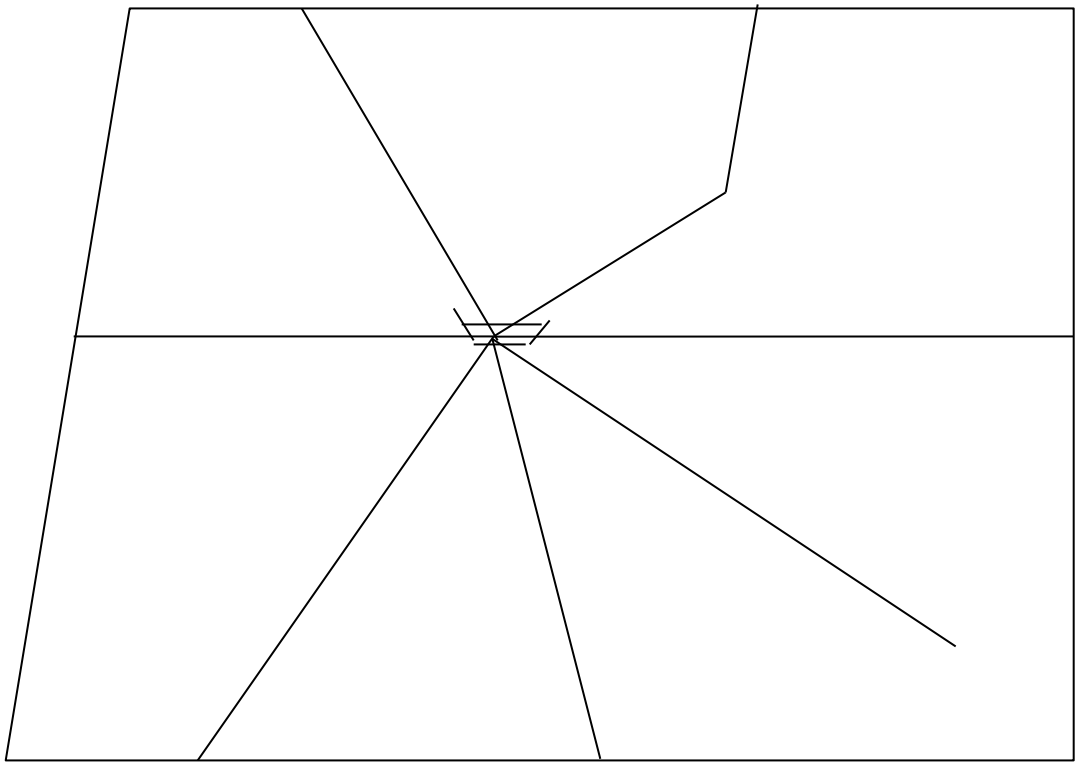
4. *INTENSIVE:*

Intensive grazing systems utilize high stocking densities to minimize selective grazing on preferred species.

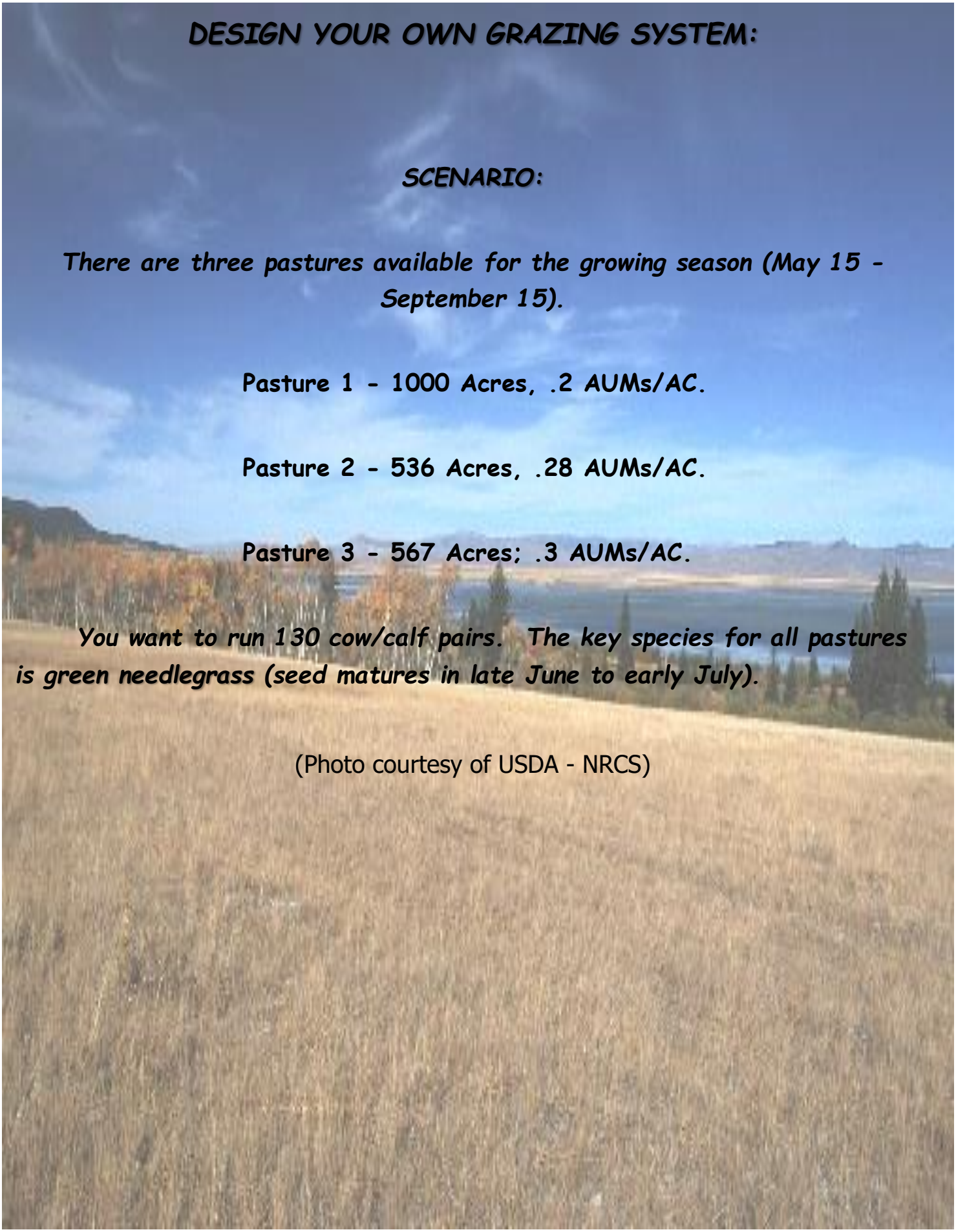
Time Controlled grazing **is one example of an intensive grazing system that is being applied in Montana. This rotational system requires a minimum of seven pastures, adequate water facilities and high levels of management, time and labor.**

Plant growth rates **are an important consideration when applying time controlled grazing. Careful, continuous monitoring is essential. When plants grow fast, the livestock are rotated rapidly. For example, livestock might be moved to a new pasture every 2-5 days. When plant growth slows, the rotations also slow (every 4-10 days). As a rule, plants grow rapidly in the spring and early summer. In late summer and early fall, plant growth is slow.**

Plant growth also influences the *grazing interval.* During rapid plant growth, plants will need approximately 30 days to recover before another grazing event. Sixty days are necessary when plant growth slows.



(This grazing unit has been cross-fenced into 7 pastures to facilitate time controlled grazing.)



DESIGN YOUR OWN GRAZING SYSTEM:

SCENARIO:

There are three pastures available for the growing season (May 15 - September 15).

Pasture 1 - 1000 Acres, .2 AUMs/AC.

Pasture 2 - 536 Acres, .28 AUMs/AC.

Pasture 3 - 567 Acres; .3 AUMs/AC.

You want to run 130 cow/calf pairs. The key species for all pastures is green needlegrass (seed matures in late June to early July).

(Photo courtesy of USDA - NRCS)

FACILITATING PRACTICES

STOCKWATER DEVELOPMENT:

Stockwater development is the most commonly used facilitating practice. Well-planned stockwater developments may improve rangeland health and increase stocking rates by improving forage utilization and livestock distribution. Increasing the availability of fresh water will also maximize livestock gains. There are many considerations when planning stockwater developments.

(Photo courtesy of the USDA-Natural Resources Conservation Service)

LOCATION OF WATER: The location of stockwater influences livestock movement, distribution and concentration patterns. If an inventory reveals that livestock are not grazing some areas of a pasture, or that utilization levels are not even, the location of water sources may be the actual problem.

DISTANCE TO WATER: The distance that livestock should travel to water varies with the topography or terrain.

Rough terrain (extremely steep).....1/2 mile

Level or relatively smooth terrain..... 1 mile

QUALITY AND QUANTITY: The quality and quantity of water also need to be considered. Stockwater should be clean and fresh to maximize animal performance. Daily water requirements vary with temperature, forage maturity and salt consumption.

GENERAL GUIDELINES FOR WATER QUANTITY:

Animal	*Water requirement (Gallons/Day)*
Horses	20 to 25
Beef Cattle	15 to 30
Sheep	2 to 2 ½
Elk	2 to 3
Deer	1 to 1 ½
Antelope	1 to 1 ½

WATER STORAGE: Water storage is factored into the design of water developments. There should be enough water in reserve to meet livestock requirements for three days. This guarantees that livestock will have water even if the supply is temporarily interrupted.

WATERING SYSTEMS: There are many types of livestock watering systems. Examples include: dams, pits, tanks, spring developments, wells and pipelines. Each system should be designed with consideration to management objectives, dependability, quantity, quality, livestock distribution and animal performance.

FENCING:

Fences enhance grazing management by controlling livestock distribution. Types of fence will vary depending on the class of livestock and the producer's goals. Fencing alternatives include barbed wire, woven wire, suspension, buck and pole, temporary electric and permanent electric.

LOCATION OF FENCES:

EXISTING FENCES:

Most fences in use today were designed properly with regard to topography, water distribution, animal management and maintenance. Other fences were designed poorly, perhaps because of legal boundaries, changes in management or difficult terrain. These fences often become problems. For example, a fence located on an extremely sandy hill may result in erosion when livestock trail up and down that line.

NEW FENCES:

When planning a new fenceline remember to consider planning objectives, livestock behavior, vegetation and topography. Ideally, similar vegetation and topography should be fenced together as a grazing unit. This practice promotes even patterns of livestock distribution and forage utilization. Uniformity of vegetation and topography is especially important when designing intensive grazing systems.

PASTURE SIZE:

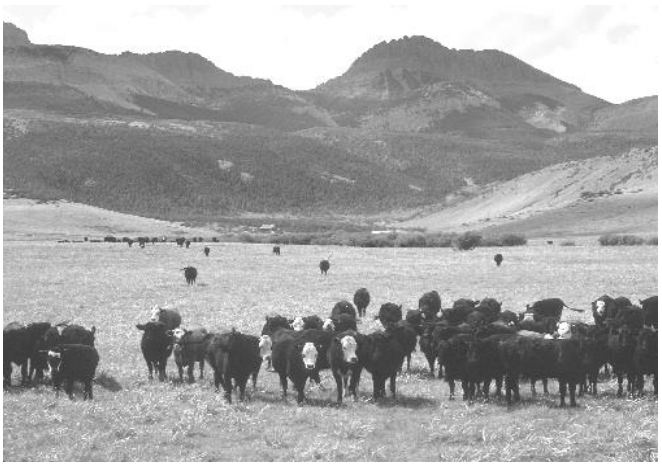
Consideration should also be given to pasture size. Pastures should be divided evenly according to carrying capacity. Grazing systems are easier to design and implement when the carrying capacity of individual pastures is relatively equal.

SALT AND MINERAL:

Salt and mineral are used to influence grazing distribution. These supplements should not be located near water sources. Strategically located salt and mineral can be used to improve livestock distribution and forage utilization within a grazing unit. Livestock patterns can be altered by gradually moving salt and mineral from one location to the next.

HERDING:

Herding can be an effective tool to distribute grazing animals throughout a pasture. However, this practice is time consuming and, therefore, not applicable to every operation.



(Photo courtesy of USDA-NRCS)

ACCELERATING PRACTICES

BRUSH MANAGEMENT

Brush species, such as big sagebrush, Rocky Mountain juniper and western snowberry, are a common component of the species composition of Montana rangelands.

However, if the brush canopy is too dense, other range plants occupying the same site have a difficult time competing for sunlight, nutrients and water. Consequently, rangeland health and productivity declines.

There are a number of techniques used to control dense stands of brush including:

1. chemical applications
2. mechanical treatments
3. fire
4. grazing management

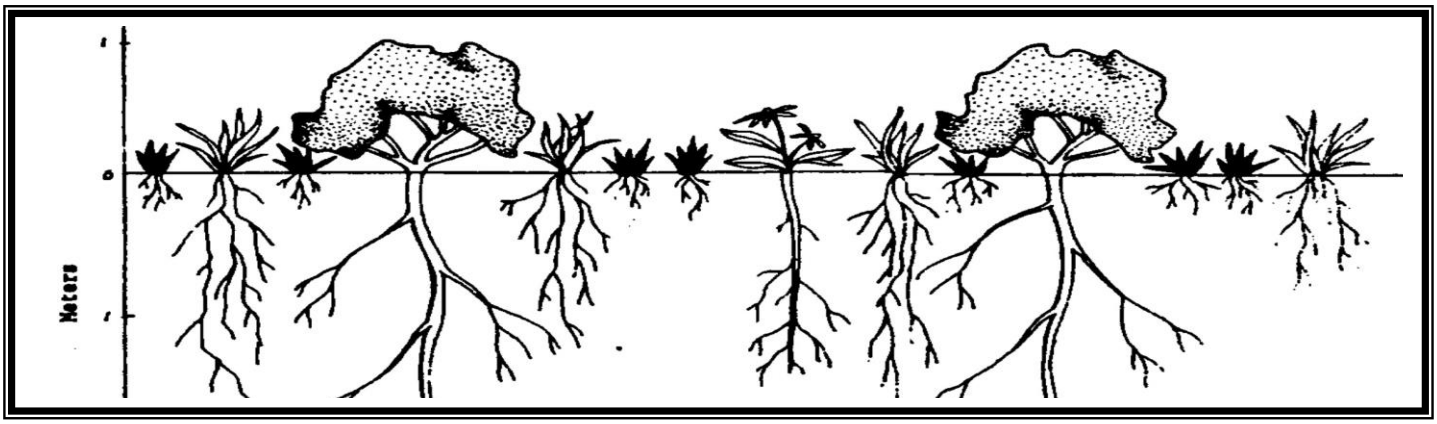
Key considerations in brush control are economics, soils, brush species and topography. *Control methods are not recommended unless the canopy cover of a brush species is greater than 20%.*

Proper grazing management is necessary after applying brush control practices. Grazing should be deferred during the growing season for two years following the practice so that desirable forage species have an opportunity to recover.

WEED MANAGEMENT

Weeds are a serious economic and ecological concern to Montana's rangeland. Healthy rangelands are key to controlling the spread of weeds. This is because vigorous range plants can compete with many weedy species for space, light, water and nutrients. Unfortunately, some noxious weeds will occupy a site regardless of management.

DISTRIBUTION OF PLANTS AND ROOTS WITHIN A HEALTHY RANGE SITE



Weedy species reproduce rapidly and often infest an entire ranch in just a few years. Therefore, early identification and management of these species is critical.

Weeds can be managed by biological and chemical control methods. Many insect species are available for biological control of noxious weeds such as leafy spurge and spotted knapweed. Sheep and goats utilize noxious weeds and provide another means of control. Biological agents function to restrict but not eradicate weedy species. The maximum level of control is achieved slowly over a number of years.

Chemicals are also used to manage weed populations, and can control and even eliminate some weedy species over a relatively short period of time. However, on large acreages, chemicals are generally cost prohibitive.

MECHANICAL RANGE RENOVATION

Techniques: *1) scalping, 2) ripping, 3) pitting, 4) waterspreading and 5) interseeding* are examples of mechanical range renovation techniques. These practices all enhance water conservation on rangelands.

SCALPING, RIPPING, PITTING

Disadvantages: include high fuel, time and labor costs.

Benefits: are generally short term.

When range condition decreases plants such as blue grama, buffalograss and dense clubmoss often increase in the species composition of a range site. These species form "mats" along the ground surface that prevent water infiltration.

Scalping, ripping and pitting enhance these range sites by disturbing the soil surface to a depth of three to six inches. After renovation, more water can penetrate the soil surface, resulting in increased water retention, less runoff and, therefore, less soil erosion. Water conservation positively influences forage production and quality.

The disturbance will decrease the percentage of "mat" forming plants in the species composition. There will be more sunlight, water and nutrients available to other rangeland plants. Rhizomatous grasses, such as western wheatgrass, often respond very well to a mechanical treatment.

(Photo courtesy of Ekalaka NRCS – Harrowing on sandy/shallow rangeland in Carter county)

WATERSPREADING AND INTERSEEDING

Waterspreading utilizes dikes, dams or ditches to divert water from natural drainages on to the surrounding rangeland. This practice increases forage production, reduces erosion and controls flooding. Waterspreading is generally applied to flat, low lying rangeland with high forage production potential.

Interseeding is applicable on sandy range sites where soil is prone to erosion and conventional seedbed preparation is not feasible. *This practice is used to modify, not replace, the existing species composition.*

Before seeding, an implement is used to create furrows and remove existing vegetation. Native species with high forage production are chosen for interseeding range sites. Grazing should be deferred for two years or until seedlings are successfully established.

PRESCRIBED BURNING:

Burning is the oldest renovation technique used to improve rangelands. Burning is widely applicable and can be implemented with minimal costs.

Benefits: increased forage palatability, improved forage utilization and livestock distribution, increased soil nutrient availability and control of undesirable plant species.

Disadvantages: The disadvantage of burning is the risk to other natural resources, human life and property.

Because of these risks, burning consultants are often hired to plan and implement prescribed burns. When a consultant is necessary, the costs associated with prescribed burning increase.

(Photo courtesy of Ekalaka NRCS)

Topography, weather, amount of fuel, erosion potential and wildlife need to be considered before burning is applied to rangelands.

Burning is often applied to rangelands infested with undesirable plant species. *Big sagebrush and other woody, non-sprouting plants are effectively removed by fire,* where as plants with deep rhizomes or taproots (silver sagebrush) are able to regenerate under the soil and re-establish. Burning is also used to renovate old, rank stands of grasses and legumes.

FERTILIZING

Low soil fertility results in poor forage production, changes in species composition and plants with low nutritive values. Fertilizers are often utilized to correct these deficiencies.

Nitrogen is the major limiting factor on most rangelands, followed by phosphorus. *The use of fertilizer is only feasible if the benefit gained is greater than the costs.*

Benefits include: increased forage and livestock production, increased forage quality, better livestock distribution and increased root growth.

Disadvantages include: costs, the potential for an increase in weedy species, increased palatability of poisonous plants and possible groundwater contamination.

Plant response to fertilizer is directly proportional to the availability of soil water. Therefore, the response will be greater in areas of high rainfall or during a wet year. Cool season plants respond more positively to range fertilization and benefit most from late fall applications.

After applying fertilizer, grazing must be managed carefully to prevent livestock from overusing these lush areas.

RANGE SEEDING

Range seeding should not be considered a substitute for good range management. Rangelands should only be re-seeded when range condition is poor and desirable native species have been entirely eliminated. Seeding is especially beneficial on old farm fields, rangelands infested with brush, high potential-low production sites, and critical erosion areas. This technique has proven most successful on sites with good soil, level topography and few physical obstacles.

Species seeded must be well adapted to the site. Many plant characteristics need to be considered including drought tolerance, soil texture adaptation, ease of establishment, longevity and species origin. Management objectives must also be considered in the selection process. Mixtures of species are often less risky, higher yielding, and provide for multiple use. Perennial grasses and legumes are the most common

Seedbed preparation is critical to the success of range seedings. Ideal seedbeds are firm (packed), free of clods and weed free.

Range seedings should occur before the growing season starts or in late fall, if favorable moisture condition exist. Grass and legume mixtures are usually seeded in the spring of the year. Species such as western wheatgrass must be seeded in the fall to ensure a vernalization process that will let the seed germinate in the spring.

Each species must be seeded at the proper seeding rate to ensure a good stand. Seeding rates are based on the purity and germination rates of the seed. To maximize both emergence and establishment a moderate seeding rate is recommended. Drills or broadcasters can be used to seed rangelands. Drills work best when a good seedbed has been prepared. The ideal drilling depth for most species is 1/4 to 3/4 inches and depends on seed size. Row spacing should be 7 to 14 inches. Broadcasting is most successful in rough terrain where conventional drilling is impractical.

New seedings need to be monitored carefully to evaluate the success of the stand. Grazing should be deferred for two growing seasons.

WHAT IS MONITORING?

Monitoring captures and documents changes in resource conditions and trends over time, and confirms whether or not current management practices are meeting management objectives.

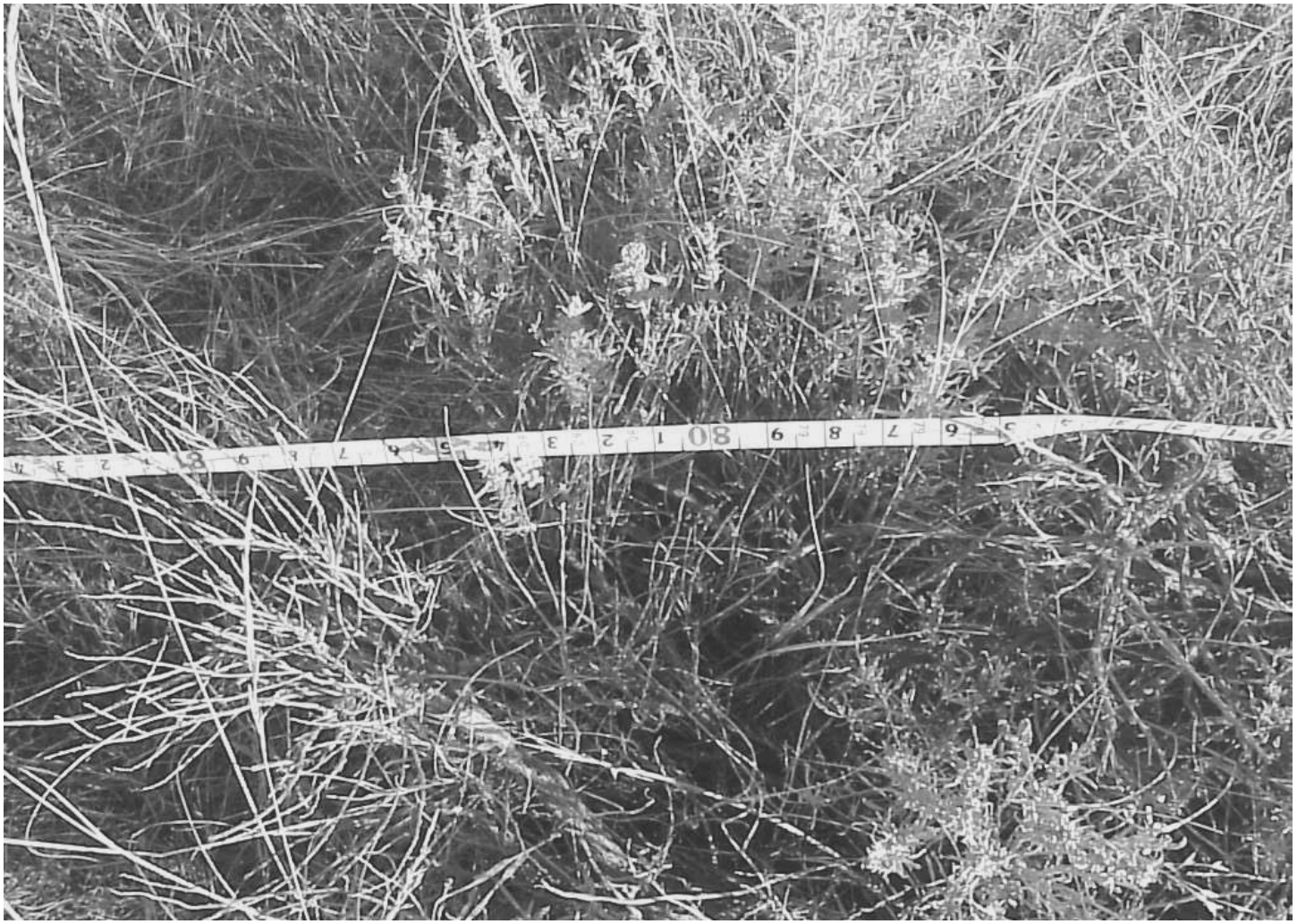
(Photo courtesy of USDA – Natural Resources Conservation Service)

TYPES OF MONITORING:

- BASELINE
- TREND
- IMPLEMENTATION
- UTILIZATION
- EFFECTIVENESS
- AND COMPLIANCE

COMPREHENSIVE MONITORING

Some types of monitoring are *comprehensive* and will require more time to implement and maintain. For example, people spend one or two days monitoring and mapping utilization levels on all pastures at the end of the grazing season each year.



(Photo courtesy of Ekalaka NRCS)

MONITORING FOR SPECIFIC OBJECTIVES

Monitoring for *specific objectives* is generally faster and easier. For example: What is the percent use on western wheatgrass in Pasture 1 on June 15th? This *"informal"* monitoring, conducted on a day to day or week by week basis throughout the grazing season, also provides valuable information.

TIME REQUIREMENT

Overall, *compiling and interpreting the information collected* in the monitoring process will be the largest time requirement involved in monitoring.

DETERMINING WHAT TO MONITOR:

Management objectives **will determine what plant, soil, animal and water attributes are considered in the monitoring process.**

RESOURCE ATTRIBUTES:

- **PLANT GROWTH RATESTURN-IN/TURN-OUT DATES**
- **PERCENT USE OF KEY PLANTS**
- **POUNDS OF FORAGE PRODUCED**
- **INSECT DAMAGE**
- **CLIMATIC CONDITIONS**
- **POISONOUS PLANTS**
- **PERCENT BARE GROUND**
- **AMOUNT OF LITTER ON THE SOIL SURFACE**
- **SOIL EROSION**
- **RECREATIONAL IMPACTS**
- **LIVESTOCK CONDITION**
- **WILDLIFE SIGHTINGS**
- **STREAMBANK STABILITY**
- **WATER TURBIDITY**

SELECTING A MONITORING LOCATION

Choosing the right location to monitor is fundamental to the success of any monitoring system. At least one monitoring site should be established in a "*key area*" in each grazing unit or pasture.

KEY AREAS

Key areas consist of specific ecological sites or groups of sites that are similar in vegetation, soils, range condition, topography and management.

(Photo courtesy of USDA-Natural Resources Conservation Service)

Key areas in uplands and riparians should be considered sites for monitoring. Limit the number of sites so that yearly sampling and monitoring is feasible.

SITE DOCUMENTATION

Be sure to document why the site was chosen and record the location for future reference.

The location of monitoring sites can be permanently marked (rebar, bolts, stakes, etc.), or documented with reference photographs.

(Photo courtesy of Ekalaka NRCS)

MONITORING TECHNIQES

There are six monitoring techniques officially endorsed by the MONTANA RANGELAND MONITORING PROGRAM:

1. KEEPING A DAILY JOURNAL

2. ESTIMATING GRASS UTILIZATION WITH PHOTO GUIDES

3. MEASURING RESIDUAL STUBBLE HEIGHT OF GRASSES AFTER GRAZING

4. MAPPING UTILIZATION

5. ESTIMATING STREAMBANK DISTURBANCE

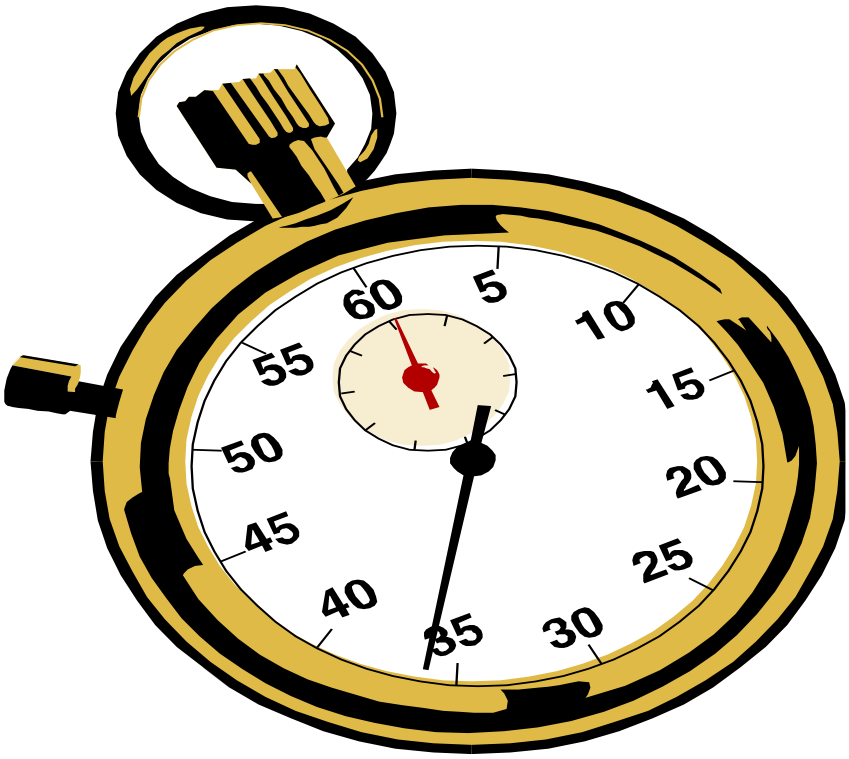
6. TAKING PHOTOGRAPHS AT PERMANENT LOCATIONS

REMEMBER…

Monitoring techniques can and should be tailored to meet management objectives.

TIMING

The timing of monitoring also depends on management objectives and can occur annually, seasonally, at the same date or plant stage each year, or at the end of the grazing season.



SOURCES OF TECHNICAL ASSISTANCE:

For additional assistance or information on rangeland monitoring contact your local NRCS, MSU Extension Service, DNRC, Bureau of Land Management or U.S. Forest Service offices.

Name:_____ Chapter:_____

Station 1 –PRACTICE FORM

Before you begin, ensure your Handout packet includes the following forms: (1) Dichotomous Key to Common Grasses (Blue), (2) Plant Identification sheet (Yellow), (3) Ecological Site Key (Orange),(4) Similarity Index forms (Pink)

PLANT IDENTIFICATION (Yellow Flags) 300 points (6 pts/plant. 1 pt/indicator)* Identify each plant by the plant ID numbers listed on your yellow Plant Identification Sheet. Write responses here, then transfer the information to the "**Plant Identification**" portion of your scantron sheet.

	Plant ID (Number)	Growth Form (P/A/B)	Origin (N/I)	Season (C/W/X)	Response (D/I/V/X)	Poisonous (Y/N)	Noxious (Y/N)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
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Name:_____ Chapter:_____

Station 2 – PRACTICE Form

Before you begin, ensure your Handout packet includes the following forms: (1) Dichotomous Key to Common Grasses (Blue), (2) Plant Identification sheet (Yellow), (3) Ecological Site Key (Orange), (4) Similarity Index forms (Pink)

PLANT ANATOMY (Blue Flags) 150 points (5 pts/plant. 25 pts/keyed plant)

* Circle your answers on this sheet, then transfer the answers to **"Exam 1"** on your scantron sheet.

		A	B	C	D
1	What is this plant's growth form?	Bunch	Sod-Forming	Decumbent	Prostrate
2	Which type of plant is this?	Grass	Grass-Like	Forb	Shrub
3	Which modified stem does this plant have?	Rhizome	Stolon	Corm	Bulb
4	Which leaf arrangement does this plant have?	Opposite	Alternate	Whorled	Fascicled
5	Which leaf attachment does this plant have?	Acauline	Sessile	Petiolate	Clasping
6	Which type of ligule does this plant have?	Absent	Membranous	Ciliate	
7	Which leaf type does this plant have?	Simple	Compound		
8	Which leaf venation does this plant have?	Arcuate	Palmate	Parallel	Pinnate
9	What shape are this plant's largest leaves?	Linear	Lanceolate	Ovate	Sagitate
10	Which seed head arrangement is shown here?	Spike	Raceme	Panicle	Umbel
11	Which leaf margin do these leaves have?	Serrate	Entire	Ciliate	Divided
12	What is the upper leaf surface on this plant?	Glabrous	Glandular	Pubescent	Pitted
13	What stem modification does this plant have?	Prickles	Spines	Tendrils	Thorns
14	This plant has which characteristic?	Auricles	Awns	Stipules	Catkins
15	What type of seed head does this plant have?	Corymb	Head	Thyrse	Umbel
16	What are the leaves' cross-sections?	Flat	Involute	Keeled	
17	Which compound leaf shape is shown here?	Palmate	Even-pinnate	Odd-Pinnate	Trifoliate
18	Does this plant have auricles?	Yes	No		
19	How many petals do this plant's flowers have?	None	Three	Five	> 5
20	How are the leaf sheaths configured?	Open	Overlapping	Closed	

21	Which plant does this key to?	A	B	C	D	E
22	Which plant does this key to?	A	B	C	D	E

Name:_____ Chapter:_____

Station 3 – PRACTICE Form

ECOLOGICAL SITE (Pink Flag) 20 points

*** Identify the correct ecological site using the orange Ecological Site Key in your handouts packet.**

*Write your answer below, then transfer the answer to the **"Ecological Sites"** portion of your scantron.*

Site 1: _____

SIMILARITY INDEX 20 points

*** Applying the Ecological Site identified above, use the pink Similarity Index Guide and Worksheet in your handouts packet to estimate percentages and calculate similarity.**

Place an X in the Site 1 column next to the correct Similarity Index below, then transfer the answer to the **"Similarity Index"** *portion of your scantron.*

	Site 1	Site 2
Excellent (76% – 100%)		
Good (51% – 75%)		
Fair (26% –50%)		
Poor (0% – 25%)		

STOCKING RATES 20 points

*** Using the pink Similarity Index Guide and the Rangeland Trend Table below, determine the trend and approximate stocking rate for the Similarity Index plot.**

Circle your answers on this sheet, then transfer them to the **"Stocking Rate"** section on your scantron sheet.

	Site 1	A	B	C
1	What is the overall rangeland trend?	Away From (< 2.6)	Not Apparent (2.6 – 3.6)	Away From (> 3.6)
2	If this pasture is stocked at a rate of 0.35 AUMs/acre, the stocking rate is:	Too high (overstocked)	About Right (+ or – 0.05)	Too low (understocked)

Rangeland Trend Indicator	Rating	
Apparent Change in Plant Composition		*Rate each indicator from 1 (low) to 5 (high) based on ecological site potential. Divide TOTAL by 5 to determine overall rangeland trend (average). Circle answer above.
Vigor of Key Species and Desirable Plants		
Litter and Residue Amount, Placement, and Accumulation		
Reproductive Capability of Key and Desirable Species		
Soil Surface Condition		
TOTAL		

TOTAL divided by 5 (Overall Rangeland Trend) = __

Name:_____ Chapter:_____

UTILIZATION (White Flag) 15 points

* Place an X in the Site 1 column next to the correct level of utilization, then transfer your answer to the box labeled "**Degree of Utilization**" on your scantron sheet.

	Site 1	Site 2	Site 3
None to Slight (0 – 20%) *Key areas are practically undisturbed. There is light use on key species in choice areas. Some key plants are not grazed.* 			
Moderate (21 – 40%) *Plants accessible to livestock are grazed. Use levels are low on less desirable plants*. 			
Full (41 – 60%) *All accessible plants have been grazed. Most key species are used fully. Increaser plants are also utilized. Less than 10% of total plant population is used more than 60%.*			
Close (61 –80%) *All accessible plants have been cropped. Key species are grazed 50% or more. Use evident on less desirable plants. Choice areas are overused.* 			
Severe (81 – 100%) *Key species almost completely used. Less desirable plants are carrying grazing load. Livestock trampling and trailing evident. Plants in poor health and lack vigor.*			

Name:_____ Chapter:_____

Station 4 – PRACTICE Form

ECOLOGICAL SITE (Pink Flag) 20 points

*** Identify the correct ecological site using the orange Ecological Site Key in your handouts packet.**

Write your answer below, then transfer the answer to the **"Ecological Sites"** portion of your scantron.

Site 2: _____

SIMILARITY INDEX 20 points

*** Applying the Ecological Site identified above, use the pink Similarity Index Guide and Worksheet in your handouts packet to estimate percentages and calculate similarity.**

Place an X in the Site 2 column next to the correct Similarity Index below, then transfer the answer to the **"Similarity Index"** *portion of your scantron.*

	Site 1	Site 2
Excellent (76% – 100%)		
Good (51% – 75%)		
Fair (26% –50%)		
Poor (0% – 25%)		

STOCKING RATES 20 points

*** Using the pink Similarity Index Guide and the Rangeland Trend Table below, determine the trend and approximate stocking rates for the Similarity Index plot.**

Circle your answers on this sheet, then transfer them to the **"Stocking Rate"** section on your scantron sheet.

	Site 2	A	B	C
1	What is the overall rangeland trend?	Away From (< 2.6)	Not Apparent (2.6 – 3.6)	Away From (> 3.6)
2	If this pasture is stocked at a rate of 0.35 AUMs/acre, the stocking rate is:	Too high (overstocked)	About Right (+ or – 0.05)	Too low (understocked)

Rangeland Trend Indicator	Rating
Apparent Change in Plant Composition	
Vigor of Key Species and Desirable Plants	
Litter and Residue Amount, Placement, and Accumulation	
Reproductive Capability of Key and Desirable Species	
Soil Surface Condition	
TOTAL	

*Rate each indicator from 1 (low) to 5 (high) based on ecological site potential.

Divide TOTAL by 5 to determine overall rangeland trend (average). Circle answer above.

TOTAL divided by 5 (Overall Rangeland Trend) = ___

Name:_____ Chapter:_____

UTILIZATION (White Flag) 15 points

** Place an X in the Site 2 column next to the correct level of utilization, then transfer your answer to the box labeled "***Degree of Utilization***" on your scantron sheet.*

	Site 1	Site 2	Site 3
None to Slight (0 – 20%) *Key areas are practically undisturbed. There is light use on key species in choice areas. Some key plants are not grazed.* 			
Moderate (21 – 40%) *Plants accessible to livestock are grazed. Use levels are low on less desirable plants*. 			
Full (41 – 60%) *All accessible plants have been grazed. Most key species are used fully. Increaser plants are also utilized. Less than 10% of total plant population is used more than 60%.* 			
Close (61 –80%) *All accessible plants have been cropped. Key species are grazed 50% or more. Use evident on less desirable plants. Choice areas are overused.* 			
Severe (81 – 100%) *Key species almost completely used. Less desirable plants are carrying grazing load. Livestock trampling and trailing evident. Plants in poor health and lack vigor.* 			

Name:_____ Chapter:_____

SITE 5 – PRACTICE FORM

STATION C — ECOLOGICAL SITE (Pink Flag) 20 points

*** Identify the correct ecological site using the yellow Ecological Site Key in your handouts packet.**

Write your answer below, then transfer the answer to the **"Ecological Sites"** portion of your scantron.

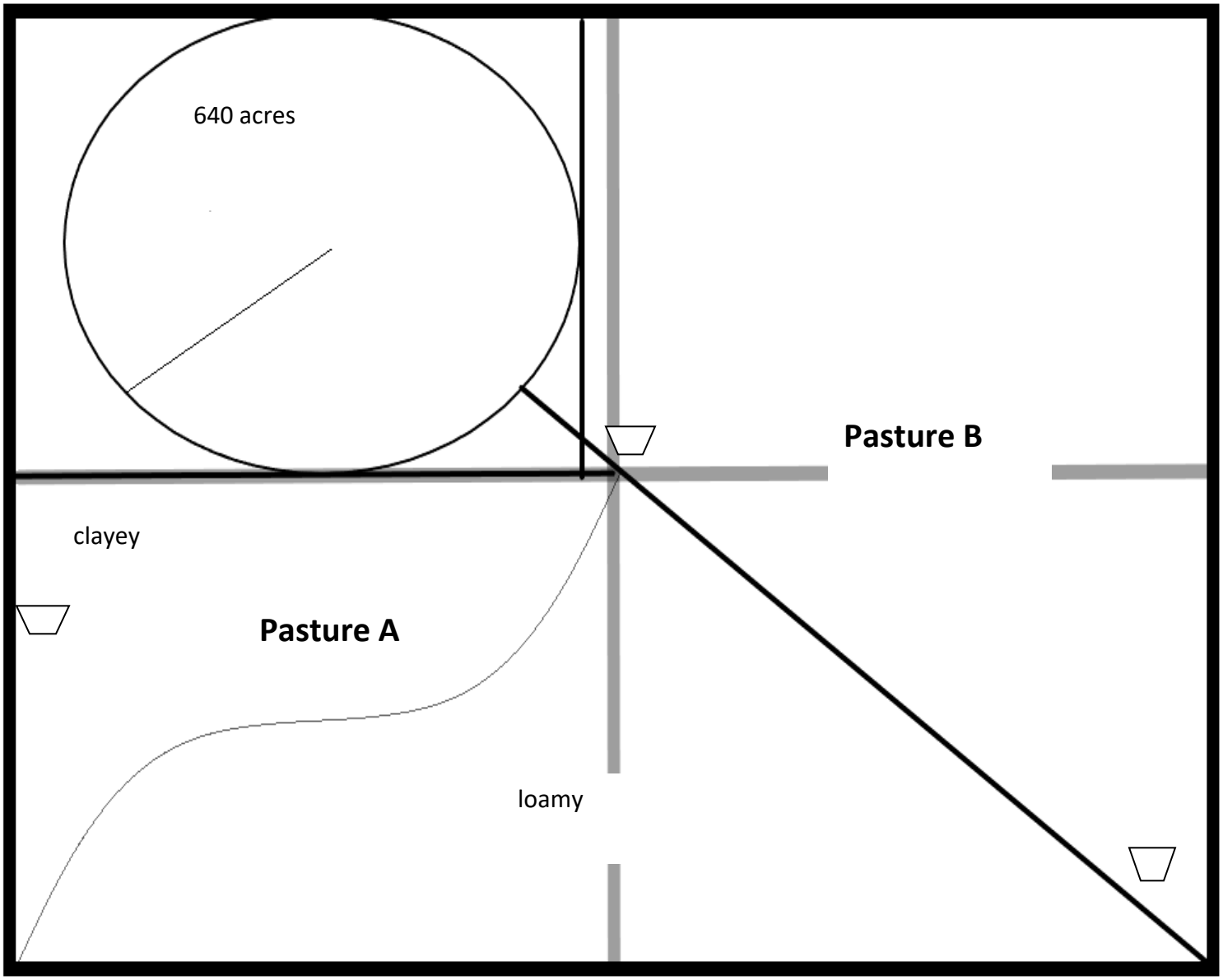
Site 3: _____

Name:_____ Chapter:_____

STOCKING RATES AND RANGE PLANNING (Purple Flag) 70 points

Rick Jones owns a cattle ranch in Beaverhead County named Lucky Falls Ranch. The ranch consists of four contiguous sections of land (2,560 acres). 640 acres are irrigated and used for hay production. The remaining 1,920 acres are in native rangelands. The 1,920 acres of rangelands are divided into two pastures: Pasture A, and Pasture B. Lucky Falls Ranch is located in the Rocky Mountains 10–14" Precipitation Zone.

The following map shows the ranch layout.



MANAGEMENT RECOMMENDATIONS	
I. Cross Fence	V. Mechanical Treatment
II. Develop Water	VI. Rest/Defer Livestock Grazing
III. Salt/Mineral Placement	VII. VII. No Management Recommendations
IV. Chemical or Biological Weed Control	

Name:_____ Chapter:_____

* Answer the following questions using the narrative, map, and management recommendations table above. Circle the correct answers below, then transfer the answers to the "**Exam 2**" on your scantron sheet.

	Exam 2	**A**	**B**	**C**	**D**	**E**
1	Pasture B consists of 960 acres that is Limy and in good condition (SI 65%). How many AUMs are available in Pasture B?	182	240	190	57	183
2	Pasture A consists of 960 acres, 500 of which are loamy in fair condition and 460 of which are clayey in excellent condition. How many total AUMs does Rick have in Pasture A?	125	256	179	304	372
3	Rick uses Pasture B for five months out of the year. If Rick uses the pasture for cow/calf pairs, how many pairs can he graze over the five-month period?	36	21	37	45	70
4	How many AUMs does Rick need for his 5 head of horses?	100	6.25	75	60	98
5	Although Rick has ample forage in pasture B, every year he winds up moving his cattle out of the pasture to avoid damage to the subirrigated lands. Based on the map shown above, what can Rick do to better utilize Pasture B?	I.	II.	IV.	VII.	I., II., & III.
6	300 antelope graze on Lucky Falls Ranch's irrigated hayland for three months in the fall and winter. How many AUMs must Rick allow for antelope grazing in determining available forage?	275	300	180	900	228
	STOCKING RATE ROUNDING RULES FOR CONTESTS: ***1. Round stocking rates to the nearest whole number. For example, 5.277 AUMs/acre would be rounded to 5 AUMs per acre.*** ***2. If you are figuring numbers of animals, round DOWN to the nearest whole number. For example, calculation of a number of yearlings is rounded from 333.3 or 333.6 to 333.*** ***3. Round AUM calculations to the nearest whole number.*** ***4. Round months to the nearest whole number.***					

Name:_____ Chapter:_____

CONSERVATION MANAGEMENT (Orange Flag) 60 points

* Circle the correct answers below, then transfer the answers to the "**Conservation Management**" portion of your scantron sheet.

		A	B	C	D
1	Does this site have abundant sagebrush in different size and age classes?	Yes	No		
2	Does this site have a rich bio-diversity (>3 species of perennial forbs and >3 species of perennial grasses)?	Yes	No, <3 spp. forbs	No, <3 spp. grasses	No, <3 spp. forbs AND grasses
3	What shape are the sagebrush at this site? (What quality nesting habitat?)	Spreading (Excellent)	Mixed spreading & columnar (Fair)	Columnar (Poor)	Little to no sage-brush (None)
4	Is cheatgrass present in the marked area?	No	Yes, trace amounts (<1%)	Yes, abundant (>1%)	
5	Conifer thinning should be considered when conifers reach what level of canopy cover in sage-grouse habitat?	1%	2%	4%	25%
6	Which of the following are human disturbances that may affect sage-grouse use on a landscape?	Grazing	Mining/Oil Development	Roads/ Powerlines	All of the Above
7	Fence lines may pose a risk to sage-grouse that cross mid-flight.	True	False		
8	What amount of sagebrush canopy cover is needed for sage-grouse nesting habitat?	1-5%	5-10%	15-25%	75-100%
9	Sage-grouse brood-rearing habitat has open sagebrush canopy cover with abundant forbs and insects.	True	False		

Name:_____ Chapter:_____

PLANT IDENTIFICATION

GRASSES

101	basin wildrye	*Leymus cinereus*
102	blue grama	*Bouteloua gracilis*
103	bluebunch wheatgrass	*Pseudoroegneria spicata*
104	bottlebrush squirreltail	*Elymus elymoides*
105	cheatgrass	*Bromus tectorum*
106	crested wheatgrass	*Agropyron cristatum*
107	foxtail barley	*Hordeum jubatum*
108	green needlegrass	*Nassella viridula*
109	Idaho fescue	*Festuca idahoensis*
110	Indian ricegrass	*Achnatherum hymenoides*
111	inland saltgrass	*Distichlis spicata*
112	Japanese brome	*Bromus japonicus*
113	Kentucky bluegrass	*Poa pratensis*
114	needle-and-thread	*Hesperostipa comata*
115	oatgrass	*Danthonia spp.*
116	plains muhly	*Muhlenbergia cuspidata*
117	plains reedgrass	*Calamagrostis montanensis*
118	prairie junegrass	*Koeleria macrantha*
119	prairie sandreed	*Calamovilfa longifolia*
120	red threeawn	*Aristida purpurea*
121	sand dropseed	*Sporobolus cryptandrus*
122	Sandberg bluegrass	*Poa secunda*
123	slender wheatgrass	*Elymus trachycaulus*
124	smooth brome	*Bromus inermis*
125	thickspike wheatgrass	*Elymus lanceolatus*
126	timothy	*Phleum pratense*
127	tufted hairgrass	*Deschampsia cespitosa*
128	western wheatgrass	*Pascopyrum smithii*

GRASSLIKES

129	baltic rush	*Juncus balticus*
130	needleleaf sedge	*Carex duriuscula*
131	threadleaf sedge	*Carex filifolia*

FORBS

132	American vetch	*Vicia americana*
133	annual sunflower	*Helianthus annuus*
134	arrowleaf balsamroot	*Balsamorhiza sagittata*
135	bastard toadflax	*Commandra umbellata*
136	biscuitroot	*Lomatium spp.*
137	blanketflower	*Gaillardia aristata*
138	blue flax	*Linum lewisii*
139	buckwheat	*Eriogonum spp.*
140	Canada thistle	*Cirsium arvense*
141	cinquefoil	*Potentilla spp.*
142	cudweed sagewort	*Artemisia ludoviciana*
143	curlycup gumweed	*Grindelia squarrosa*
144	dense clubmoss	*Selaginella densa*
145	dotted gayfeather	*Liatris punctata*
146	evening primrose	*Oenothera spp.*
147	field chickweed	*Cerastium arvense*
148	fleabane	*Erigeron spp.*
149	hairy goldenaster	*Heterotheca villosa*
150	harebell	*Campanula spp.*

FORBS – Continued

151	Hood's phlox	*Phlox hoodii*
152	houndstongue	*Cynoglossum officinale*
153	leafy spurge	*Euphorbia esula*
154	loco weed	*Oxytropis spp.*
155	low larkspur	*Delphinium bicolor*
156	lupine	*Lupinus spp.*
157	manyflowered aster	*Symphyotrichum ericoides*
158	meadow deathcamas	*Zygadenus venenosus*
159	milkvetch	*Astragalus spp.*
160	miner's candle	*Cryptantha celosioides*
161	Missouri goldenrod	*Solidago missouriensis*
162	penstemon	*Penstemon spp.*
163	prairie coneflower	*Ratibida columnifera*
164	prairie onion	*Allium spp.*
165	prairiesmoke	*Geum triflorum*
166	purple prairieclover	*Dalea purpurea*
167	pussytoes	*Antennaria spp.*
168	salsify	*Tragopogon dubius*
169	scarlet gaura	*Gaura coccinea*
170	scarlet globemallow	*Sphaeralcea coccinea*
171	segolily mariposa	*Calochortus nuttallii*
172	spotted knapweed	*Centaurea maculosa*
173	sticky geranium	*Geranium viscosissimum*
174	wavyleaf thistle	*Cirsium undulatum*
175	western yarrow	*Achillea millefolium*
176	yampah	*Perideridia gairdneri*
177	yellow owl's clover	*Orthocarpus luteus*
178	yellow sweetclover	*Melilotus officinalis*

CACTI

179	pincushion cactus	*Escobaria spp.*
180	plains pricklypear	*Opuntia polyacantha*

HALF-SHRUBS, SHRUBS, & TREES

181	big sagebrush	*Artemisia tridentata*
182	broom snakeweed	*Gutierrezia sarothrae*
183	chokecherry	*Prunus virginiana*
184	creeping juniper	*Juniperus horizontalis*
185	fringed sagewort	*Artemisia frigida*
186	Gardner's saltbush	*Atriplex gardneri*
187	gray horsebrush	*Tetradymia canescens*
188	green rabbitbrush	*Chrysothamnus viscidiflorus*
189	ponderosa pine	*Pinus ponderosa*
190	quaking aspen	*Populus tremuloides*
191	Rocky Mountain juniper	*Juniperus scopulorum*
192	rubber rabbitbrush	*Ericameria nauseosa*
193	serviceberry	*Amelanchier alnifolia*
194	shrubby cinquefoil	*Dasiphora fruticosa*
195	silver sagebrush	*Artemisia cana*
196	skunkbush sumac	*Rhus trilobata*
197	soapweed	*Yucca glauca*
198	western snowberry	*Symphoricarpos occidentalis*
199	wild rose	*Rosa spp.*
200	winterfat	*Krascheninnikovia lanata*

Dichotomous Key to Common Grasses

** If you arrive at "try again," you made a mistake. Start over and work through the key again.*

1a. Plants annual

2a. Leaf Sheaths hairy and closed.

3a. 7-12 inflated florets per spikelet. Lemmas are awned. Panicle seedheads. Small, winter annual ..... **Try again**

3b. 3-6 florets per spikelet. Lemmas awned. Panicle seedheads. Small, winter annual. Turns reddish-purple when ripe. ..... **A**

2b. Leaf sheaths are not very hairy and split open.

4a. 5-17 florets per spikelet. Lemmas have short awns. Panicle seedhead. Very small plant that may grow solitary or in a bunch ..... **Try again**

1b. Plants perennial (look for last year's leaves and stems) stems hollow and jointed, round, blades flat, folded or rolled, not in ranks of three.

5a. Plants in bunches, not mat-forming.

6a. Seedhead inflorescence is a spike. Spikelets crowded, strongly overlap. Leaf sheaths open but overlapping. Leaf blades flat and vary in width. Leave are bright green. Stems grow upright. Glumes and lemmas taper into awns ..... **B**

6b. Seedhead inflorescence is a spike. Spikelets not crowded, barely overlap. 4-8 florets per spikelet. Lemma awns bend to 90 degree angle when mature. Leaf sheaths open, old sheaths persistent. Auricles well developed, reddish-colored. ..... **Try again**

5b. Plants with rhizomes, stolons or "mat-forming" habits, NOT in bunches.

7a. Seedhead inflorescence is a spike, spike-like raceme or has spike-like branches.

8a. Auricles present. Lemmas not hairy. Leaf blades very rough on upper surface and margins. Leaves blue. Auricles claw-like and often "purple". Glumes unequal. Spikelets overlap by ½ of spikelet length. ..... **C**

8b. Auricles not present. Plants form dense mats, plants without stolons. Spicate branches curve "grandma's eyebrows" and consist of 30-40 spikelets. Spikelets have one perfect floret and may have several sterile florets above. Lemmas are awned. Leaf collars are hairy, but not leaf blades. Plants have short rhizomes ..... **Try again**

7b. Seedhead inflorescence is a panicle.

9a. Leaves with "railroad tracks". Leaf blades soft, folded or flat with boat-shaped tips and paired, parallel mid-grooves "railroad tracks". Ligule short, flat (truncate). "Cobwebs" at the base of the spikelet ..... **D**

9b. **Leaves without "railroad tracks".** Leaf blades with an "M". Leaves large, soft and flat. Membranous ligule. Large panicle seedheads. Glumes shorter than spikelet. Many florets per spikelet. Awn-tipped lemmas ..... **E**

ECOLOGICAL SITE KEY (SOUTHWEST MONTANA)

** Mark the correct ecological site for each station on this form, then transfer your answer to the box labeled "**Ecological Sites**" on your scantron sheet.*

To identify an ecological site, first identify the correct group by determining which one of these three questions can be answered "yes."

A. Does the site receive additional moisture from overflow or does it have groundwater close to the surface (within 40 inches) at least part of the growing season? If yes, go to **GROUP I**; if no, proceed to the next sentence.

B. Is the soil depth at least 20 inches from the surface with no sign of significant additional moisture? If yes, go to **GROUP II**; if no, go to next sentence.

C. Is the soil depth less than 20 inches to bedrock? If yes, go to **GROUP III**; if no, start over.

GROUP I **ECOLOGICAL SITES THAT RECEIVE ADDITIONAL MOISTURE**

1. Is the groundwater within 20" to 40" of the surface at least during part of the growing season?

If YES, the ecological site is …..……..**[10]** SUBIRRIGATED (Sb) If NO, go to next sentence.

2. Is there additional moisture from runoff of nearby slopes or stream overflow?

If YES, the ecological site is ……..……..……..…..**[11]** OVERFLOW (Ov) If NO, start over. Check if you are in the correct group and try again.

GROUP II **SOILS AT LEAST 20 INCHES DEEP – NO ADDITIONAL WATER**

1. Is the surface layer strongly or violently effervescent in surface mineral 4"? Lime concentration increasing with depth (typically limestone parent material.)

If YES, the ecological site is ...……..……..……**[12]** LIMY (Ly) If NO, go to next sentence.

2. Is the surface layer a coarse to fine sandy loam texture, and water drains through fairly fast; nearly level to strongly sloping landscapes (<15% slopes)?

If YES, the ecological site is ……..……..……..……**[13]** SANDY (Sy) If NO, go to next sentence.

3. Is the surface layer loam or silt loam; on level to rolling (0-15%) slopes?

If YES, the ecological site is ……..……..……..…**[14]** LOAMY (Lo) If NO, go to next sentence.

4. Is the surface layer a granular clay surface, clayey subsoil with blocky or prismatic structure, (<15% slopes)?

If YES, the ecological site is ……..……..……..…… **[15]** CLAYEY (Cy) If NO, start over. Check if you are in the correct group and try again.

GROUP III **SOILS LESS THAN 20 INCHES DEEP**

1. Is the soil depth between 10" and 20" over granite, sandstone, siltstone, or shale?

If YES, the ecological site is …..……..……..……**[16]** SHALLOW (Sw) If no, go to next sentence.

2. Is the soil less than 10" to hard bedrock (except for cracks in rock)?

If YES, the ecological site is ……..……**[17]** VERY SHALLOW (VSw) If NO, start over. Check if you are in the correct group and try again.

SIMILARITY INDEX GUIDE

Ecological Sites	Rocky Mountains 10-14" Precipitation Zone															
	Group I				Group II								Group IIII			
	Sb		Ov		Ly		Sy		Lo		Cy		Sw		VSw	
	%	#/ac	%	#/ac	%	#/ac	%	#/ac	%	#/ac	%	#/ac	%	#/ac	%	#/ac
Grasses & Grasslikes																
Basin wildrye					0	0			10	210						
Bluebunch wheatgrass					65	910			55	1155						
Slender Wheatgrass					3	42			5	105						
Green needlegrass					0	0			10	210						
Idaho fescue					5	70			10	210						
Spike fescue					10	140			5	105						
Needle and thread					15	210			5	105						
Cusick's bluegrass					3	42			5	105						
Columbia needlegrass					0	0			10	210						
Prairie junegrass					5	70			5	105						
Plains reedgrass					3	42			5	105						
Sandberg bluegrass					3	42			5	105						
Blue grama					3	42			0	0						
Western or Thickspike Wheatgrass					10	140			5	105						
Other native grasses and grasslikes					10	140			2	42						
Maximum Grasses Allowed					85	1190			75	1575						
Forbs																
Maximum Forbs Allowed					10	140			10	210						
Shrubs																
Fringed Sagewort					5% Not more than 45# each or 70# total shrubs	Not more than 45# each or 70# total shrubs			15% Nor more than 105# each or 315# total shrub	Not more than 105# each or 315# total shrub						
Big Sagebrush																
Rubber rabbitbrush																
Skunkbush sumac																
Spineless horsebrush																
Shrubby cinquefoil																
Snowberry																
Winterfat																
Other native shrubs																
Maximum Shrubs Allowed					5	70										
Total Production @ 17"					1400				2100							

Initial Stocking Rate Factor									
Hayland aftermath 0.4 AUMS/ac	**Sb**	**Ov**	**Ly**	**Sy**	**Lo**	**Cy**	**Sw**	**VSw**	
AUM/ac	**Excellent**	**1.4**	**.6**	**.25**	**.4**	**.42**	**.39**	**.26**	**.28**
	Good	**1.0**	**.45**	**.19**	**.32**	**.34**	**.3**	**.18**	**.22**
	Fair	**.6**	**.3**	**.1**	**.21**	**.25**	**.2**	**.12**	**.12**
	Poor	**.2**	**.1**	**.06**	**.09**	**.1**	**.1**	**.06**	**.05**

Animal	AUE	lbs/day	lbs/month	Animal	AUE	lbs/day	lbs/month
Cow, dry	.92	27.6	842	Goat, mature	.15	4.5	137
1000 lb. Cow, with calf	1.00	30	915	Kid, 1 year old	.10	3	92
Bull, mature	1.35	40.5	1235	Deer, white-tailed, adult	.15	4.5	137
Cattle, 1 year old	.60	18	549	Deer, mule, adult	.20	6	183
Cattle, 2 years old	.80	24	732	Elk, mature	.60	18	549
Horse, mature	1.25	37.5	1144	Antelope, mature	.20	6	183
Sheep, mature	.20	6	183	Bison, mature	1.00	30	915
Lamb, 1 year old	.15	4.5	137	Sheep, bighorn, mature	.20	6	183

SIMILARITY INDEX WORKSHEET (Site 1)

Plant List (A)	Present Plant Composition		Historic Climax Plant Community		
GRASSES and GRASSLIKES	**(B)** Percent Composition	**(C)** Pounds per Acre	**(D)** Percent Composition	**(E)** Pounds per Acre	**(F)** Allowable Pounds
TOTAL GRASSES	%		%		%
FORBS and CACTUS					
TOTAL FORBS	%		%		%
SHRUBS and TREES					
TOTAL SHRUBS	%		%		%
TOTAL ALL SPECIES	100%		–		

Similarity Index:
(Column F total, divided by Column E total)

SIMILARITY INDEX WORKSHEET (Site 2)

Plant List (A)	**Present Plant Composition**		**Historic Climax Plant Community**		
GRASSES and GRASSLIKES	**(B)** Percent Composition	**(C)** Pounds per Acre	**(D)** Percent Composition	**(E)** Pounds per Acre	**(F)** Allowable Pounds
TOTAL GRASSES	%		%		%
FORBS and CACTUS					
TOTAL FORBS	%		%		%
SHRUBS and TREES					
TOTAL SHRUBS	%		%		%
TOTAL ALL SPECIES	100%		–		

Similarity Index:
(Column F total, divided by Column E total)

Rangeland Trend Factors (*use with worksheet*)

4. ***Find a representative area to look at within the range site you wish to evaluate.***
5. ***Walk around to get a good idea of what the plant community and soil surface look like.***
6. ***Rate the following factors from 1 to 5.***
   - ***1 is very low compared to Historic Climax Plant Community.***
   - ***5 is very High compared to Historic Climax Plant Community.***
   - **3 is average compared to Historic Climax Plant Community.**

F. Apparent Change in Plant Composition:

5 = All major plant species in HCPC are present and in proper proportions.
3 = A mixture of both native plants, with some weeds or undesirable plants present.
1 = Plant community is composed mostly of invader species and weeds.

G. Vigor of Key Species and Desirable Plants:

5 = Native plant species are of good size for their age and appear healthy.
3 = Native plants appear generally healthy, but exhibit some stress from grazing or other disturbance.
1 = Native plants are very small in size, appear unhealthy, and may be dead or dying.

H. Litter and Residue Amount, Placement and Accumulation:

5 = A large amount of plant litter is evident and in place on soil surface.
3 = Plant residue is average for the site.
1 = Plant residue is absent, much open space and bare ground are present.

I. Reproductive Capability of Key and Desirable Species:

5 = Native plants are reproducing at an appropriate rate, and young plants are visible for dominant plant species.
3 = Plant reproduction is average for the site.
1 = Plant reproduction of native plants is not occurring. There are a high number of seedlings and young plants of weeds or undesirable plants.

J. Soil Surface Condition:

5 = Soil surface horizons are in tact, with no evidence of soil erosion taking place.
3 = Some soil loss has taken place, some plant pedestals are occurring.
1 = Severe soil loss has taken place. Soil surface may be gravel pavement or bare ground. Plant pedestals are very evident.

(Photo courtesy of the Phillips County Range Committee)

Rangeland Trend Worksheet

RANGELAND TREND INDICATORS: Rate each factor from a low of 1 to a high of 5 based on ecological site potential.					
	1	**2**	**3**	**4**	**5**
A. Apparent Change in Plant Composition					
E. Vigor of Key Species and Desirable Plants					
F. Litter and Residue Amount, Placement, and Accumulation					
G. Reproductive Capability of Key and Desirable Species					
E. Soil Surface Condition					
TOTAL:					

TOTAL SCORE: DIVIDED BY 5 = AVERAGE SCORE:

OVERALL RANGELAND TREND RATING: (Toward or away from historic climax plant community)

Circle One:

TOWARD (AVE > 3.6) **NOT APPARENT (AVE 2.6 - 3.6)**

AWAY FROM (AVE < 2.6)

Rangeland Health Worksheet

What is Rangeland Health?

- The degree to which the integrity of the soil, vegetation, water, air, and ecological processes of the rangeland ecosystem are balanced and sustained.
- Rangeland health looks at three broad categories of ecosystem function:
  - ✓ Soil/Site Stability
  - ✓ Plant/Biotic Integrity
  - ✓ Watershed Function

Why Do We Measure Rangeland Health?

- To evaluate the rangeland ecosystem to see if it is healthy and sustainable.
- To be aware of warning signs that indicate the rangeland is declining in health.
- To help us see if we are meeting our goals.

TABLE 1: A CHECKLIST OF USEFUL INDICATORS FOR JUDGING RANGELAND HEALTH. (Prepared by Jeff Mosley, Extension Range Management Specialist, Montana State University, Bozeman, 8/97.

	YES	NO
1. Are desirable forage species abundant?		
2. Are noxious weeds rare or absent?		
3. Is there a variety of species of perennial plants?		
4. Are the plants well distributed across the site?		
5. Is mulch present and well distributed across the site?		
6. Are all age classes of plants (seedlings, young, mature) present?		
7. Are preferred forage species accessible to grazing/browsing animals?		
8. Do preferred forage species have adequate residue remaining after grazing?		
9. Are lowly palatable plants grazed lightly or not at all?		
10. Is gully erosion minimal or absent?		
11. Is soil movement minimal?		
12. Is at least 70% of the ground covered by a combination of plants, mulch, and rock?		
13. Are plant pedestals rare or absent?		
14. Do lichen lines on rocks extend to the soil surface?		
15. Is the mulch becoming incorporated into the soil?		

If you answered "Yes" to most of these questions, your rangeland exhibits good rangeland health.

Montana Range
Form #602MT-1

Incorrect Marks Correct Mark

Team Name / Additional Info

Team #

Last Name

First Name

Code

Similarity Index

one answer per site (make 4 total marks)	1 Site	2 Site	3 Site	4 Site
Excellent (76% - 100%)	1	2	3	4
Good (51% - 75%)	1	2	3	4
Fair (26% - 50%)	1	2	3	4
Poor (0% - 25%)	1	2	3	4

Degree of Utilization

one answer per site (make 4 total marks)	1 Site	2 Site	3 Site	4 Site
None	1	2	3	4
Moderate	1	2	3	4
Full	1	2	3	4
Close	1	2	3	4
Severe	1	2	3	4

Stocking Rates

Site 1	1	A B C D E	one answer per row (make 8 total marks)
	2	A B C D E	
Site 2	1	A B C D E	
	2	A B C D E	
Site 3	1	A B C D E	
	2	A B C D E	
Site 4	1	A B C D E	
	2	A B C D E	

Management Recommendations

	one answer per site (make 4 total marks)			
	1 Site	2 Site	3 Site	4 Site
I.	1	2	3	4
II.	1	2	3	4
III.	1	2	3	4
IV.	1	2	3	4
V.	1	2	3	4
VI.	1	2	3	4

Ecological Sites

write and bubble the code for each site (make 8 total marks)

Site 1 | Site 2 | Site 3 | Site 4

Exam 1

1	A	B	C	D	E	26	A	B	C	D	E
2	A	B	C	D	E	27	A	B	C	D	E
3	A	B	C	D	E	28	A	B	C	D	E
4	A	B	C	D	E	29	A	B	C	D	E
5	A	B	C	D	E	30	A	B	C	D	E
6	A	B	C	D	E	31	A	B	C	D	E
7	A	B	C	D	E	32	A	B	C	D	E
8	A	B	C	D	E	33	A	B	C	D	E
9	A	B	C	D	E	34	A	B	C	D	E
10	A	B	C	D	E	35	A	B	C	D	E
11	A	B	C	D	E	36	A	B	C	D	E
12	A	B	C	D	E	37	A	B	C	D	E
13	A	B	C	D	E	38	A	B	C	D	E
14	A	B	C	D	E	39	A	B	C	D	E
15	A	B	C	D	E	40	A	B	C	D	E
16	A	B	C	D	E	41	A	B	C	D	E
17	A	B	C	D	E	42	A	B	C	D	E
18	A	B	C	D	E	43	A	B	C	D	E
19	A	B	C	D	E	44	A	B	C	D	E
20	A	B	C	D	E	45	A	B	C	D	E
21	A	B	C	D	E	46	A	B	C	D	E
22	A	B	C	D	E	47	A	B	C	D	E
23	A	B	C	D	E	48	A	B	C	D	E
24	A	B	C	D	E	49	A	B	C	D	E
25	A	B	C	D	E	50	A	B	C	D	E

Exam 2

1	A	B	C	D	E	26	A	B	C	D	E
2	A	B	C	D	E	27	A	B	C	D	E
3	A	B	C	D	E	28	A	B	C	D	E
4	A	B	C	D	E	29	A	B	C	D	E
5	A	B	C	D	E	30	A	B	C	D	E
6	A	B	C	D	E	31	A	B	C	D	E
7	A	B	C	D	E	32	A	B	C	D	E
8	A	B	C	D	E	33	A	B	C	D	E
9	A	B	C	D	E	34	A	B	C	D	E
10	A	B	C	D	E	35	A	B	C	D	E
11	A	B	C	D	E	36	A	B	C	D	E
12	A	B	C	D	E	37	A	B	C	D	E
13	A	B	C	D	E	38	A	B	C	D	E
14	A	B	C	D	E	39	A	B	C	D	E
15	A	B	C	D	E	40	A	B	C	D	E
16	A	B	C	D	E	41	A	B	C	D	E
17	A	B	C	D	E	42	A	B	C	D	E
18	A	B	C	D	E	43	A	B	C	D	E
19	A	B	C	D	E	44	A	B	C	D	E
20	A	B	C	D	E	45	A	B	C	D	E
21	A	B	C	D	E	46	A	B	C	D	E
22	A	B	C	D	E	47	A	B	C	D	E
23	A	B	C	D	E	48	A	B	C	D	E
24	A	B	C	D	E	49	A	B	C	D	E
25	A	B	C	D	E	50	A	B	C	D	E

Conservation Management

1	A	B	C	D	E
2	A	B	C	D	E
3	A	B	C	D	E
4	A	B	C	D	E
5	A	B	C	D	E
6	A	B	C	D	E
7	A	B	C	D	E
8	A	B	C	D	E
9	A	B	C	D	E
10	A	B	C	D	E
11	A	B	C	D	E
12	A	B	C	D	E
13	A	B	C	D	E
14	A	B	C	D	E
15	A	B	C	D	E
16	A	B	C	D	E
17	A	B	C	D	E
18	A	B	C	D	E
19	A	B	C	D	E
20	A	B	C	D	E

Plant Tag	Plant Identification - Plant Number			Growth Form			Origin		Season			Response				Poisonous		Noxious	
	First Digit	Second Digit	Third Digit	Perennial	Annual	Biennial	Native	Introduced	Cool	Warm	Inappropriate	Decreaser	Increaser	Invader	Inappropriate	Yes	No	Yes	No
1		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
2		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
3		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
4		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
5		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
6		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
7		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
8		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
9		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
10		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
11		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
12		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
13		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
14		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
15		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
16		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
17		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
18		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
19		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
20		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
21		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
22		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
23		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
24		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
25		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
26		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
27		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
28		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
29		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N
30		0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	P	A	B	N	I	C	W	X	D	I	V	X	Y	N	Y	N