
# Wrangler Workbook

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**Montana Range Days Plant List (2021)**

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FORBS

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| 240 | penstemon | *Penstemon spp.* | PNCI |
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FORBS

| | | | |
|---|---|---|---|
| 242 | prairie onion | *Allium spp.* | PNCI |
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| 244 | pussytoes | *Antennaria spp.* | PNCI |
| 245 | **salsify** | ***Tragopogon dubius*** | BICV |
| 246 | scarlet globemallow | *Sphaeralcea coccinea* | PNCI |
| 247 | segolily mariposa | *Calochortus nuttallii* | PNCD |
| 248 | spotted knapweed | *Centaurea maculosa* | P/BIWV N |
| 249 | sticky geranium | *Geranium viscosissimum* | PNCD |
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| 252 | yellow owl's clover | *Orthocarpus luteus* | ANCV |
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CACTI

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|---|---|---|---|
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HALF-SHRUBS, SHRUBS, TREES

| | | | |
|---|---|---|---|
| 256 | **big sagebrush** | ***Artemisia tridentata*** | PNWI |
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| 258 | **fringed sagewort** | ***Artemisia frigida*** | PNWI |
| 259 | **ponderosa pine** | ***Pinus ponderosa*** | PNXX P |
| 260 | **Rocky Mountain juniper** | ***Juniperus scopulorum*** | PNXX |
| 261 | rubber rabbitbrush | *Ericameria nauseosa* | PNWI |
| 262 | silver sagebrush | *Artemisia cana* | PNWI |
| 263 | western snowberry | *Symphoricarpos occidentalis* | PNCI |
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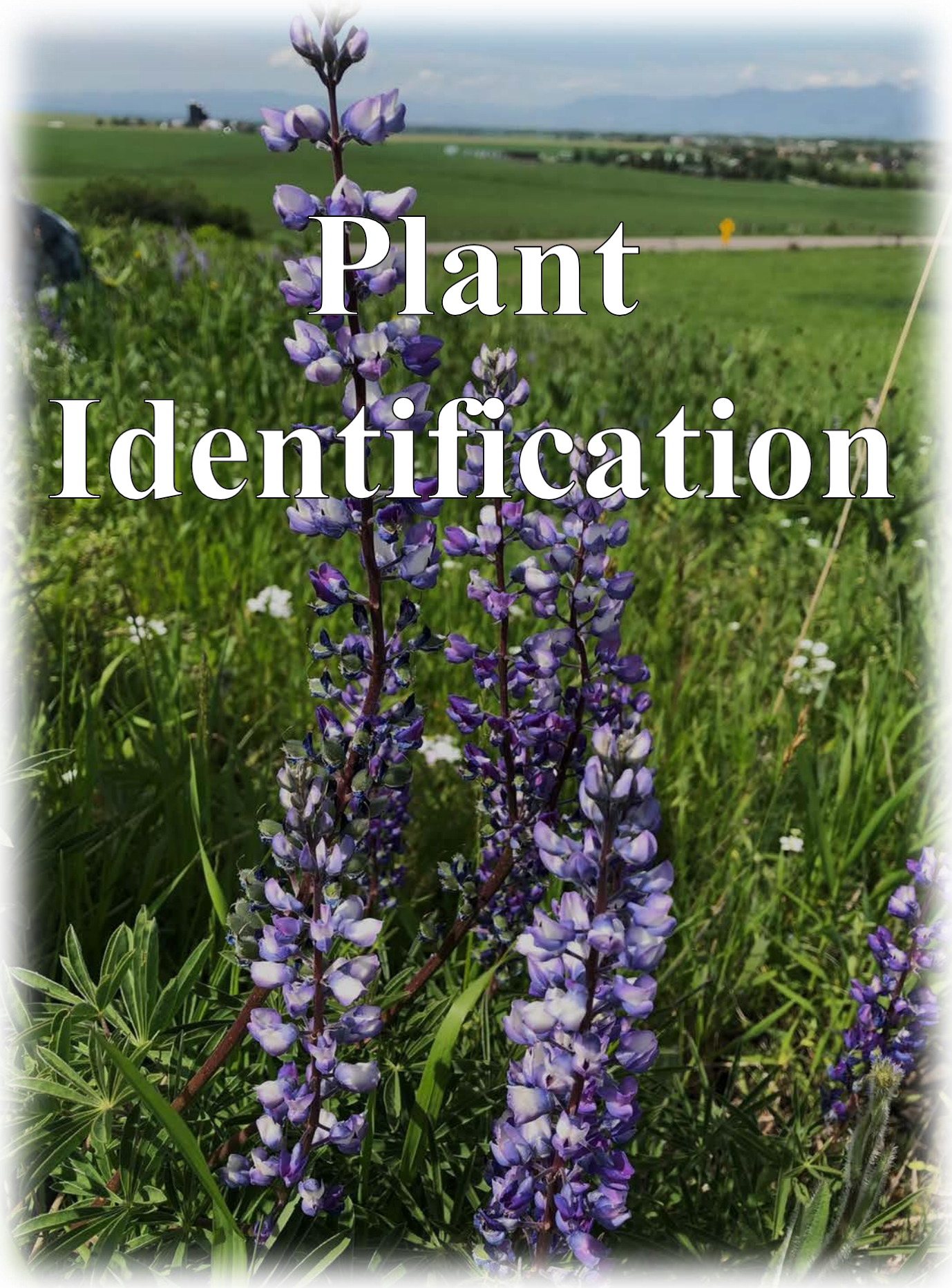
| 265 | winterfat | *Krascheninnikovia lanata* | PNWD |

**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

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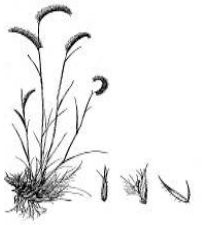
|---|---|
|  | **201 – basin wildrye - *Leymus cinereus* - PNCD**<br>Bunchgrass with short, thick rhizomes. This grass is very tall (3-7ft.). There is more than one spikelet at each node on the seedhead. Glumes are bristle-like. Leaf blades are wide and flat. Auricles and ligules are prominent. Grown in deep soils, saline overflow and saline subirrigated sites. Growing points are elevated, so heavy grazing hurts this plant. |
|  | **202 – blue grama – *Bouteloua gracilis* - PNWI**<br>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. |
|  | *** 203 – bluebunch wheatgrass – *Pseudoroegneria spicata* - PNCD**<br>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. |
|  | *** 204 - cheatgrass - *Bromus tectorum* - AICV**<br>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. |
|  | **205 – crested wheatgrass – *Agropyron cristatum* - PICV**<br>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. |
|  | **206 – foxtail barley – *Hordeum jubatum* - PNCI**<br>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. |

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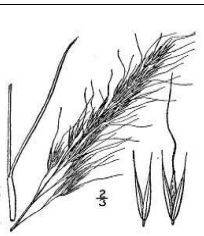
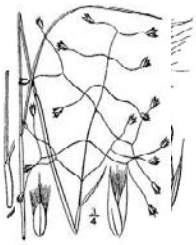
|  | **207 – green needlegrass – *Nassella viridula* - PNCD**<br>A perennial bunchgrass that grazing animals prefer. It has large leaves that grow from the base of the plant. The backs of the leaves are very shiny. The throat of the leaf collar is hairy. There are not very many seedheads per plant (1-3) 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. |
|  | **208 - Idaho fescue - *Festuca idahoensis* - PNCI**<br>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. |
|  | **209 – Indian ricegrass – *Achnatherum hymenoides* - PNCD**<br>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. |
|  | **210 – Kentucky bluegrass – *Poa pratensis* - PICV**<br>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. |
|  | *** 211 – needle-and-thread – *Hesperostipa comate* - PNCI**<br>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. |
|  | *** 212 – prairie junegrass – *Koeleria macrantha* - PNCI**<br>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. |

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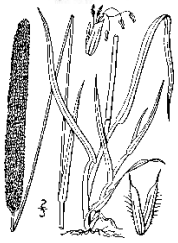
|  | *** 213 – Sandberg bluegrass – *Poa secunda* - PNCI**<br>A small-stature bunchgrass that flowers early in the spring. It has very short basal leaves. Seedhead culms are taller than the leaves. Like other bluegrasses, it has 2 sunken veins in the middle of each leaf (railroad tracks), and keeled 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. |
|  | **214 – smooth brome – *Bromus inermis* - PICV**<br>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. |
|  | **215 - timothy – *Phleum pratense* - PICV**<br>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. |
|  | *** G28 – western wheatgrass – *Pascopyrum smithii* - PNCI**<br>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

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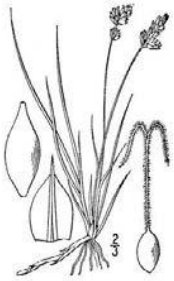
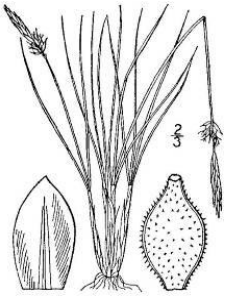
|  | **217 – baltic rush – *Juncus balticus* - PNCI**<br>A rhizomatous rush that grows up 8-32 inches tall. You might need a hand lens to study the seedhead. The inflorescence is a panicle, about 2 ½ inches long. The flowers are very small. Flower parts are bract-like and in series of three. The perianth (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. |
|  | **218 – needleleaf sedge – *Carex duriuscula* - PNCI**<br>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. |
|  | *** 219 –threadleaf sedge - *Carex filifolia* - PNCI**<br>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

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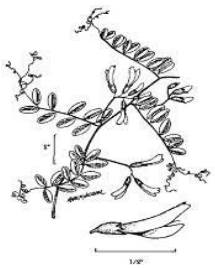
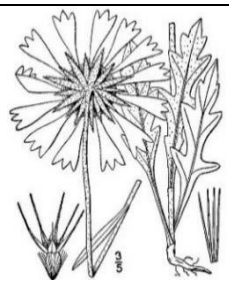
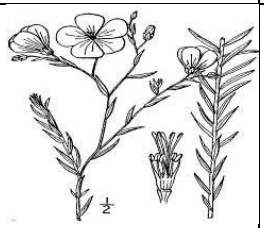
|  | *** 220 – American vetch – *Vicia americana* (Pea Family) - PNCD**<br>This forb spreads and climbs by clinging to other vegetation using tendrils (modified leaflets). It is also rhizomatous. Leaves are even-pinnate with the tendril being terminal. There are 8-18 leaflets. Raceme inflorescences develop 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. |
|  | **221 - arrowleaf balsamroot - *Balsamorhiza sagittata* (Aster Family) - PNCI**<br>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. |
|  | **222 – biscuitroot – *Lomatium spp.* (Parsley Family) - PNCI**<br>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. |
|  | **223 - blanketflower - *Gaillardia aristata* (Aster Family) - PNWI**<br>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. |
|  | **224 – blue flax *Linum lewisii* (Flax Family) - PNCI**<br>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. |
|  | *** 225 – Canada thistle – *Cirsium arvense* (Aster Family) – PICV N**<br>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. |

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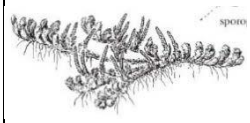
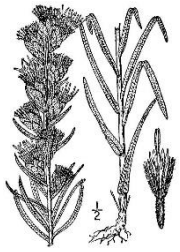
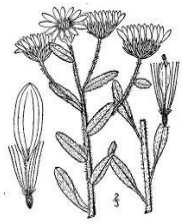
|  | *** 226 – cudweed sagewort – *Artemisia ludoviciana* (Aster Family) - PNWI**<br>Alternate leaves, simple mostly cauline, blades linear to lanceolate or elliptic. Reduced above, margins entire or apically toothed or lobed. Top of the leaves pilose and green to white tomentose, bottom of the leaves white tomentose. Sessile leaves. Erect rhizomatous forb. |
|  | **227 – curlycup gumweed – *Grindelia squarrosa* (Aster Family) - BNWV**<br>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. |
|  | **228 - dense clubmoss - *Selaginella densa* (Selaginella family) - PNXI**<br>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. |
|  | **229 – dotted gayfeather – PNWD – *Liatris punctata* (Aster Family*)* - PNWD**<br>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. |
|  | **230 - fleabane - *Erigeron spp.* (Aster Family) - PNCI**<br>There are many types of *Erigeron spp.* Infloresence mostly open, coymbiform or paniculate or solitary heads. Heads usually radiate, sometimes apparently discoid. |
|  | **231 - hairy goldenaster - *Heterotheca villosa* (Aster Family) - PNWI**<br>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. |

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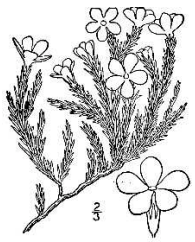
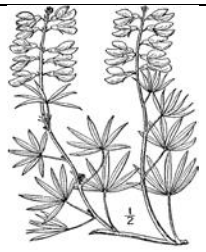
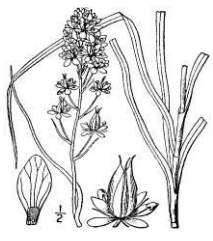
|  | **232 - Hood phlox - *Phlox hoodii* (Polemoniaceae family) - PNCI**<br>A low, mat forming forb that grows only 2-8 cm high. Leaves are opposite and clustered. They are linear shaped, stiff and sharp-tipped. Leaves often have cobwebby hairs at the axils. Flower is a solitary white to purple flower at the stem tip. Flower petals are lobed. |
|  | *** 233 - houndstongue - *Cynoglossum officinale* (Borage Family) – BICV N**<br>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. |
|  | **234 - leafy spurge - *Euphorbia esula* (Spurge Family) – PICV N**<br>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. |
|  | **235 – low larkspur – *Delphinium bicolor* (Buttercup Family) – PNCI P**<br>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. |
|  | *** 236 - lupine - *Lupinus argenteus* (Pea family) – PNCI P**<br>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. |
|  | **237 – meadow deathcamas – Zygadenus venenosus (Lily Family) PNCI P**<br>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. |

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|  | **238 - milkvetch – *Astragalus spp.* (Pea Family) - PNCI**<br>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. |
|  | **239 – Missouri goldenrod – *Solidago missouriensis* (Aster Family) – PNWI**<br>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. |
|  | **240 – penstemon – *Penstemon spp.* (Figwort Family) - PNCI**<br>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. |
|  | **241 - prairie coneflower - *Ratibida columnifera* (Aster family) - PNWI**<br>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. |
|  | **242 - prairie onion – *Allium spp.* (Lily Family) -PNCI**<br>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. |
|  | **243 - purple prairie clover - *Dalea purpurea* - (Pea family) - PNWD**<br>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. |

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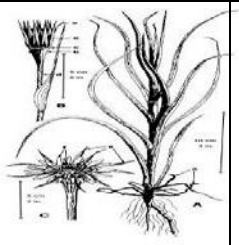
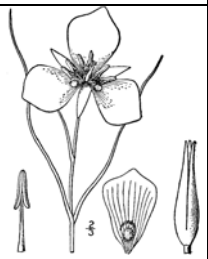
|  | **244 – pussytoes – *Antennaria spp.* (Aster Family) - PNCI**<br>Very robust. The bract tips are bright white or seldom dull white or pinkish, dry corollas of female florets usually 5-8 mm long. |
|  | *** 245 – salsify – *Tragopogon dubius* (Aster family) *BICV***<br>Because of its linear leaves, 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. |
|  | **246 – scarlet globemallow – *Sphaeralcea coccinea* (Mallow Family) - PNCI**<br>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. |
|  | **247 - segolily mariposa - *Calochortus nuttallii* (Lily Family) - PNCD**<br>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. |
|  | **248 - spotted knapweed – *Centaurea stoebe* (Aster Family) – P/BIWV**<br>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. |
|  | **249 - sticky geranium - *Geranium viscosissimum* – (Geranium Family) - PNCD**<br>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. |

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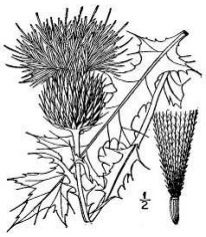
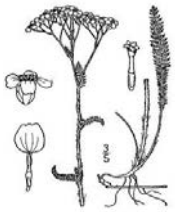
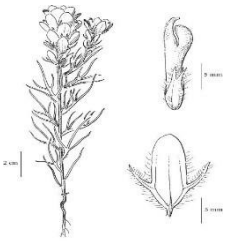
|  | **250 - wavyleaf thistle –*Cirsium undulatum* (Aster Family) – P/BNWV**<br>Has a taproot. Grows a rosette the first year and then bolts during the second. It has stout stems with a single head inflorescence at the tops. The pink/purple flowers are all disk. The leaves have wavy, toothed margins. 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. |
|  | *** 251 - western yarrow – *Achillea millefolium* (Aster Family) - PNWI**<br>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 |
|  | **252 – yellow owl's clover – *Orthocarpus spp.* (Broomrape Family) - ANCV**<br>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. |
|  | **253– Yellow sweetclover –Melilotus officinalis (Pea Family) – BICV**<br>A tap-rooted biennial that is much-branched. It produces a rosette the first year. The second year it flowers. 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

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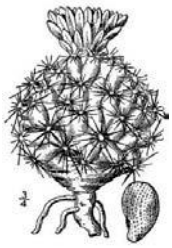
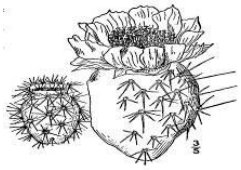
|  | **254 - pincushion cactus - *Mammillaria spp.* - PNCI**<br>**S**tems buried in soil. Spines white, weathering to brown, 11 to 55 per areole (small bumps out of which grows clusters of spines). Central spines 3-6, reddish. Flowers 2-3 cm long, tepals 21 to 56 yellow or magenta. Fruit green to brown. |
|  | *** 255 – plains pricklypear – *Opuntia polyacantha* - PNCI**<br>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. |

# Shrubs & Half-Shrubs

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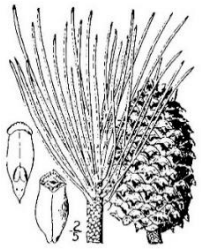
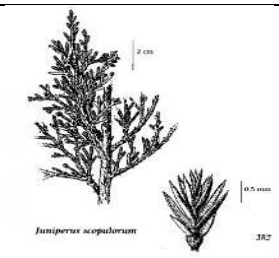
|  | *** 256 - big sagebrush - *Artemisia tridentata* - PNWI**<br>Stems are woody with growth rings. Leaves are covered with hair and appear silver-gray. Leaves are also three-tipped or "three-toed." Flowers are heads. Deep tap root, no rhizomes. Evergreen shrub. Important winter browse species for a variety of rangeland animals. |
|  | **257 – broom snakeweed – *Gutierrezia sarothrae* -PNWI**<br>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. |
|  | *** 258 – fringed sagewort – *Artemisia frigida* - PNWI**<br>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. |
|  | *** 259 - ponderosa pine - *Pinus ponderosa* – PNXX P**<br>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. |
|  | *** 260 – Rocky Mountain juniper – *Juniperus scopulorum* - PNXX**<br>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. |
|  | **261 – rubber rabbitbrush – *Ericameria nauseosa* - PNWI**<br>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. |

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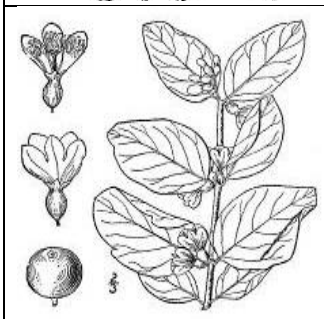
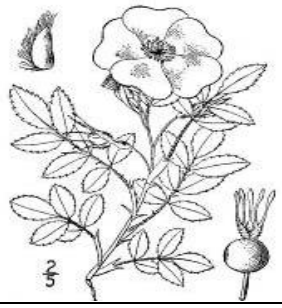
|  | **262 - silver sagebrush - *Artemisia cana* - PNWI**<br>Densely branched shrub with a rounded crown often forming colonies from extensive rhizomes. Flower heads in perfect terminal leafy panicles, subtended by leaf-like bracts that surpass the head. Leaves are alternate simple, with linear blades and entire margins. Twigs are green to straw colored, with the older stems brown to gray. Very aromatic. |
|  | **S18 – western snowberry – *Symphoricarpos occidentalis* - PNCI**<br>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. |
|  | *** S19 – wild rose – *Rosa spp.* - PNCI**<br>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<br>> 10. Fruit a swollen, pulpy hypanthium (hip) enclosing the hairy achenes. |
|  | **S20 – winterfat – *Krascheninnikovia lana* – PNWD**<br>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. |

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Plant
Anatomy

**PSI – Plant Science Investigation**
**Anatomy and Identification**

A botanist without basic plant anatomy skills is like a CSI investigator without knowledge of human anatomy and crime science.

Botanists and CSI investigators both scrutinize fine details to find answers. The clues are different, but the process and attention to detail are much the same. The clues gathered during a plant science investigation can be applied to plant identification keys, so that the true identity of a plant can be determined.

# THE FACTS ABOUT PLANT PARTS

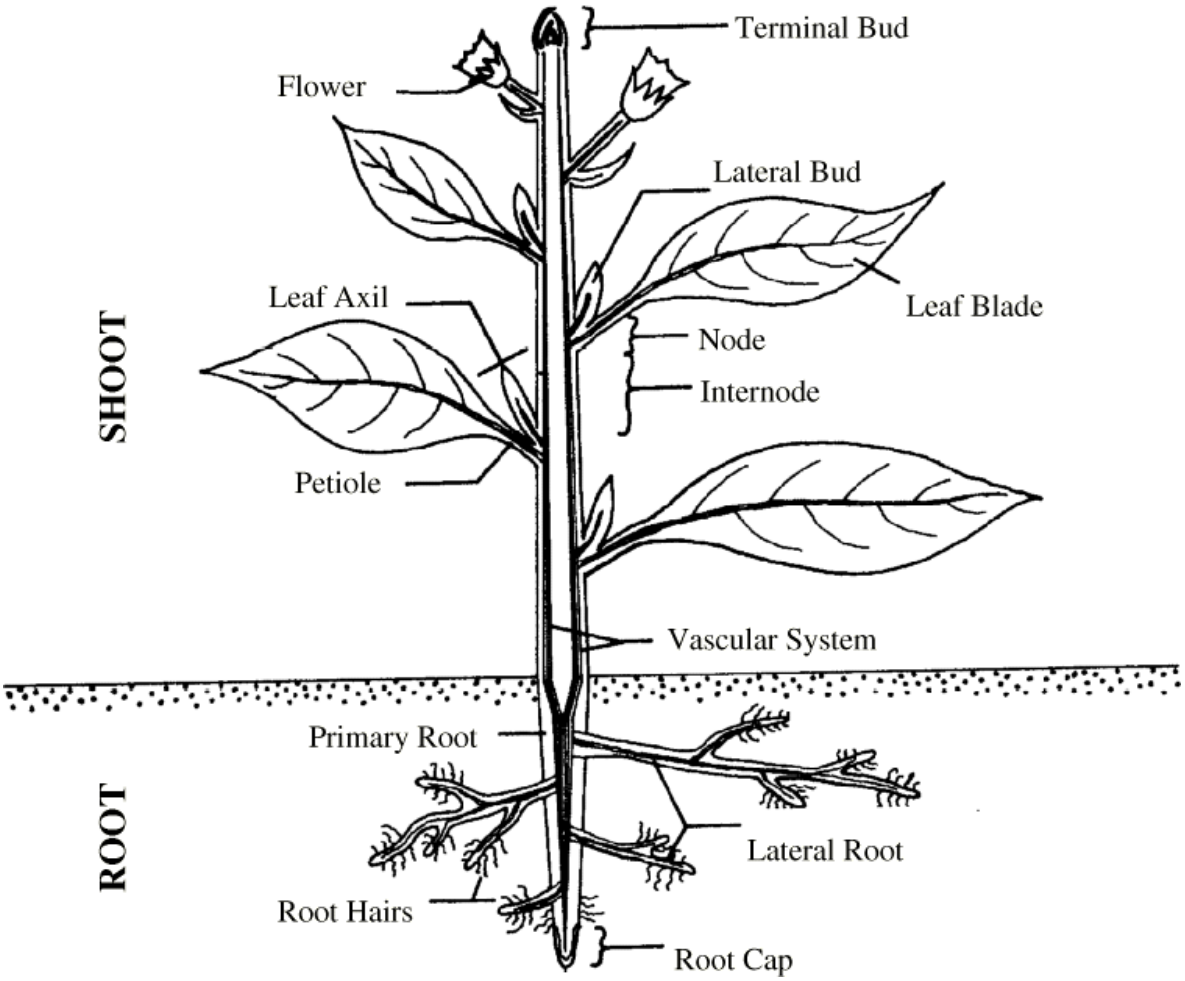
The vascular, flowering plants that you find on rangelands all have the same basic structure.

**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***

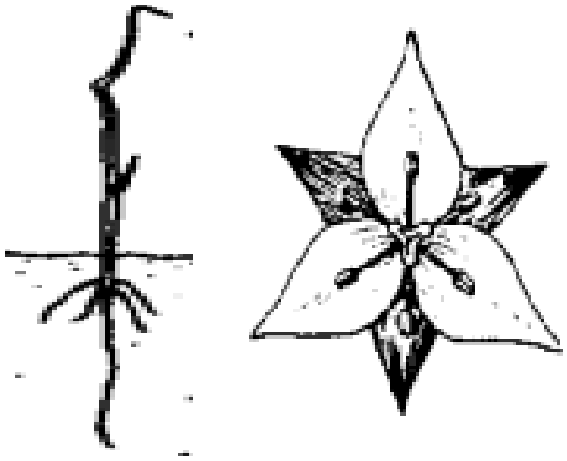


# SOLVING THE MYSTERY OF PLANT TYPE

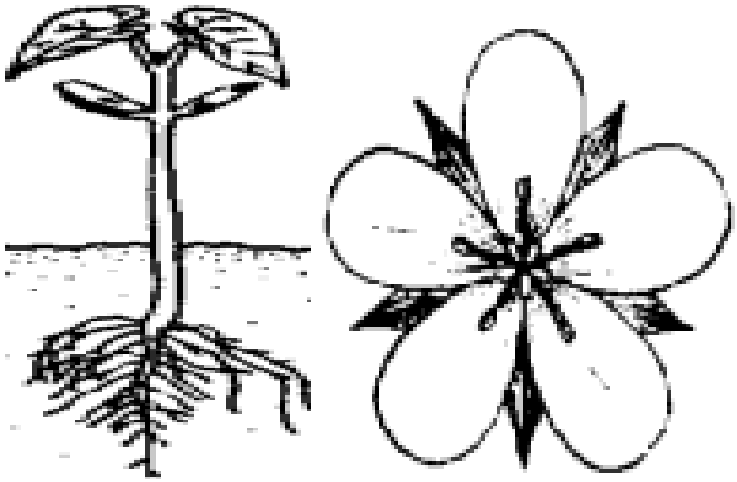
**For this workshop, let's focus on vascular, flowering plants that have seeds enclosed in an ovary. This does not include conifers.**

**There are two categories of plants that fit the description above.**

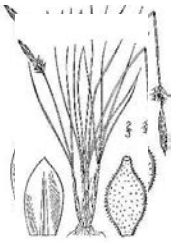
**Monocots - Have one seed leaf and mostly flower parts in 3's.**
**Includes: Grasses, Grass-likes and some forbs (ex. Iris)**



**Dicots - Have two seed leaves and mostly flower parts in 4's, 5'.**
**Includes: most forbs, shrubs and deciduous trees.**



# 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 |

# SOLVING THE MYSTERY OF 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

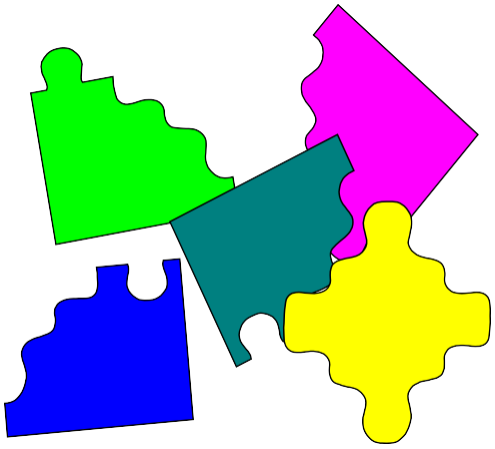
**STIPEAE - needlegrasses**
- Spikelets laterally compressed (squeezed)
- Spikelets 1 flowered, fall apart above the glumes
- Glumes 2, as long or longer than the lowest floret
- Lemmas harden with maturity (think about the needle on needle and thread)
- Lemmas awned
- Panicle inflorescence

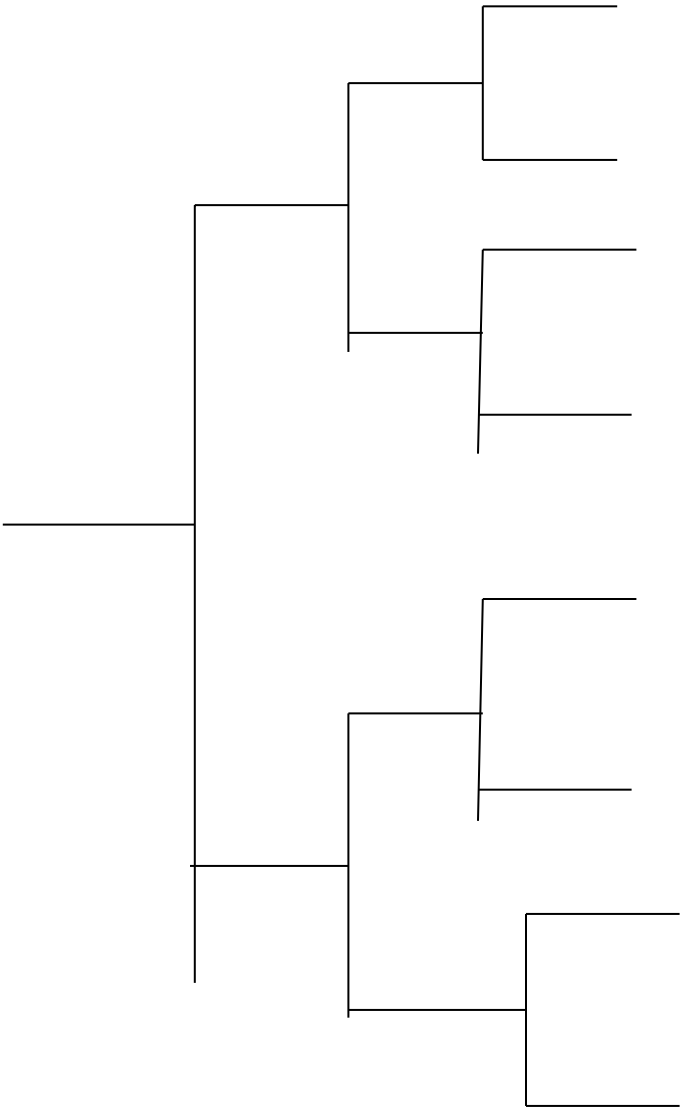
**POEAE - bluegrasses**
- Spikelets laterally compressed (squeezed)
- Spikelets many flowered
- Glumes 2, shorter than the lowest floret
- Panicle inflorescence
- Plants are monoecious (male and female flowers on the same plant)
- Ligules are membranous.

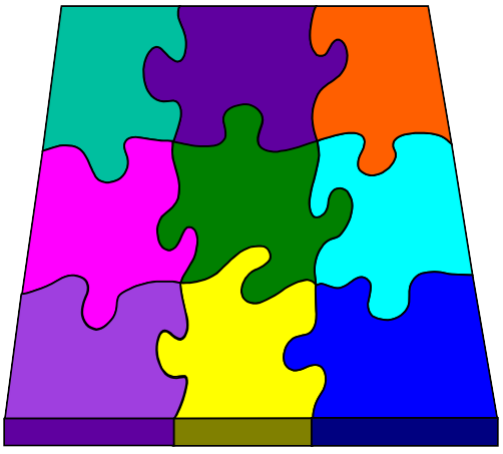
Compare these grass tribes with you instructors.

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. It is an easy key to start with.

# 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

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

Remember that plants, like people, have places they like to hang-out at and comrades they prefer to associate with. If we determine the ecological site our plant is growing on, and which plants are growing along-side (plant community), we can narrow the choices to its identity.

Some plants are very adaptable. They can thrive in different places (habitats). We find these plants on many ecological sites in a variety of climate zones. For example, as MRD has traveled across the state, bluebunch wheatgrass has always been on the plant list.

Other plants are limited to specific habitats. For example, warm season grasses such as big bluestem can be found in southeast Montana. Rough fescue grows at higher elevations and higher precipitation areas.

**Here are some examples of common grass and grass-like plant communities by range site.**
**Sedimentary Plains: 10 – 14" precipitation zone**

**Normal Range Sites**

green needlegrass
needleandthread
western wheatgrass
bluebunch wheatgrass (more common in W. Montana)
prairie junegrass
blue grama

**Run-In Sites**

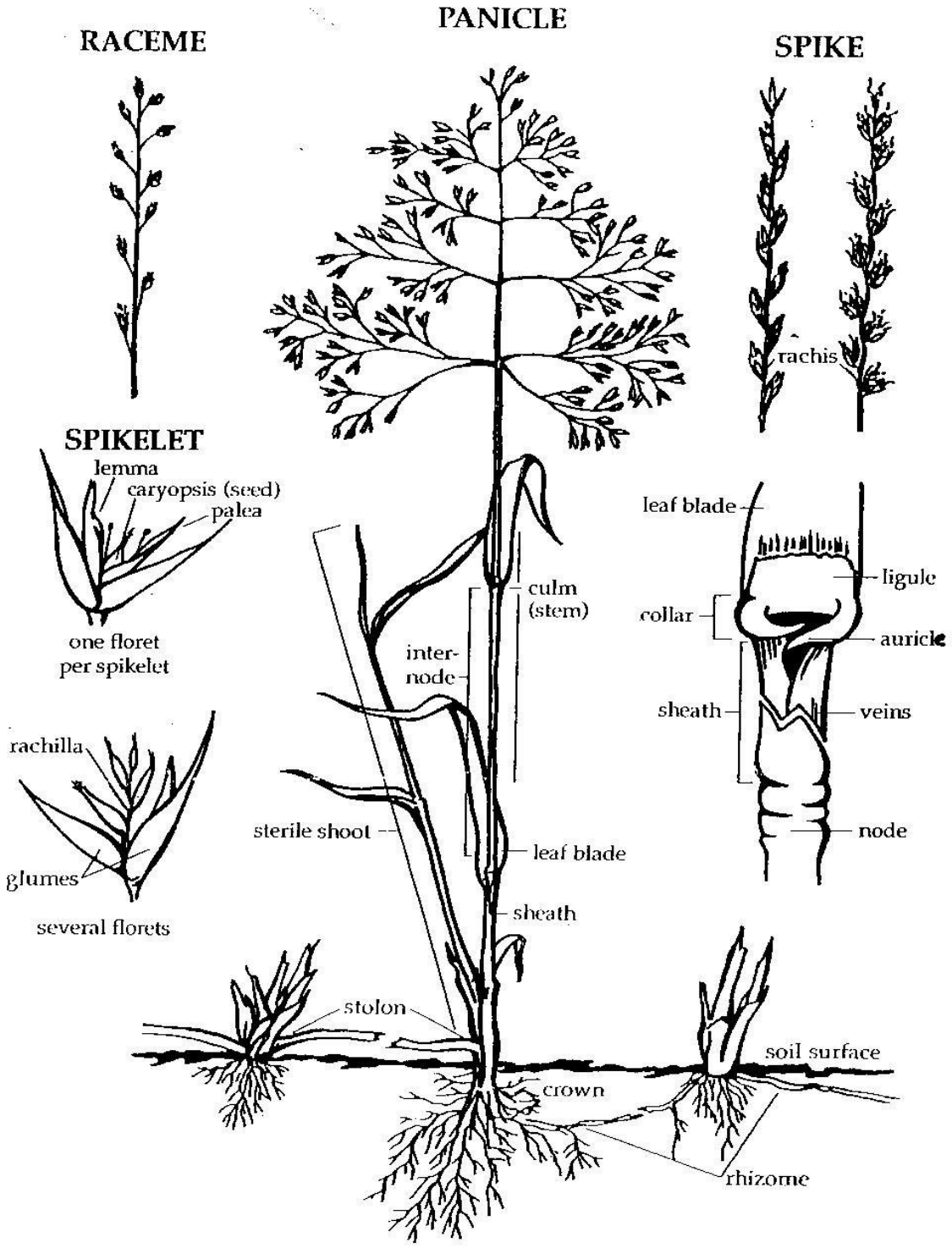
big bluestem
green needlegrass
western wheatgrass
switchgrass
needleandthread
Canada wildrye
slender wheatgrass
Kentucky bluegrass

**Run-Off Sites**

bluebunch wheatgrass
prairie sandreed
little bluestem
plains muhly
sideoats grama
western wheatgrass
threadleaf sedge
needleandthread
prairie junegrass
blue grama

**To find additional information about what plant species and plant communities are adapted to specific ecological sites, visit the Montana NRCS website and review the ecological site descriptions for your area.**

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.




2

# 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

**1a. Plants annual** (Small stature, many seedheads, small root system that pulls out easily)
**2a. leaf blades minutely hairy,** sheaths split, small ligule _____**Sixweeks fescue (Vulpia octoflora)**

**2b. leaf blades hairy,** sheaths not split (Closed, to very near the collar), lemmas long-awned. Plant turns purple when
mature. _____**Cheatgrass brome (Bromus tectorum)**

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

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

**4a. 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)**

**4b. 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)**

**3b. 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, *spike-like raceme or has spike-like branches***

**7a. Leaf sheaths rounded**

**8a. 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)**

**8b. 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)**

**7b. Sheaths compressed (flattened)**

**9a. 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 awn._____**little bluestem (Schizachyrium scoparium)**

**6b. <u>Seedhead inflorescence a panicle.</u>**

**10a. <u>Plants with one floret per spikelet.</u>**

**11a. <u>Leaf collars and/or sheaths hairy.</u>**

**12a. <u>Glumes equal or almost equal.</u>** 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)**

**12b. <u>Glumes uequal.</u>** Leaves mostly basal. Spikelets with very unequal glumes. Long hair at collar. The floret is awned, and splits into 3 segments. Each being 6-8cm long._____**Red threeawn (Aristida purpurea)**

**11b. <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)**

**10b. <u>Plants with more than one floret per spikelet</u>**

**13a. <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)**

**13b. <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)**

**5b. <u>Plants with rhizomes, stolons or "mat-forming" habits</u>**

**14a. <u>Seedhead inflorescence is a spike, *spike-like raceme or has spike-like branches*</u>**

**15a. <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)**

**15b. <u>Auricles not present, plants often forming dense, mats</u>**

**16a. <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)**

**16b. <u>Plants without stolons</u>**. 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)**

**14b. <u>Seedhead inflorescence a panicle.</u>**

**17a. <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)**

**17b. <u>Leaves without "railroad tracks".</u>**

**18a. <u>Membranous Ligule.</u>** Leaf blades with an "M". Leaves large, soft and flat. Large, panicle seedheads. Glumes are shorter than spikelet. Many florets per spikelet. Awn-tipped lemmas_____**smooth bromegrass (Bromus inermis)**

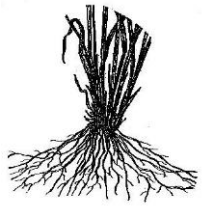
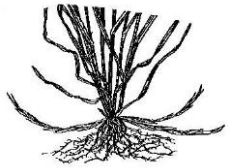
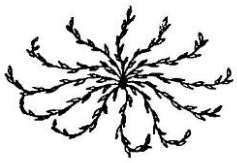
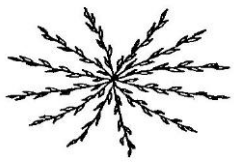
**18b. <u>Hairy Ligule.</u>** Leaf blades very firm, tapering to along fine point. Leaf margins are hairy. Seedhead looks "shiny". Glumes are large and Unequal. One floret with hairs at base of single spikelet. _____**Prairie sandreed (Calamovilfa longifolia)**

**14c. <u>Seedhead inflorescence a raceme.</u>**

Leafblades have scattered hairs and small white glands on leaf margins. Hairy ligule. Seedhead with 9-80 branches, each containing 3-7 spikelets, with the majority Of the branches located on 1 side of the seedhead. Has rhizomes _____**sideoats grama (Bouteloua curtipendula)**

# *PLANT ANATOMY REFERENCE MATERIAL*

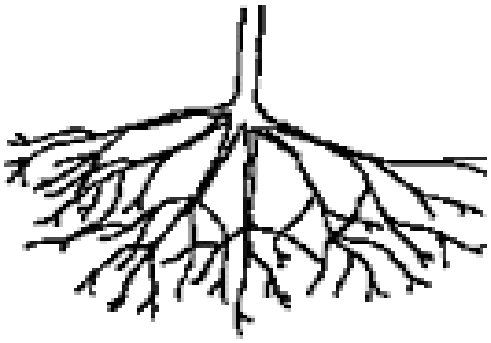
**The "style" of a plant is called the growth habit or growth form.**

| 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** – needleandthread, 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 pointloco |
| **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 |

## 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) or like hair (fibrous). Note the color and texture of roots. Ex. Threadleaf sedge has black, wiry roots. Bracted spiderwort has white roots.

| **TAP ROOT** | **FIBROUS ROOT** |
|---|---|
| Most forbs. Ex. dandelion, milkwort, prairie coneflower, lupine | Grasses and some forbs. Ex. threadleaf sedge, needleandthread, Idaho fescue, bracted spiderwort, star lily |
|  |  |

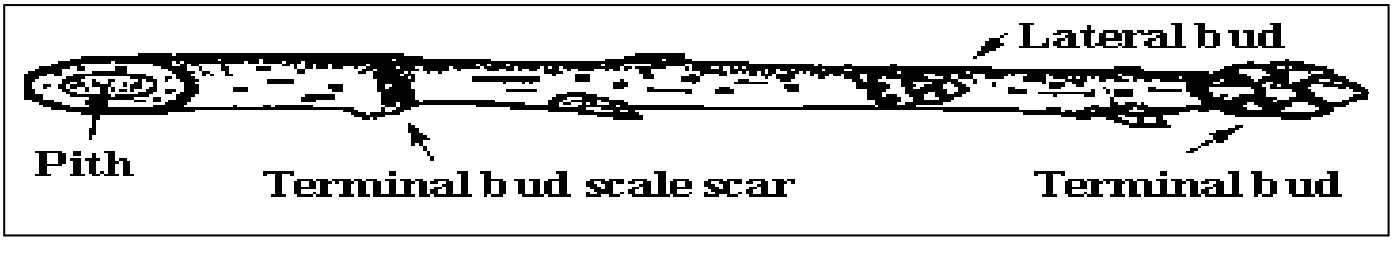
## STEMS

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.

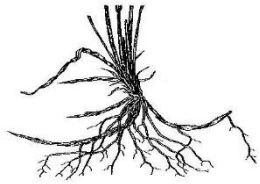
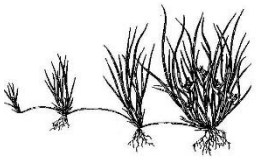
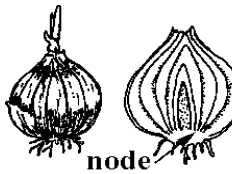
You can observe the shape and texture of a stem just by looking at it. Sedge stems will be triangle shaped. Northern bedstraw will have a square stem. Grass stems have visible nodes(knees). Prairie coneflower has a heavy-veined stem (ribbed).

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.

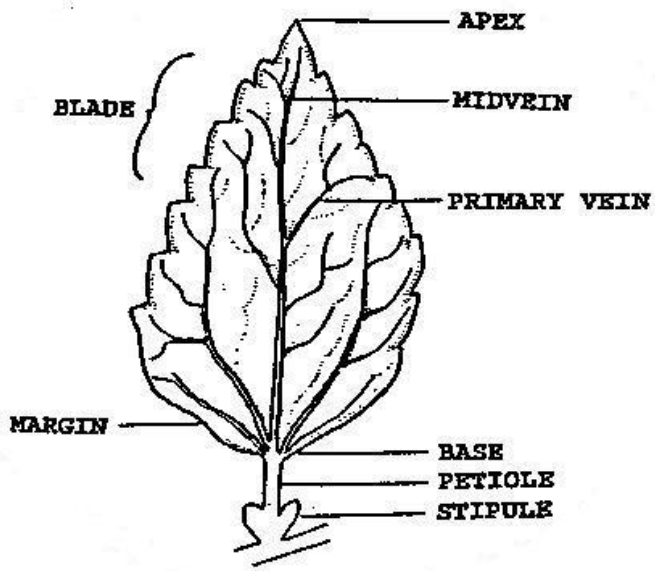


## MODIFIED STEMS/STORAGE ORGANS

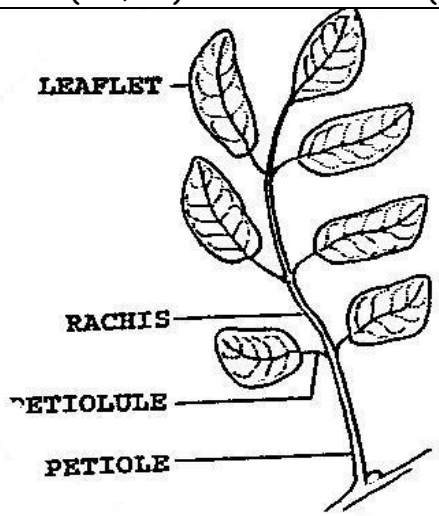
| MODIFICATION | DESCRIPTION | VISUAL | EXAMPLE |
|---|---|---|---|
| **Rhizomes** | A rhizome is a horizontal, underground stem, with nodes, internodes, leaf scales and buds. At the nodes, shoots may develop into new plants. Sod-forming grasses have rhizomes. |  | Western wheatgrass, smooth bromegrass, 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 onions, 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

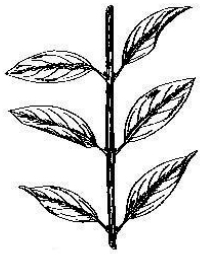
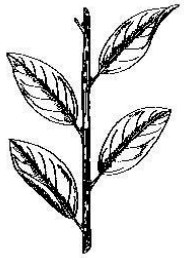
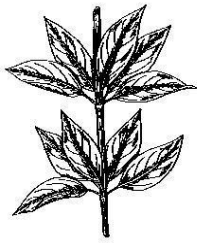
| **SIMPLE LEAVES**<br>Leaf blade is a single, undivided structure. | **COMPOUND LEAVES**<br>Leaf blade is divided into sub-structures. Each substructure (leaflet) has its own stalk (petiolule). |
|---|---|
|  |  |
| *EXAMPLE: prairie coneflower, hairy goldenaster, scarlet globemallow, penstemon spp., sunflower spp., pussytoes, snowberry spp., chokecherry, curlycup gumweed* | *EXAMPLE: Purple prairieclover, 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). | |
|  | |

**LEAF ATTACHMENT**

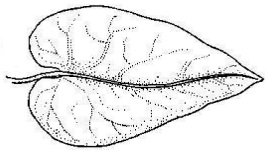
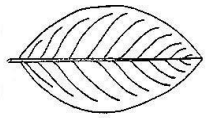
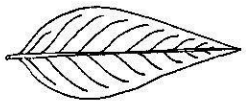
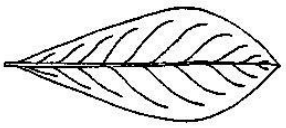
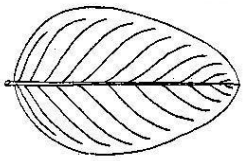
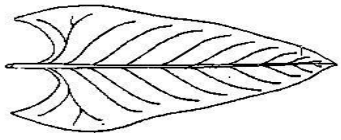
Plant leaves are attached to the stem in different ways. A dandelion would be a good example of a forb with basal leaves. One of Montana's noxious weeds has clasping leaves. Do you know which one?

| **ACAULINE (BASAL)**<br>Dandelion | **CAULINE (SESSILE)**<br>Prairie coneflower |
|---|---|
|  |  |

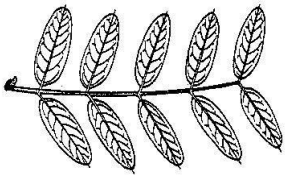
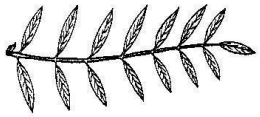
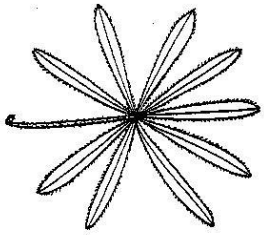
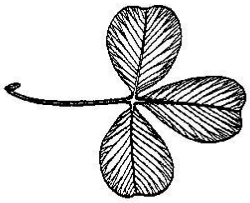
**LEAF VEINATION**

| VEINATION TYPE | DESCRIPTION | VISUAL | EXAMPLE |
|---|---|---|---|
| **PALMATE** | Several main veins radiating from the base of the leaf with smaller viens branching from them. |  | snowbrush, black sampson, false Solomon's seal |
| **PARALLELL** | Veins do not branch. Viens run straight up and down without intersecting. |  | Compare the viens 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 |

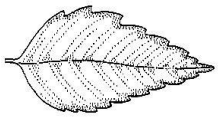
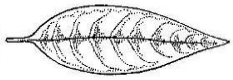
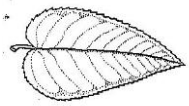
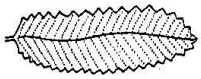
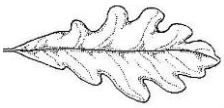
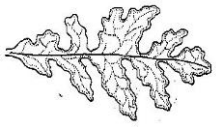
## SIMPLE LEAF SHAPES

| SIMPLE LEAF SHAPES | DESCRIPTION | VISUAL | EXAMPLE |
|---|---|---|---|
| **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 |
| **LANCEOLATE** | Lance shaped. Leaves several times longer than wide. The widest ½ from the base. Tapering to the apex. |  | lupine leaflets, stonecrop, mountain ash, curlleaf mountainmahogany, 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 |
| **OVATE** | Egg-shaped. Leaf attached at the broad end. |  | Red osier dogwood, quaking aspen, snowberry |
| **SAGITATE** | Leaves in the shape of an arrowhead with the basal lobes pointed backward towards the petiole. |  | arrowleaf balsamroot |

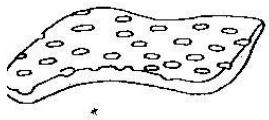
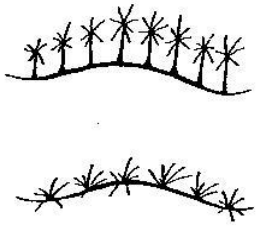
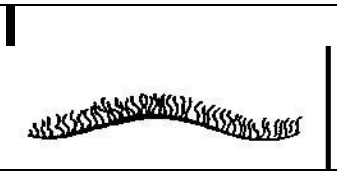
**COMPOUND LEAF SHAPES**

| 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 prairieclover, purple pointloco, Oregon grape, tall cinquefoil |
| **Palmate** | Leaflets radiate from a central point. |  | Silverleaf scurfpea spp., lupine spp. |
| **Trifoliate** | T<br>hree leaflets from one point. |  | Goldenpea, alfalfa, sweetclover, slimflower scurfpea, milkwort spp. |
| **Ternate** | When a compound leaf is divided into three from different points. |  | Skunkbush sumac |

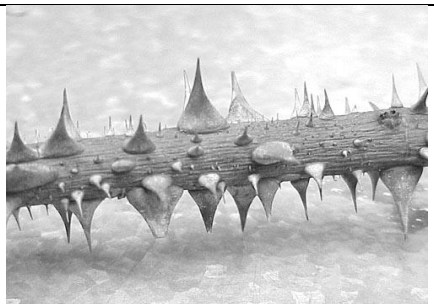
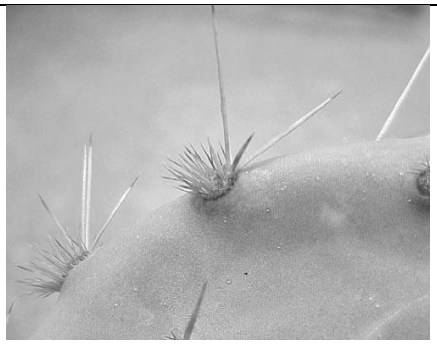
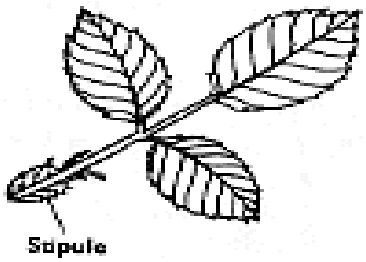
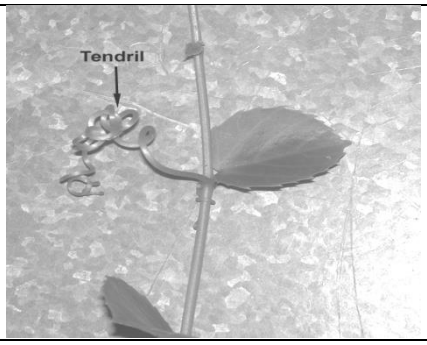
## LEAF MARGINS

| MARGINS | DESCRIPTION | VISUAL | EXAMPLE |
|---|---|---|---|
| **Serrate** | Coarsely toothed with teeth pointing forward. |  | Rosa spp., snowbush ceanothus, Oregon grape, serviceberry, Wyoming kittentails (Besseya) |
| **Entire** | Smooth leaf margin |  | showy milkweed, snowberry, broom snakeweed, fireweed, silver buffaloberry |
| **Serrulate** | Finely serrated with teeth pointing forward. |  | Chokecherry |
| **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 sampson, hairy goldenaster |
| **Lobed** | Divisions less than one-half the distance to the base or midvein. |  | Golden currant, Bur oak |
| **Divided** | Divisions that extend to near the midvein. |  | Scarlet globemallow, Pineappleweed, Globeflower, Prairie coneflower. |

**LEAF SURFACES**

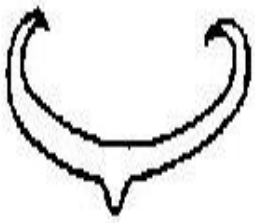
| LEAF SURFACES | DESCRIPTION | VISUAL | EXAMPLE |
|---|---|---|---|
| **Glabrous** | Smooth, without hair |  | Penstemon, whitetop, scarlet gaura |
| **Glandular** | Supplied with glands |  | Common St. Johnswort, slimflower scurfpea, black sagebrush, curly cup gumweed, sticky geranium |
| **Pitted** | With depressions in the surface of the leaf |  | Dotted gayfeather |
| **Pubescent** | Covered with soft hairs |  | Wooly plantain |
| **Stellate** | Star-like hairs |  | Scarlet globemallow |
| **Tomentose** | Matted, tangled hairs |  | Rubber rabbitbrush, spotted knapweed |

## LEAF AND STEM MODIFICATIONS

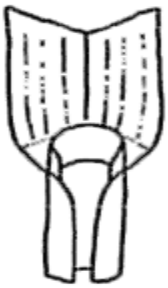
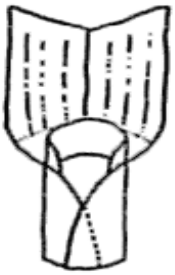
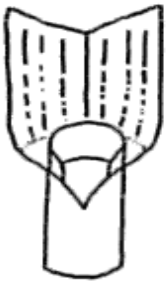
| MODIFICATIONS | DESCRIPTION | VISUAL | EXAMPLE |
|---|---|---|---|
| **PRICKLES** | Modified skin (epidermal)cells |  | Rose spp. |
| **SPINES** | Modified leaves |  | Cactus |
| **STIPULES** | Modified leaves at the leaf axil (paired) |  | Rose, snowberry |
| **TENDRILS** | Modified leaves that twine |  | 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 | INVOLUTE | V-SHAPED OR KEELED (FOLDED) |
|---|---|---|
| Images: Kansas State University  |  |  |
| Ex. western wheatgrass, bluebunch wheatgrass, prairie junegrass, blue grama, cheatgrass, smooth bromegrass | Ex. The leaves of many grasses roll with maturity or dry conditions. Indian ricegrass, Idaho fescue have rolled leaves all the time. | Ex. Kentucky bluegrass, little bluestem(sometimes) |

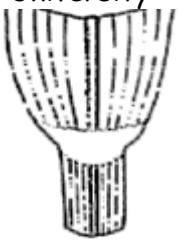
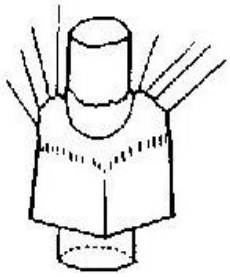
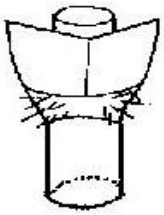
***LEAF SHEATH -*** *The leaf sheath is the lower part of the leaf that begins at the node. The sheath encloses the stem to the collar.*

| SPLIT-OPEN | SPLIT OVERLAP | CLOSED |
|---|---|---|
| Images: Kansas State  Universtiy |  |  |
| 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.**

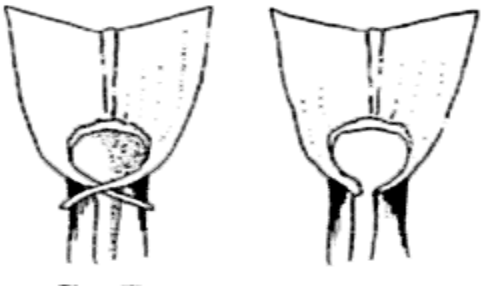
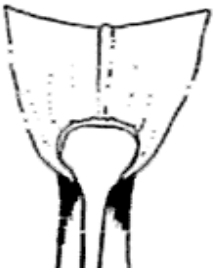
***COLLAR -*** *The collar is a tiny band where the leaf blade and sheath join and is usually a different color.*

| 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.*

| MEMBRANEOUS | HAIRY/CILIATE | ABSENT |
|---|---|---|
|  |  |  |
| Ex. needleandthread | 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.*

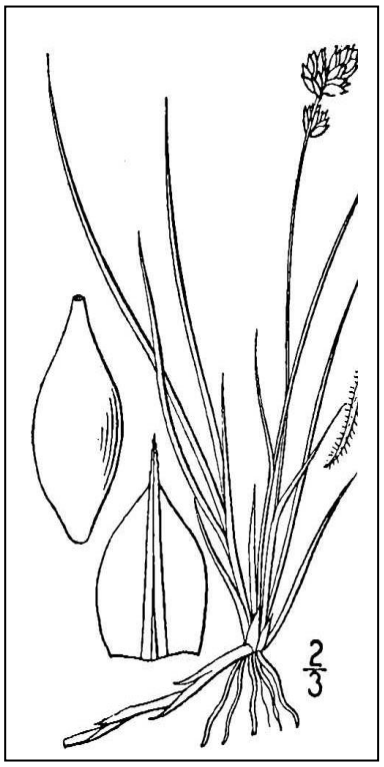
| PRESENT | ABSENT |
|---|---|
| Images: Kansas State University  |  |
| Ex. western wheatgrass | Ex. smooth brome |

***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-LIKE LEAVES**

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.


USDA Plants Database

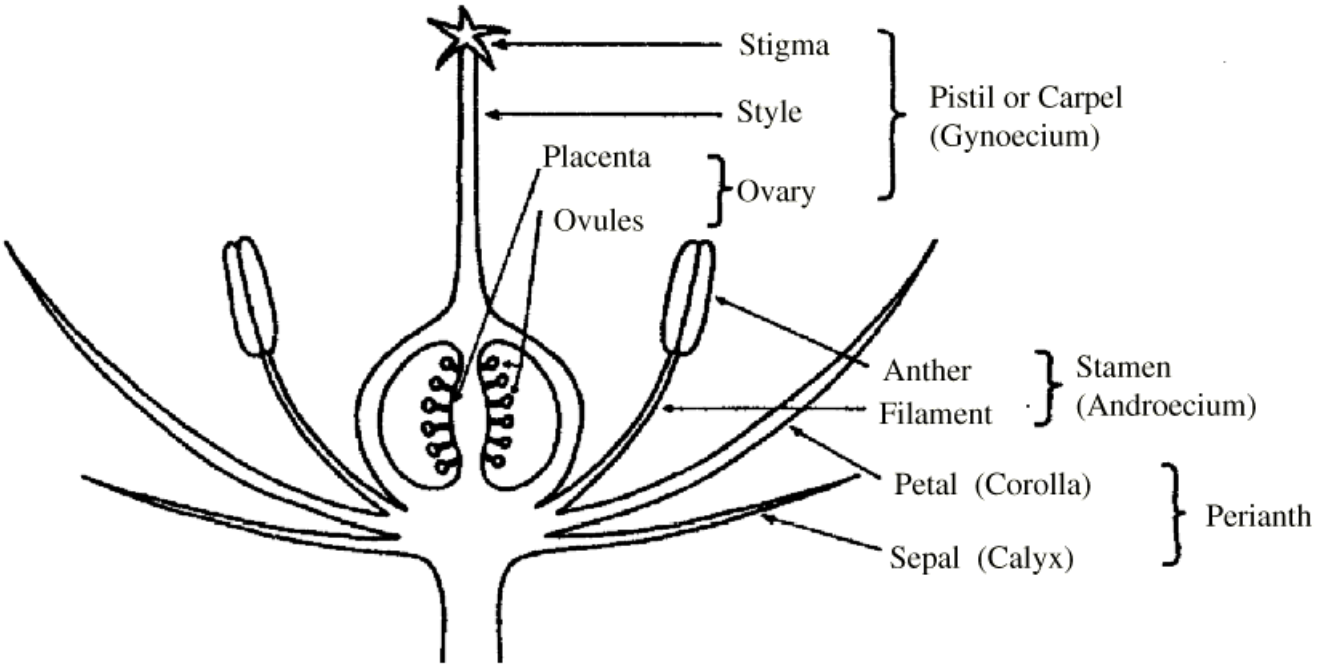
RUSHES, BULLRUSHES, SPIKERUSHES:

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).*

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.**

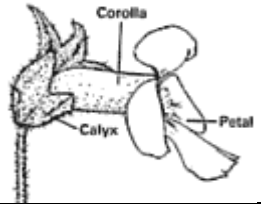
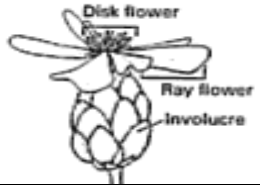
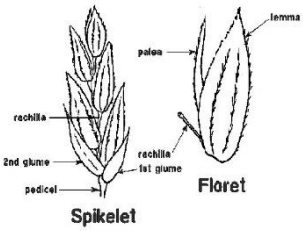
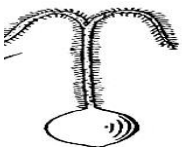
**Petals – Are usually showy. Attract insects to pollinate the plant.**

**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)** | Symetrical – can be divided two ways | University of Illinois  | ROSE FAMILY, PHLOX FAMILY, BORAGE FAMILY, MUSTARD FAMILY<br>Prairie rose, Hood phlox, houndstongue, western wallflower |
| **IRREGULAR (NON-TYPICAL)** | Not symmetrical – can divide equally only once or not at all. | University of Illinois   | BUTTERCUP FAMILY, PEA FAMILY, MINT FAMILY<br>Larkspur, white pointloco, lupine, wild bergamont |
| **HEAD** | Heads are made of many flowers. | University of Illinois   | ASTER FAMILY<br><br>Knapweeds, thistles, hairy goldenaster, sunflowers, etc. |
| **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. | University of Illinois   | POACEAE FAMILY<br><br>Kentucky bluegrass, western wheatgrass, needleandthread |
| **GRASS-LIKE** | Rush flowers are constructed like lily flowers, just smaller. The sedge flowers mature into capsules full of tiny seeds.<br><br>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. |  <br>University of Illinois  | CAREX FAMILY, RUSH FAMILY<br><br>Threadleaf sedge, needleleaf sedge, baltic rush |

**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

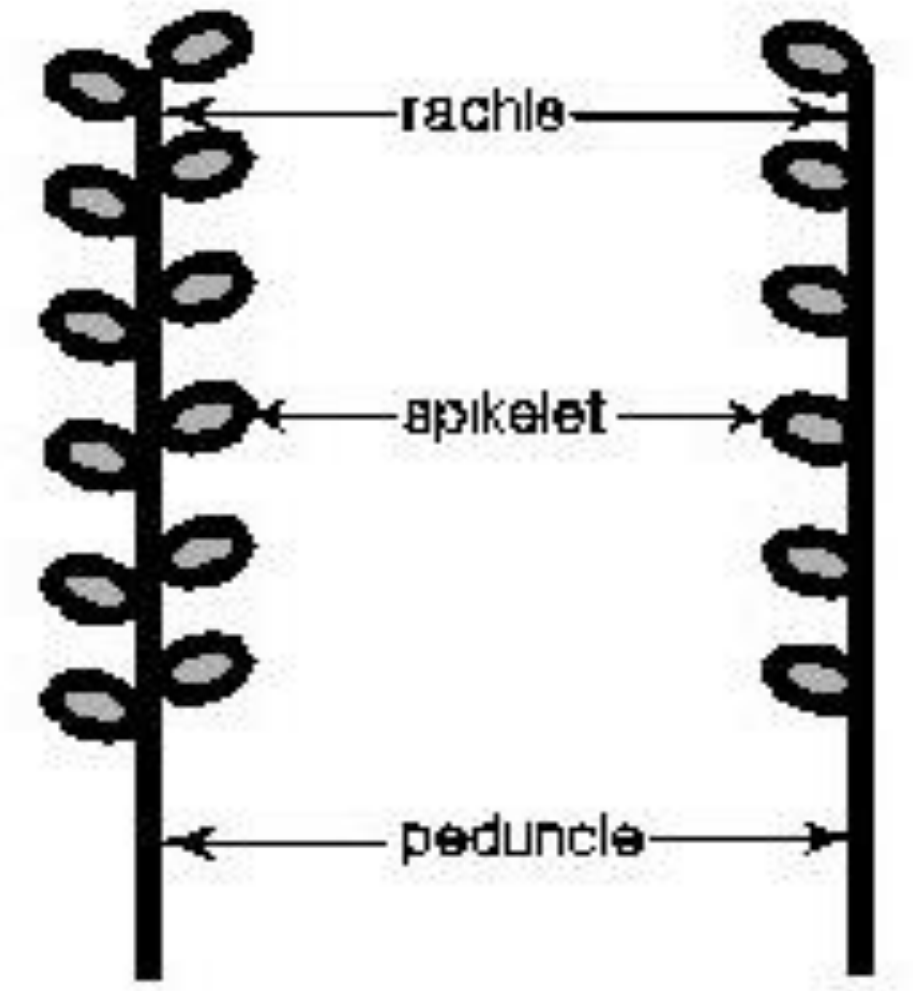
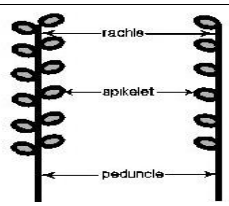
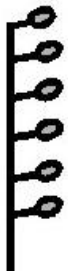
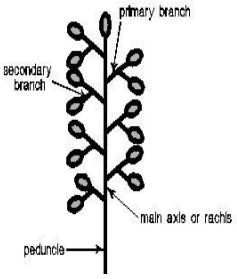
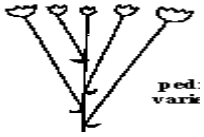



**Image: Kansas State University**

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

| COMMON SEEDHEADS | DESCRIPTION | VISUAL | EXAMPLE |
|---|---|---|---|
| **SPIKE** | Flowers are attached directly to the rachis |  | Wheatgrasses, woolly indianwheat, yellow evening primrose, skunk cabbage |
| **RACEME** | Flowers attach to a pedicel which attaches to a rachis it is a raceme (one branch)<br><br>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)<br><br>The length of the panicle branches varies. Japanes brome would have long panicle branches, while prairie junegrass and timothy would have very short branches (compact panicle). |  | Prairie junegrass (compact), Japanese brome, green needlegrass, Kentucky bluegrass, Idaho fescue, switchgrass |

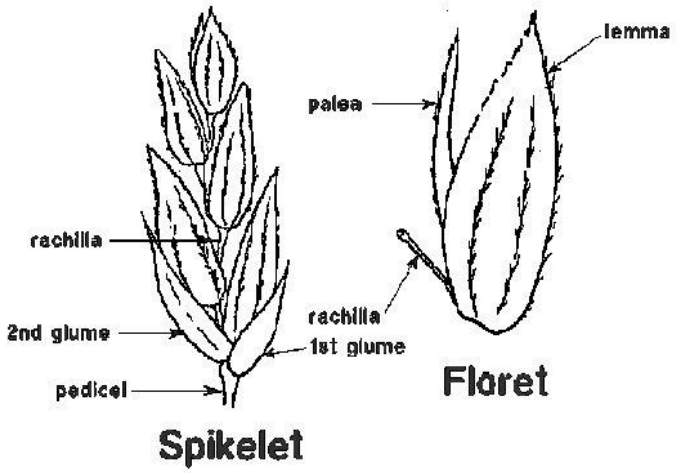
**There are other seedhead/flower variations in forb and shrub plant types, some of which are illustrated below.**

| SEEDHEADS/ FLOWER ARRANGELMENTS | DESCRIPTION | VISUAL | EXAMPLE |
|---|---|---|---|
| **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 |
| **HEAD** | A dense cluster of flowers. |  | arrowleaf balsamroot, heart-leaf arnica, stiff sunflower, dandelion, daisy fleabane, Canada thistle |
| **Solitary** | Single | | Sometimes rose species. |
| **UMBEL** | A flat-topped inflorescence with branches that radiate from a common point. |  | onion, leafy spurge, buckwheat spp. |

**GRASS SEEDHEADS**

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

Image: University of Illinois Turfgrass Program

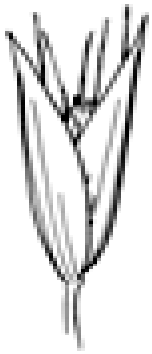



Grass seedheads have spikelets that consist of glumes (modified leaves) and florets (flowers). Look at some grass spikelets. The spikelets can be long and narrow (sandberg bluegrass, or short and wide (Kentucky bluegrass).

Spikelets 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 (membraneous), 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:

| **Membraneous** | **Bristlelike** |
|---|---|
|  |  |
| Ex. smooth brome | Ex. Canada wildrye |

| **Equal** | **Non-equal** |
|---|---|
|  |  |
| Ex. needleandthread | Ex. western wheatgrass |

**EXAMPLE PSI CASE:**

**Say that you have a plant that grows in the uplands on a sandy range site.**

**GENERAL OBSERVATIONS:**

1. **fibrous root system**
2. **no rhizomes**
3. **a bunchgrass habit**
4. **a hollow stem**
5. **2-ranked, linear, basal leaves with parallel veins**
6. **membranous, split ligule – no auricles**
7. **panicle seedhead arrangement**
8. **non-showy flowers**

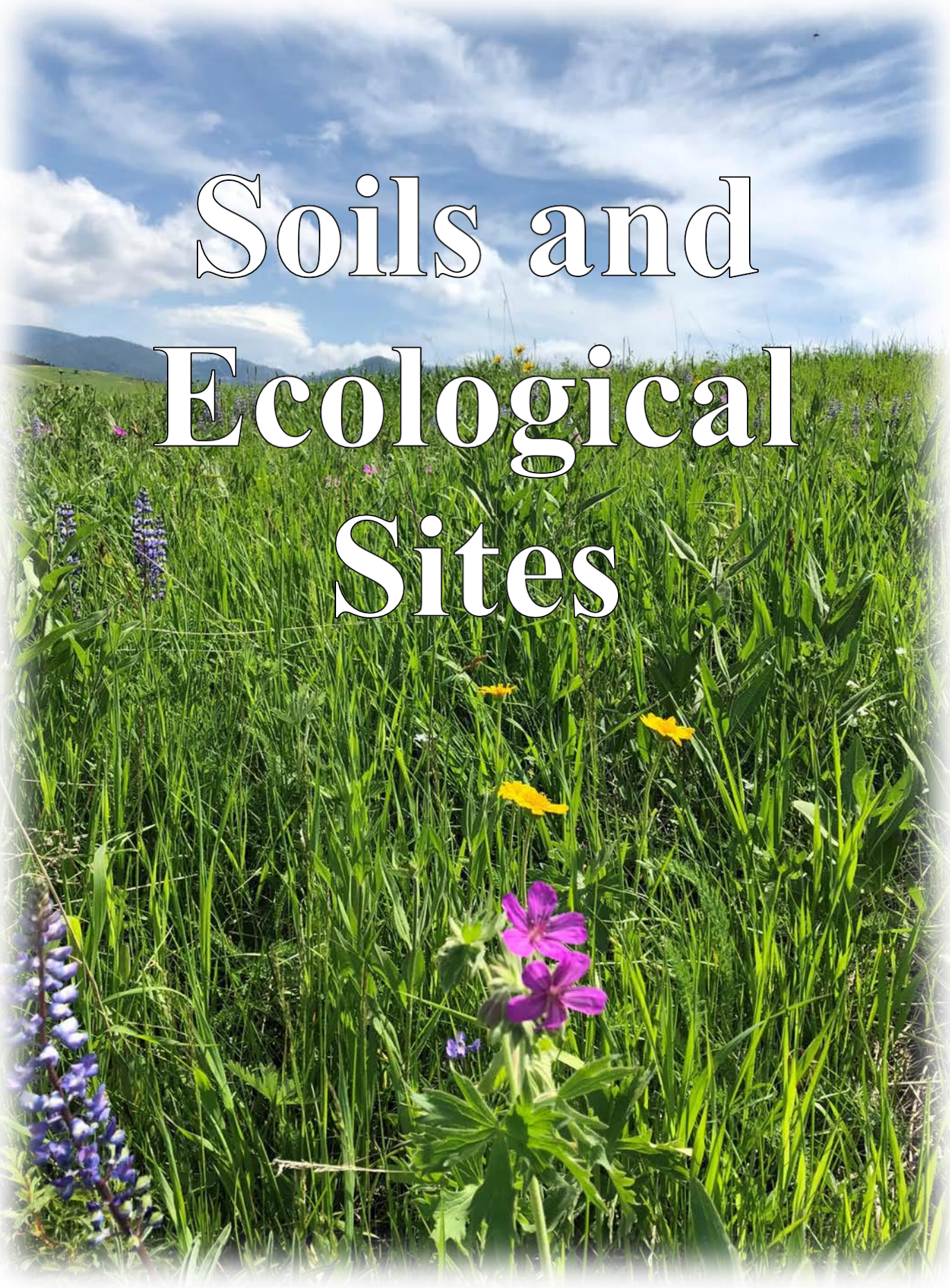
**This plant appears to be an upland grass species, but there are many grasses with the above characteristics.**

**We need to take the case one step further, go back to the evidence……... back to the autopsy table. Take the specimen out of cold storage and pull out your tools. Let's look at the details of the seedhead.**

**SEEDHEAD DETAILS**

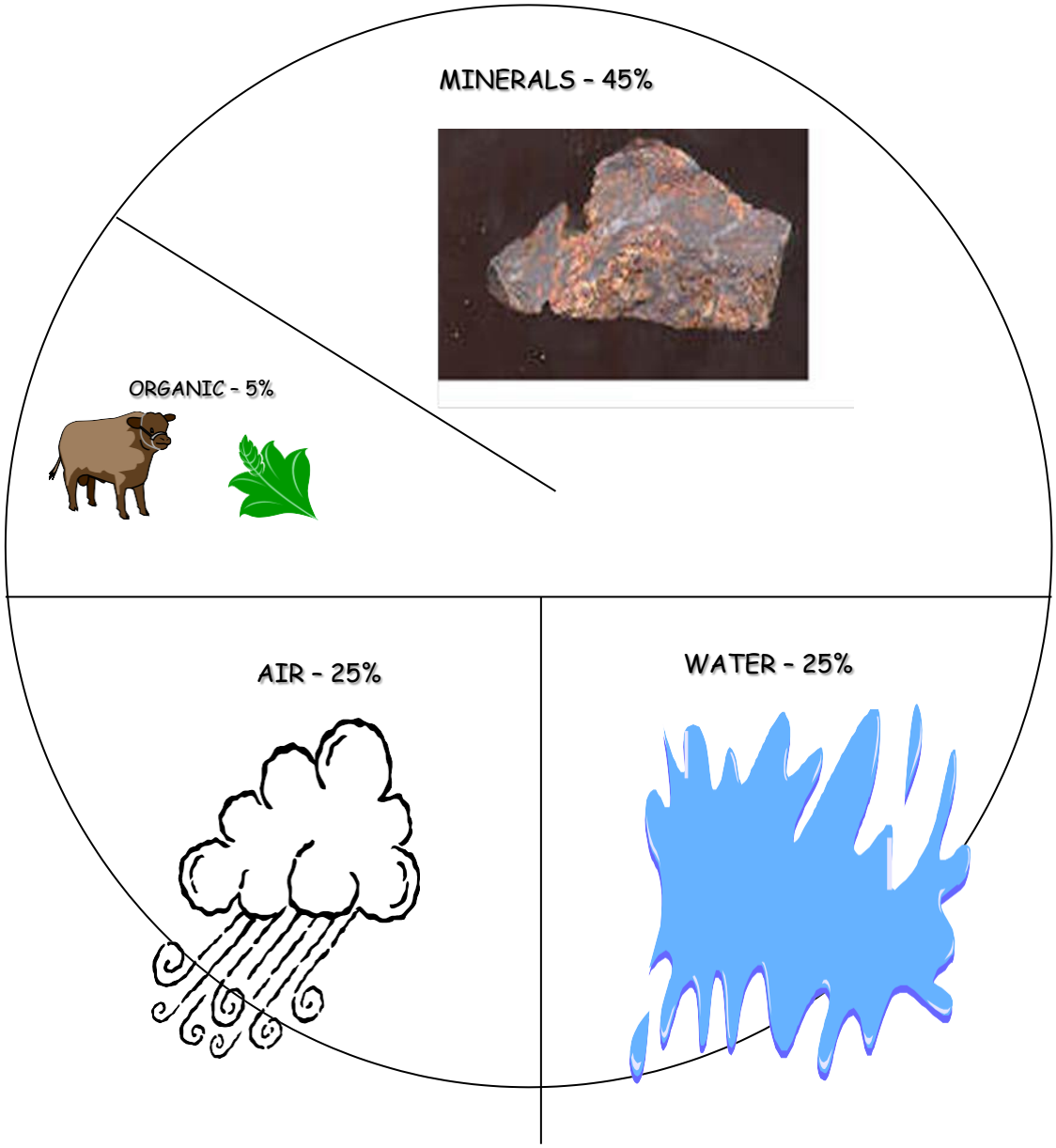
1. **loose, open panicle**
2. **membranous glumes, fairly equal in size, narrowing to a point**
3. **one, pointed floret with a long, bent awn (4-5 inches long)**
4. **the mature flower (floret) is hard and shiny**

**Using the key, we can now identify this plant.**


Soils and
Ecological
Sites

# SOIL IS THE NATURAL MEDIUM FOR PLANT GROWTH

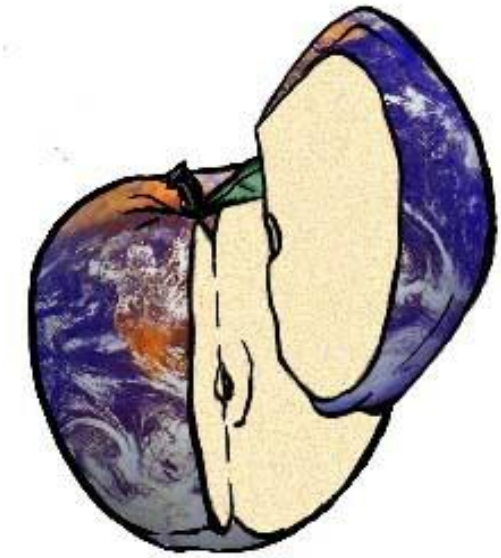
Soil is made of minerals, air, water and organic matter. Approximately 50% of a soil consists of pore space (water and air), while the remaining 50% is solid (minerals and organic matter).



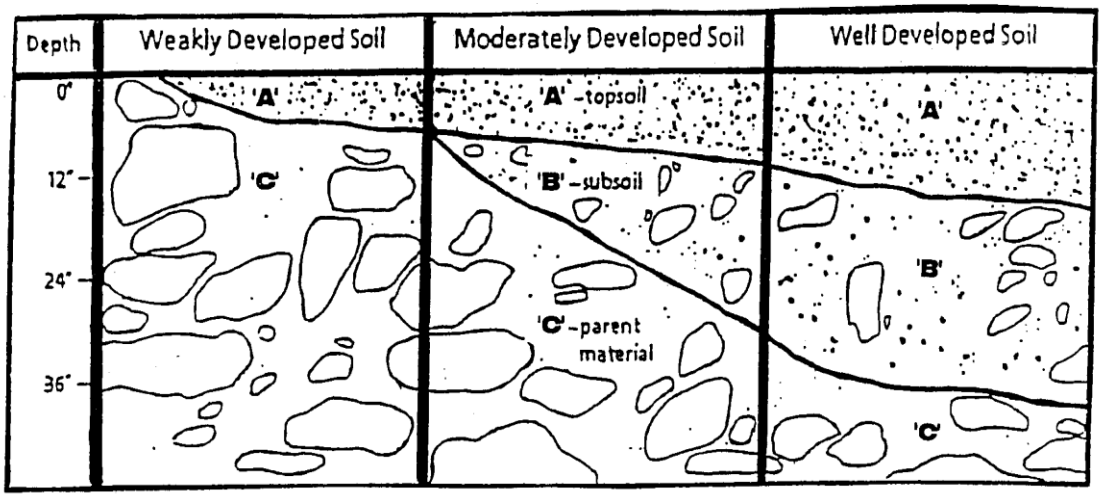
The earth is covered by a thin layer of soil. Only a tiny fraction of this layer is suitable for agriculture!

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.

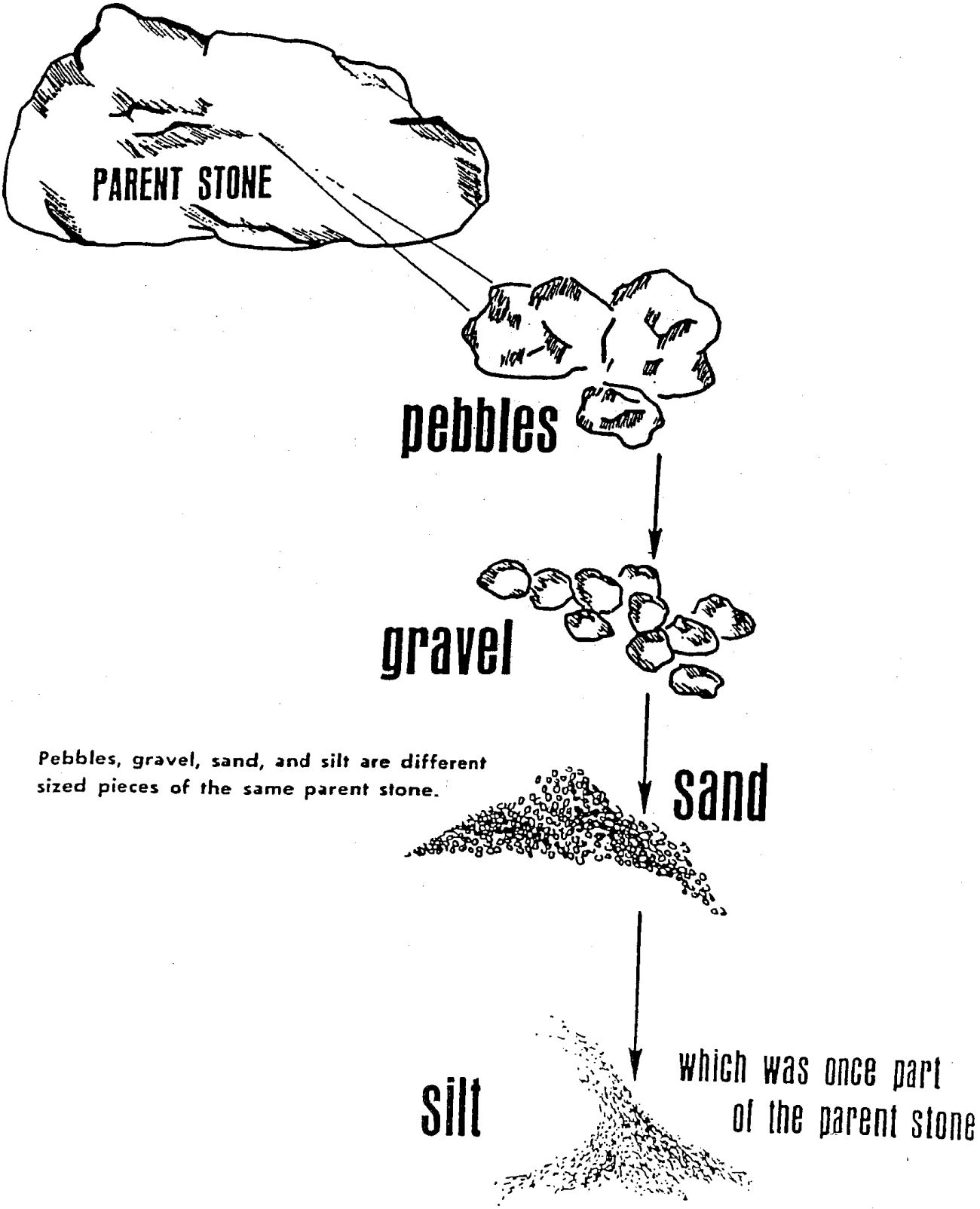
**TOPOGRAPHY:**

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.

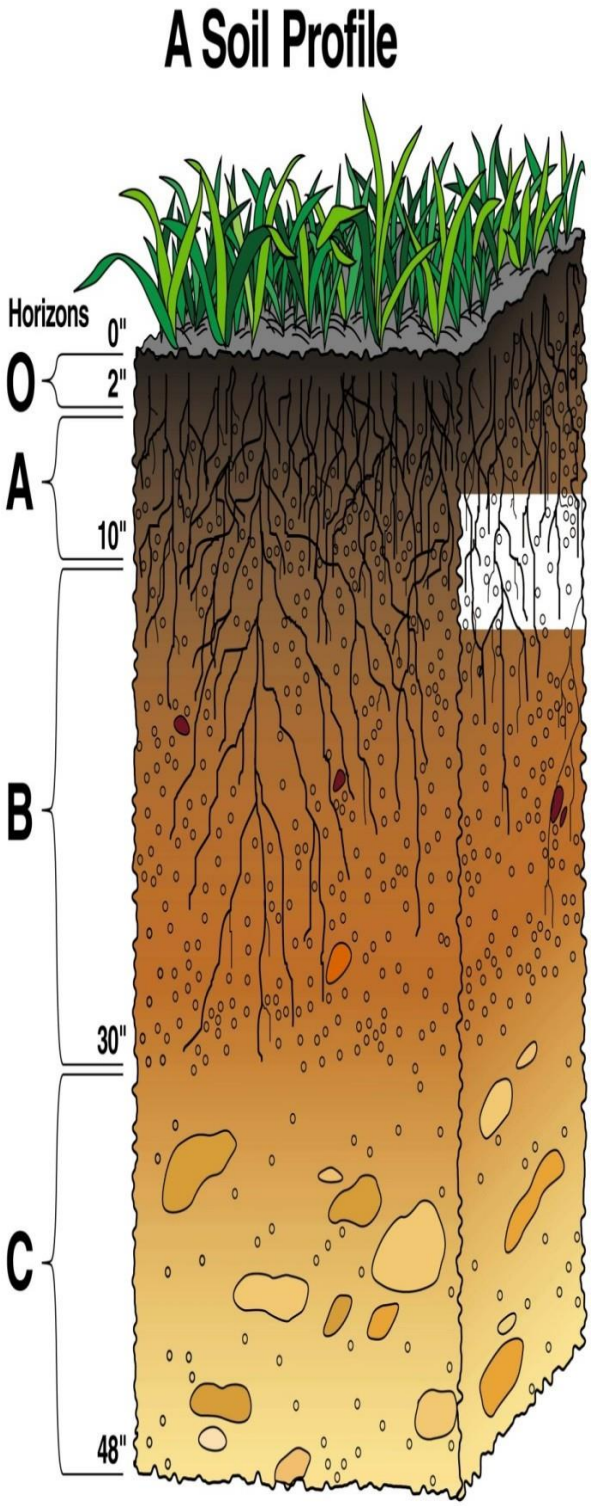
(A soil profile is a vertical “slice” of soil.)

**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).**

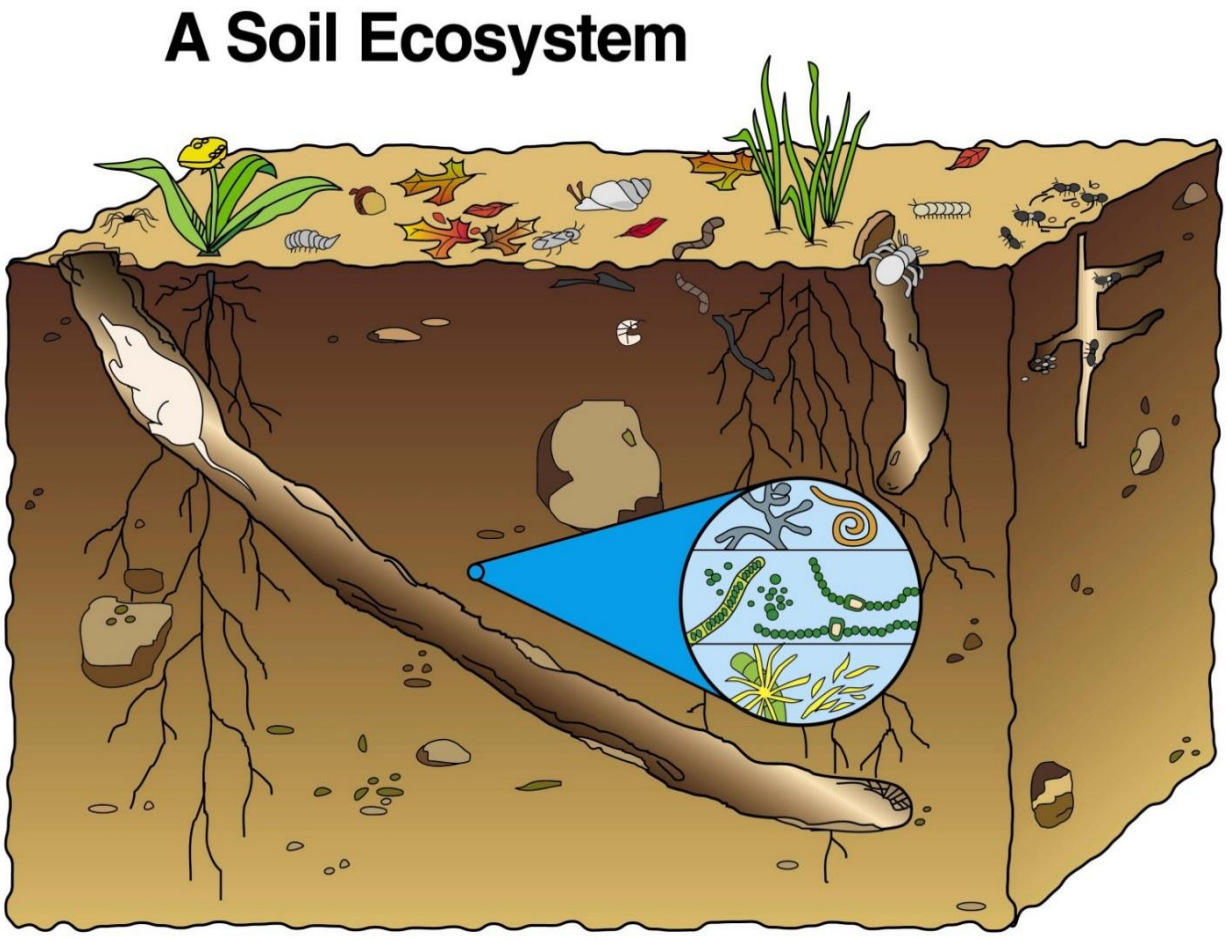


## A soil profile is very much alive!

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

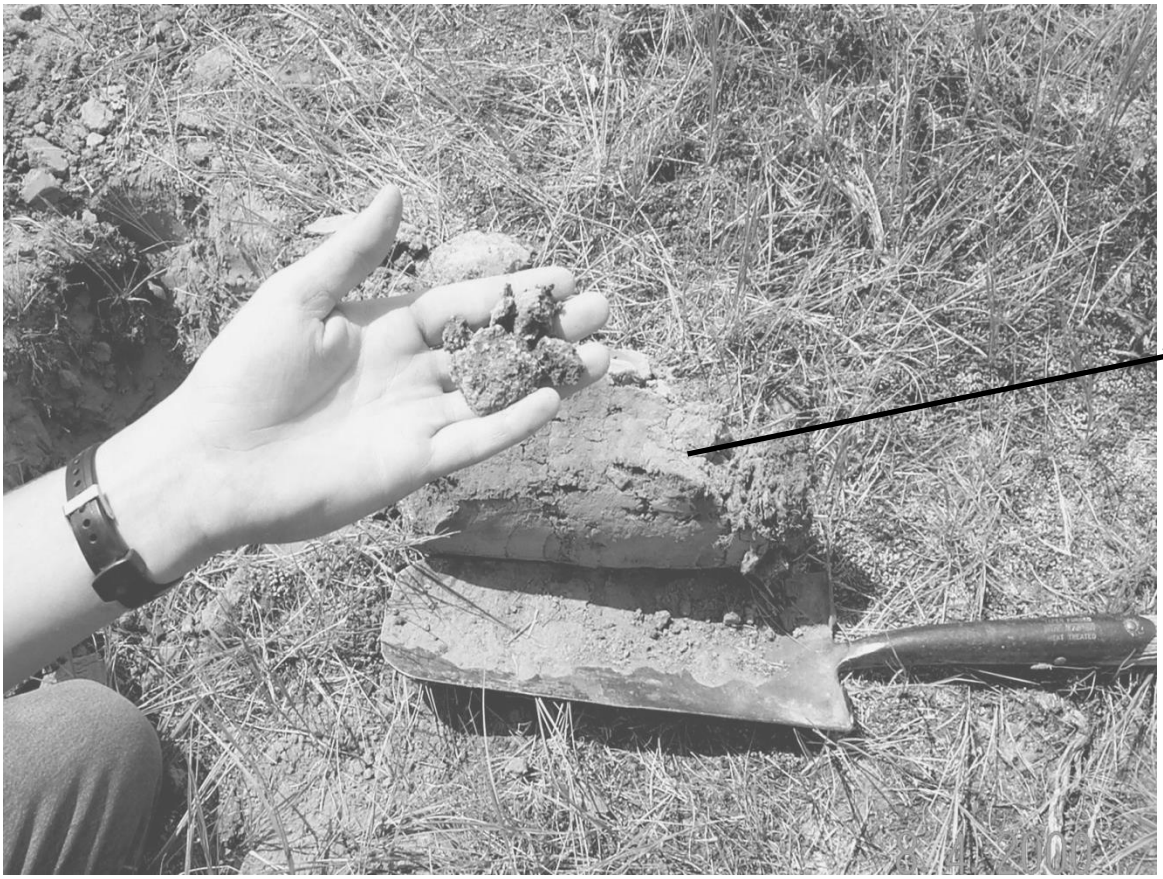
Soil Organic Matter is the dark colored portion of a soil profile, which includes plant and animal residues in various stages of decomposition.

### 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

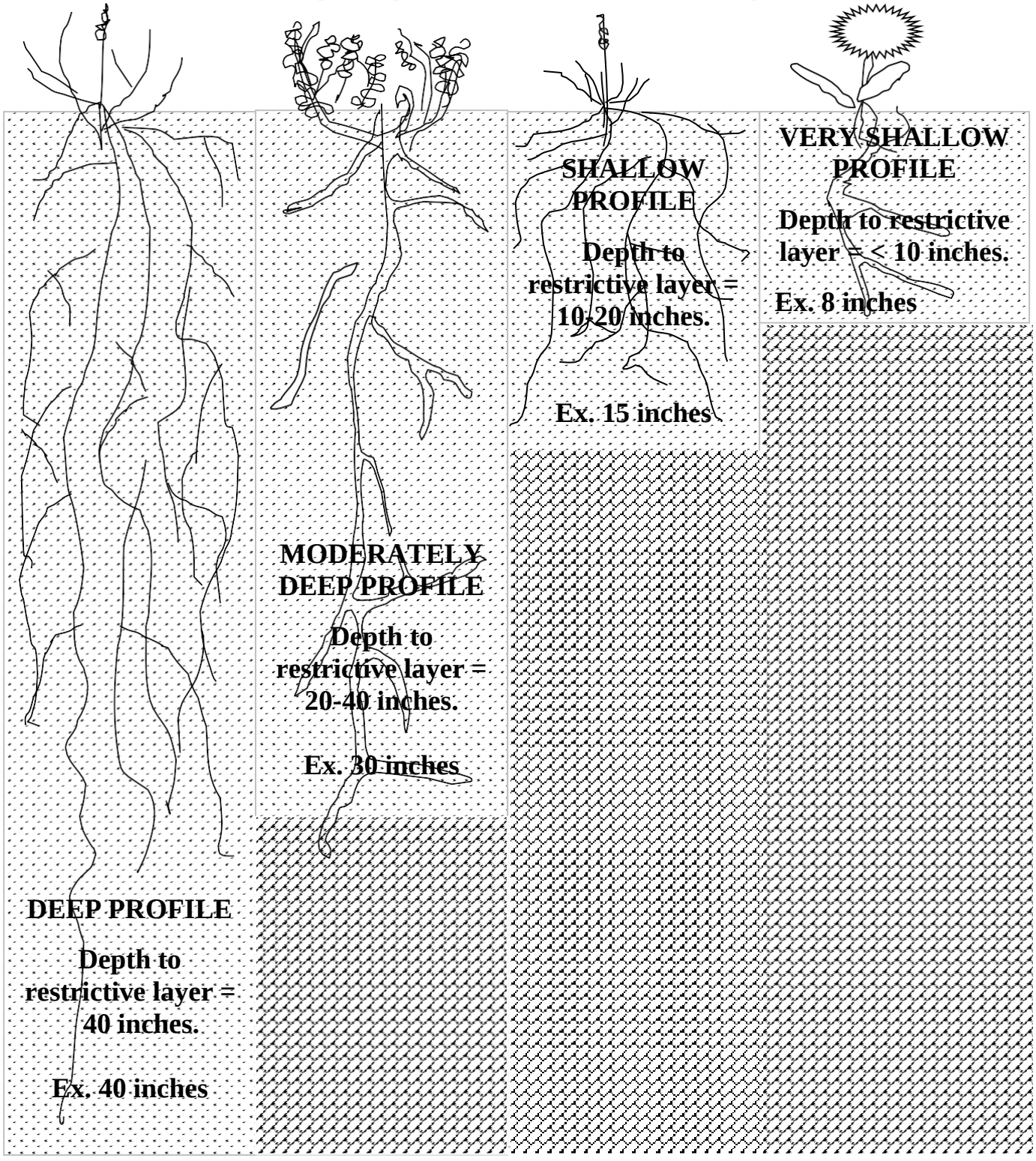
c

***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*.

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# 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)

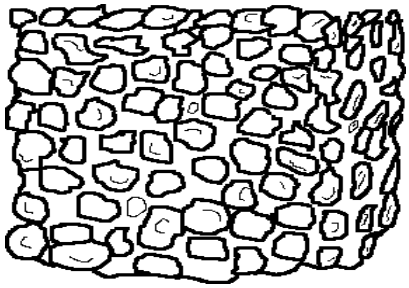
# SOIL STRUCTURE

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)

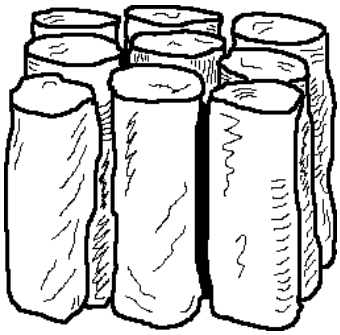
# BASIC KINDS OF SOIL STRUCTURE

**Single Grained:** Soil particles are not bound together. There is no structure. Think of beach sand.

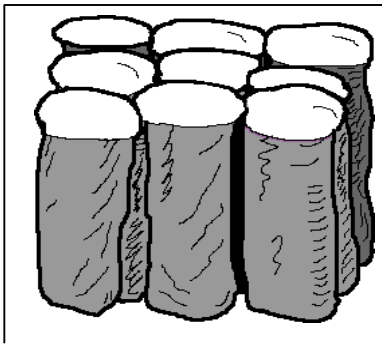


**Granular:** Small, non-porous clusters of soil particles with irregular, rounded surfaces.

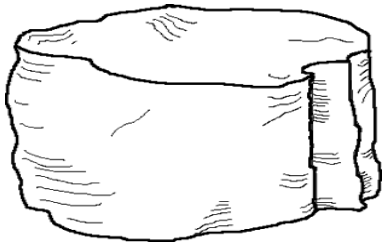
**Blocky:** Cube-shaped cluster of soil particles. Angular blocks have prominent edges. Sub-angular blocks have rounded edges.



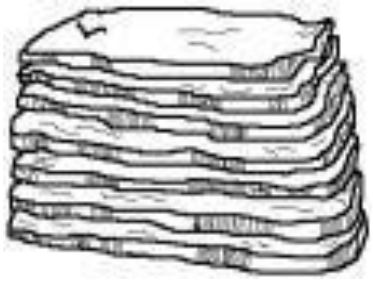
**Prismatic:** Pillar-shaped cluster of soil particles. The cluster is longer than wide and has a flat top.



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



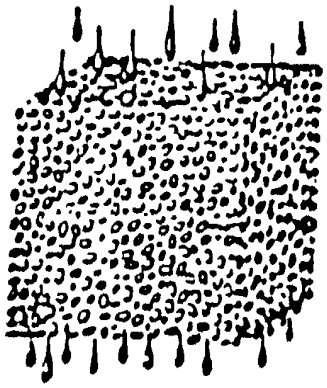
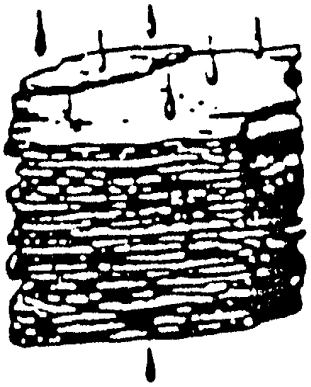
**Massive:** Soil particles are clustered together, but with little definition. No structure.

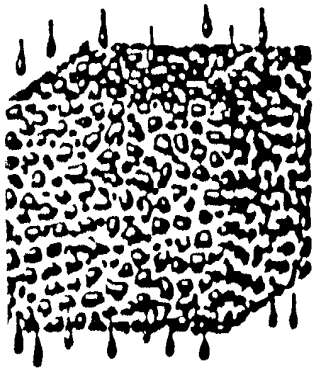
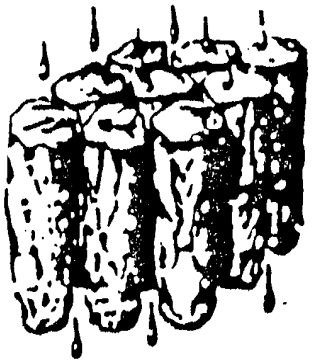
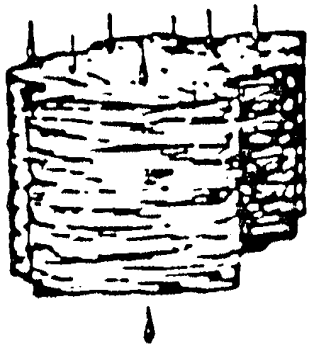


**Platy:** Cluster of soil particles consisting of thin sheets.

(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 texture of the surface layer influences:**

1. **How easy is it to till soil**
2. **How much a soil will erode**
3. **How much water a soil can store**
4. **How many nutrients plants can use**
5. **Which plants grow on the soil**

(Photo courtesy of Rebecca Wolenetz)

# 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 and can be seen and felt (gritty).

Silt particles are smaller than sand. Silt has the same characteristics as the original stone. Silt is formed when grains of sand are broken down mechanically or dissolved by chemicals. Silt particles have rounded corners like grains of flour.

Clay particles are mineral crystals formed by a chemical reaction. Clay crystals are flat and fit closely together. Clay particles are very small (.002mm or less) and feel greasy and sticky when wet.

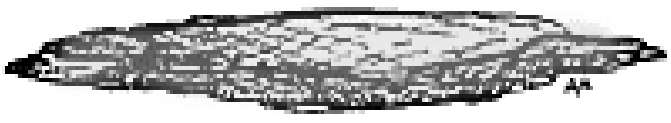
# PARTICLE SIZE

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

**SAND**

**SILT**

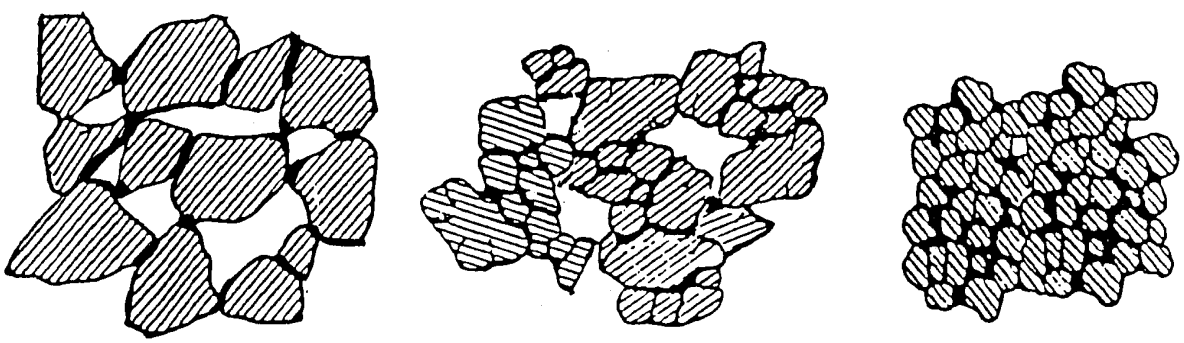
**CLAY**



# SURFACE AREA

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

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



SAND SILT CLAY

ils

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

***Sandy soils*** have less surface area than clayey soils. Coarse textured soils absorb but cannot store water and nutrients. Sandy soils erode easily, are drier and need more fertilizer.

***Clayey soils*** have small particle sizes and more surfaces for water and nutrients to attach to. Clayey soils store more water and nutrients. However, clay soils are more difficult to till. The soil surface crusts easier, and roots do not grow as deep.

***Silty textured soils* are generally considered the best for farming and ranching.**

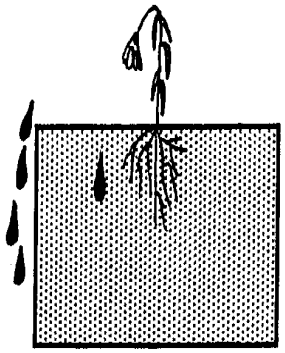
# THE RAINDROP ILLUSTRATION

- 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

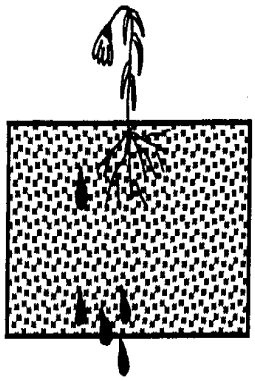
One raindrop stayed to water the plant, while four ran away.



*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

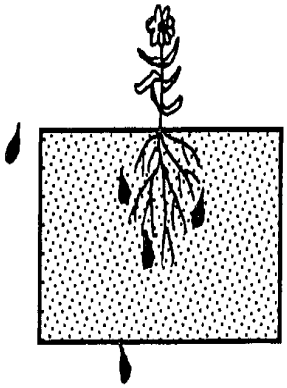
One raindrop stayed to water the plant, while four ran through the soil.



*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

# DETERMINING SOIL TEXTURE BY FEEL

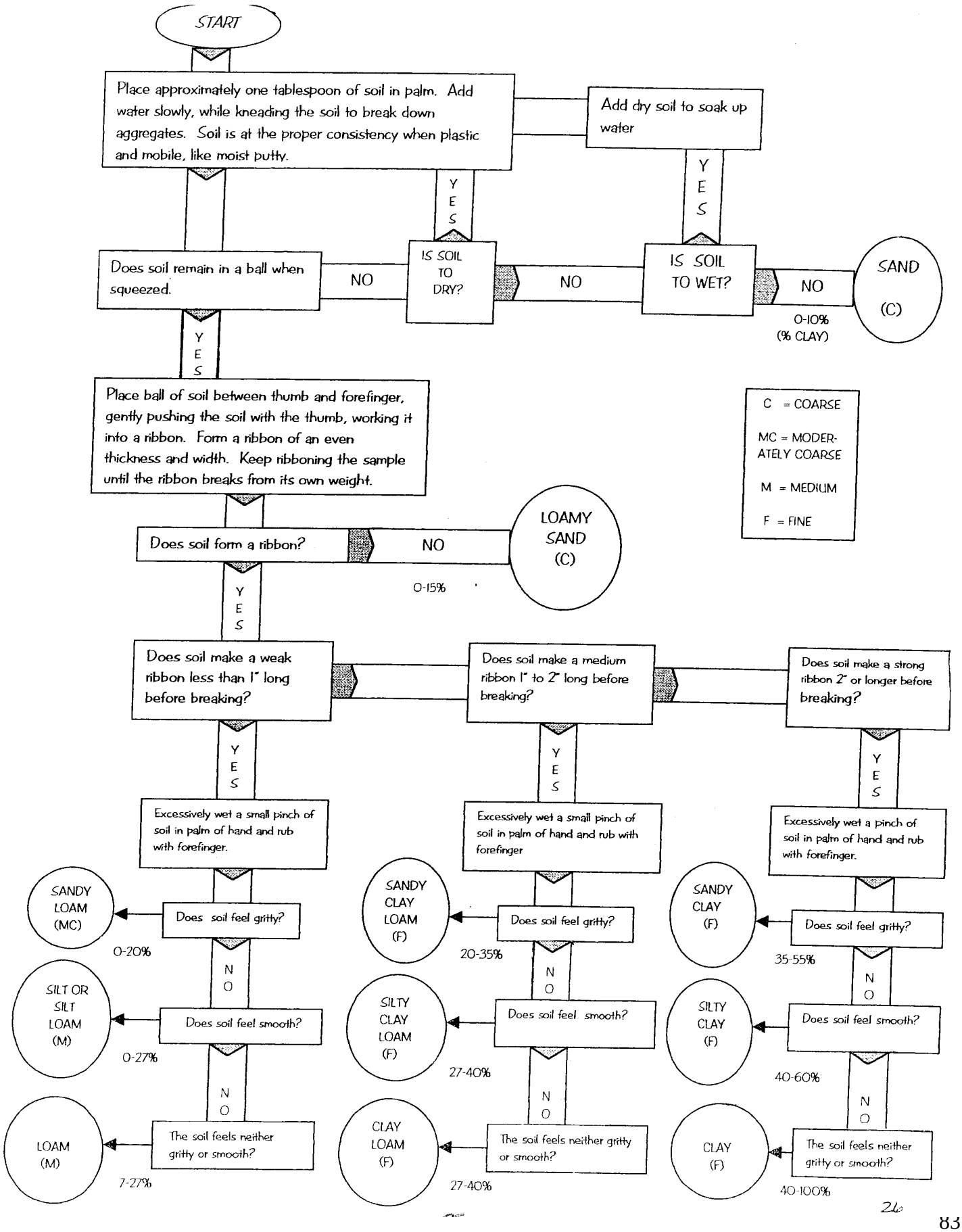
1. Place one tablespoon of soil in your hand.

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!**

# SOILTEXTURE KEY



# IDENTIFICATION OF ECOLOGICAL SITES

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

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

(Photo courtesy of the Montana Natural Heritage Program website)

The Wrangler Ecological Site Key focuses on three basic site factors

- Available soil moisture
- Topography (position on landscape, slope)
- Soil depth

# 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.***


Inventory and
Monitoring

# Rangeland Plant Community Dynamics

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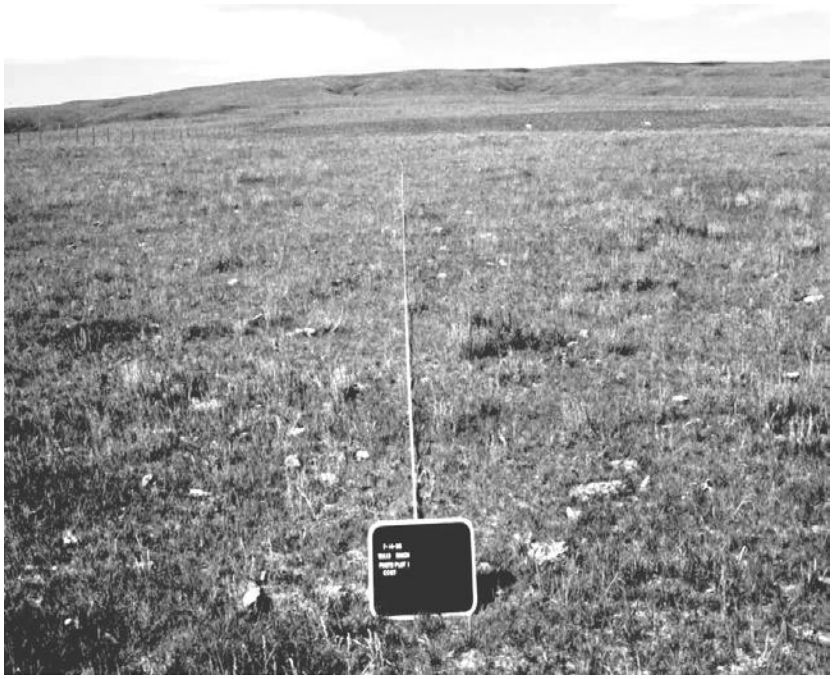
**The Historic Climax Plant Community** generally consists of tall and mid-sized perennial grasses. There is a high diversity of plants, including several native forbs and occasional shrubs.

**(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.

## 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.

## 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*

# PLANT COMMUNITY COMPOSITION AND PRODUCTION

**This inventory method is used to:**

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

## 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 at each foot mark record the plant type and species you find. Record bare ground or
   Litter if that is what you find. Calculate totals and break into percentages.

5. Use a 9.6 or 4.8 square foot hoop to sample the forage production in a plot along the transect. Determine how
   Many pounds of forage the plot is producing.

   When you move to the youth division, you will apply these skills to similarity indexes.

*Photo courtesy of Ekalaka NRCS*

# COVER DATA

## COVER POINT TRANSECT MONITORING FORM

| Cooperator: | DATE: | EXAMINER: | TRACT/FIELD: |
|---|---|---|---|
| Ecological site: | TRANSECT LOCATION: | | PRACTICE: |
| GPS Coordinates, Landmark: | Beginning marker: | Ending marker: | Photo's taken: YES NO |

## GROUND COVER DATA

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| CATEGOREY | Bare Ground | Litter | Gravel Lichens | Stone Clubmoss | Basal vegetation | TOTAL |
| DOT COUNT | | | | | | |
| GROUND COVER HITS | | | | | | |
| HITS COLUMN G TOTAL | | | | | | |

## BASAL VETEGATION AND CANOPY DATA

| G | H | I | J | K | L |
|---|---|---|---|---|---|
| Ground Cover or Basal Vegetation | Level 1 Canopy Cover | Level 2 Canopy Cover | Level 3 Canopy Cover | DOT Count | Total Canopy Cover Hits |
| | | | | | |
| Total Basal vegetation/ Plant hits | Total Plants hits | Total Plants hits | Total Plants hits | Total | Total |

% Bare Ground % ground cover % Basal Veg. % Canopy cover Total plant hits

% dominant spp. | % 2nd dominant spp | % 3rd dominant spp

Comments:

NTTDFN(6) 2008

GUIDE FOR DETERMINING SIMILARITY INDEX (Range Condition) Central Rocky Mtns. 14-19”

| ECOLOGICAL SITES | Shallow Droughty (SwDr) | | Droughty Steep (DrStp) | | Loamy (Lo) | | Loamy Steep (LoStp) | | Droughty (Dr) | | Limy (Ly) | | Limy Droughty (LyDr) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GRASSES AND GRASSLIKES** | **%** | **lbs/ acre** | **%** | **lbs/ acre** | **%** | **lbs/ acre** | **%** | **lbs/ acre** | **%** | **lbs/ acre** | **%** | **lbs/ acre** | **%** | **lbs/ acre** |
| Basin wildrye | 0 | 0 | 0 | 0 | 10 | 210 | 5 | 85 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bluebunch wheatgrass | 50 | 525 | 60 | 870 | 55 | 1155 | 70 | 1190 | 70 | 1295 | 65 | 910 | 75 | 1031 |
| Bearded or Slender wheatgrass | 1 | 11 | 1 | 15 | 5 | 105 | 5 | 85 | 5 | 93 | 3 | 42 | 3 | 41 |
| Green needlegrass | 1 | 11 | 10 | 145 | 10 | 210 | 15 | 255 | 10 | 185 | 0 | 0 | 0 | 0 |
| Idaho fescue | 15 | 157 | 20 | 290 | 10 | 210 | 10 | 170 | 10 | 185 | 5 | 70 | 5 | 69 |
| Spike fescue | 10 | 105 | 5 | 73 | 5 | 105 | 5 | 85 | 15 | 278 | 10 | 140 | 15 | 206 |
| Needle and thread | 10 | 105 | 10 | 145 | 5 | 105 | 5 | 85 | 5 | 93 | 15 | 210 | 15 | 206 |
| Cusick's bluegrass | 5 | 53 | 5 | 73 | 5 | 105 | 5 | 85 | 5 | 93 | 3 | 42 | 3 | 41 |
| Columbia needlegrass | 1 | 11 | 10 | 145 | 10 | 210 | 10 | 170 | 5 | 96 | 0 | 0 | 0 | 0 |
| Prairie junegrass | 5 | 53 | 5 | 73 | 5 | 105 | 5 | 85 | 3 | 55 | 5 | 70 | 5 | 69 |
| Plains reedgrass | 2 | 21 | 5 | 73 | 5 | 105 | 3 | 51 | 3 | 55 | 3 | 42 | 5 | 69 |
| Sandberg bluegrass | 5 | 53 | 5 | 73 | 5 | 105 | 3 | 51 | 3 | 55 | 3 | 42 | 5 | 69 |
| Blue grama | 3 | 32 | 5 | 73 | 0 | 0 | 0 | 0 | 3 | 55 | 3 | 42 | 3 | 41 |
| Western or thickspike wheatgrass | 10 | 107 | 5 | 73 | 5 | 105 | 10 | 170 | 10 | 185 | 10 | 140 | 10 | 137 |
| Other native grasses Other native grasslikes | 1 | 11 | 2 | 29 | 2 | 42 | 3 | 51 | 3 | 55 | 10 | 140 | 5 | 69 |
| **Maximum Grasses Allowed** | 70 | 735 | 80 | 1130 | 75 | 1575 | 78 | 1326 | 83 | 1535 | 85 | 1190 | 90 | 1238 |
| **FORBS:** | | | | | | | | | | | | | | |
| **Maximum Forbs Allowe d*** | 15 | 157 | 10 | 145 | 10 | 210 | 10 | 170 | 10 | 185 | 10 | 140 | 5 | 70 |
| **SHRUBS:** | | | | | | | | | | | | | | |
| Fringed sagewort | 15 % Not more than 65 # each or 158# Total Shrub | | 10% Not more than 75# each or 145# Total Shrub | | 15% Not more than 105# each or 315# Total Shrub | | 12% Not more than 100# each or 204 # Total Shrub | | 7 % Not more than 40# each or 130# Total Shrub | | 5% Not more than 45# each or 70 # Total Shrubs | | 5 % Not more than 45# each or 69# Total | |
| Big sagebrush | | | | | | | | | | | | | | |
| Rubber rabbitbrush | | | | | | | | | | | | | | |
| Skunkbush sumac | | | | | | | | | | | | | | |
| Spineless horsebrush | | | | | | | | | | | | | | |
| Shrubby cinquefoil | | | | | | | | | | | | | | |
| Snowberry | | | | | | | | | | | | | | |
| Winterfat | | | | | | | | | | | | | | |
| Other Native shrubs | | | | | | | | | | | | | | |
| **Maximum Shrubs Allowed** | 15 | 158 | 10 | 145 | 15 | 315 | 12 | 204 | 7 | 130 | 5 | 70 | 5 | 69 |
| **Total Production @ 17 inche s** | | 1050 | | 1450 | | 2100 | | 1700 | | 1850 | | 1400 | | 1375 |

*** 5% Limit on each Native Forb**

# 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

## 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.

Plants make their own food by photosynthesizing.

*Photosynthesis can be summed up in different ways:*

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

# Photosynthesis

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 plant growth. Roots supply the plant with water from the soil profile.

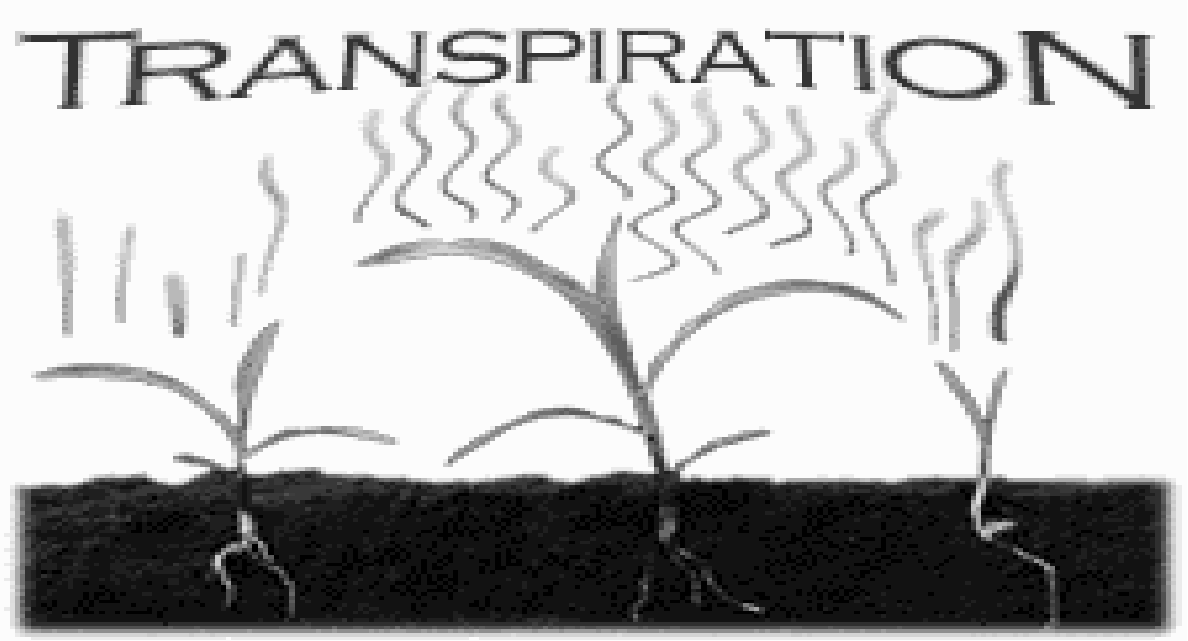
Water helps the plant maintain its shape and firmness. It also helps plant cells to grow.

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



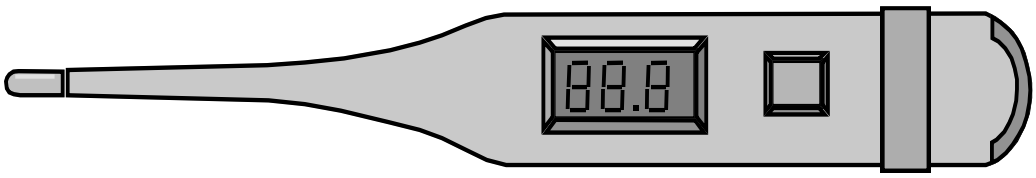
# Temperature - Growing Season

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.

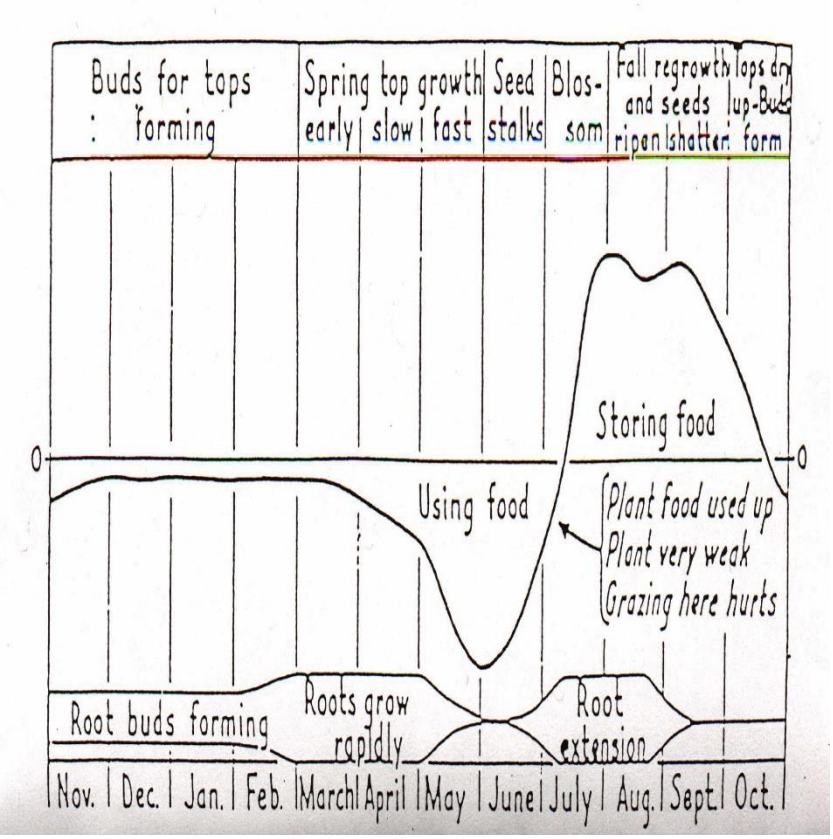
You can find climate summary information for your area at www.mtmastergardener.org/climate.html. All of the information is approximate. Expect the actual growing season to vary by plus or minus 2 weeks from year to year. Actual site conditions also play an important role in growing season characteristics.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

For Dillon:

| | |
|---|---|
| average date of last killing frost | June 6 |
| average date of first killing frost | September 7 |
| average growing season | 92 days |
| average annual precipitation | 11-14" |



# Annual growth cycle – Use and storage of carbohydrates

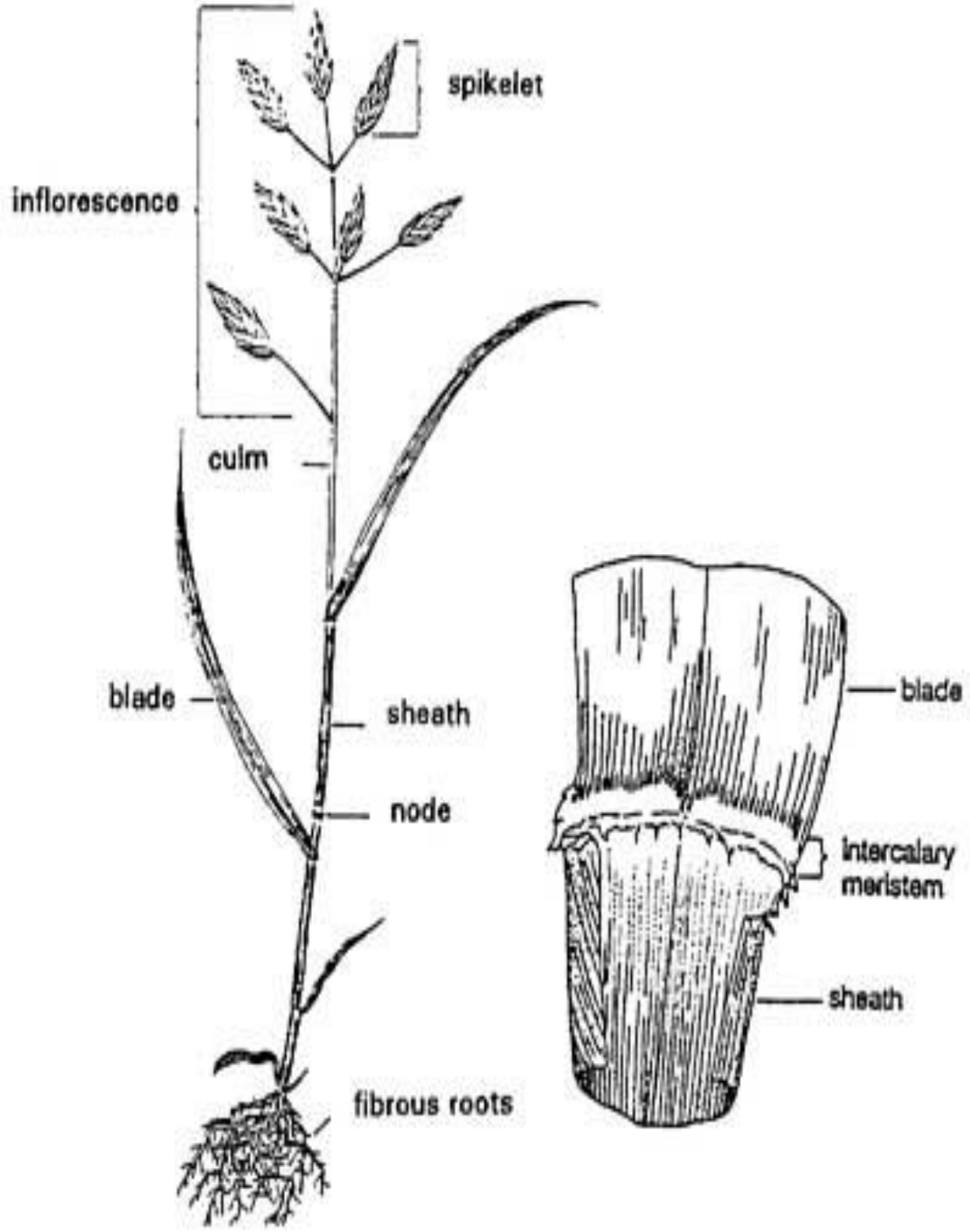



**This diagram shows what happens during the year in a grass plant that grows in Montana (cold winters, dry summers).**

**Three events are shown. The top line of the diagram is top-growth. The second line is the rate of plant food use and storage. 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 a grass plant*



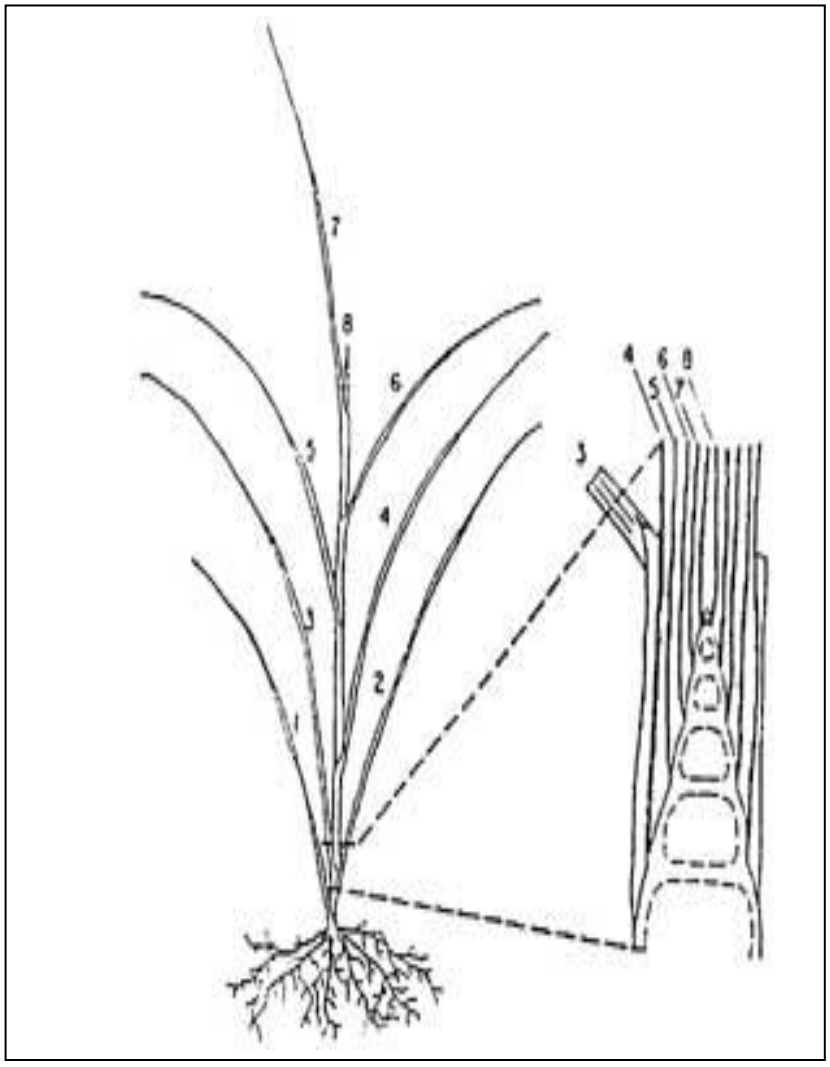
# *How do grass plants grow?*

## ***GROWTH POINTS:***

Grasses have tillers (also called shoots). Tillers consist of growing points which develop into seedheads, stems, leaves, roots, nodes and buds.

***Growing points have meristem tissue that is capable of expanding and elongating.***

The meristem tissue of a developing tiller looks much like a folded up toy telescope, with many layers of developing leaves surrounding and protecting the growth point.

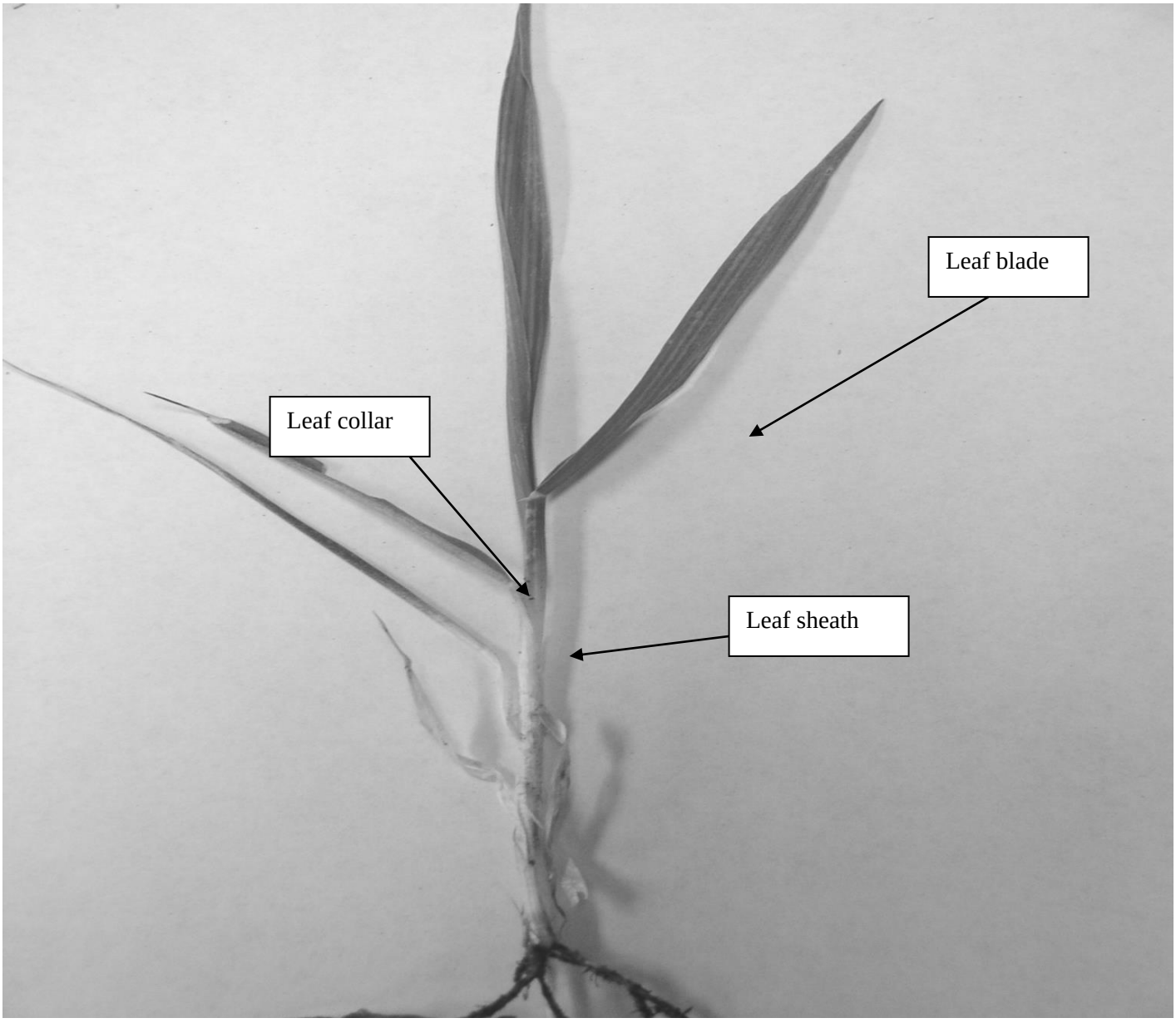


# Leaves

Leaves grow out of nodes and grow in a pattern. Leaf blades grow first **(from the bottom up – not the tip down),** followed by leaf sheaths. After leaf sheaths expand, the internode elongates. Finally, a bud is formed at the base of the leaf. Leaves let the plant photosynthesize.

More leaves, large leaves and new leaves equal more photosynthesis. Therefore, more energy will be available to plant tillers, crowns and roots.

(Photo courtesy of Ekalaka NRCS)



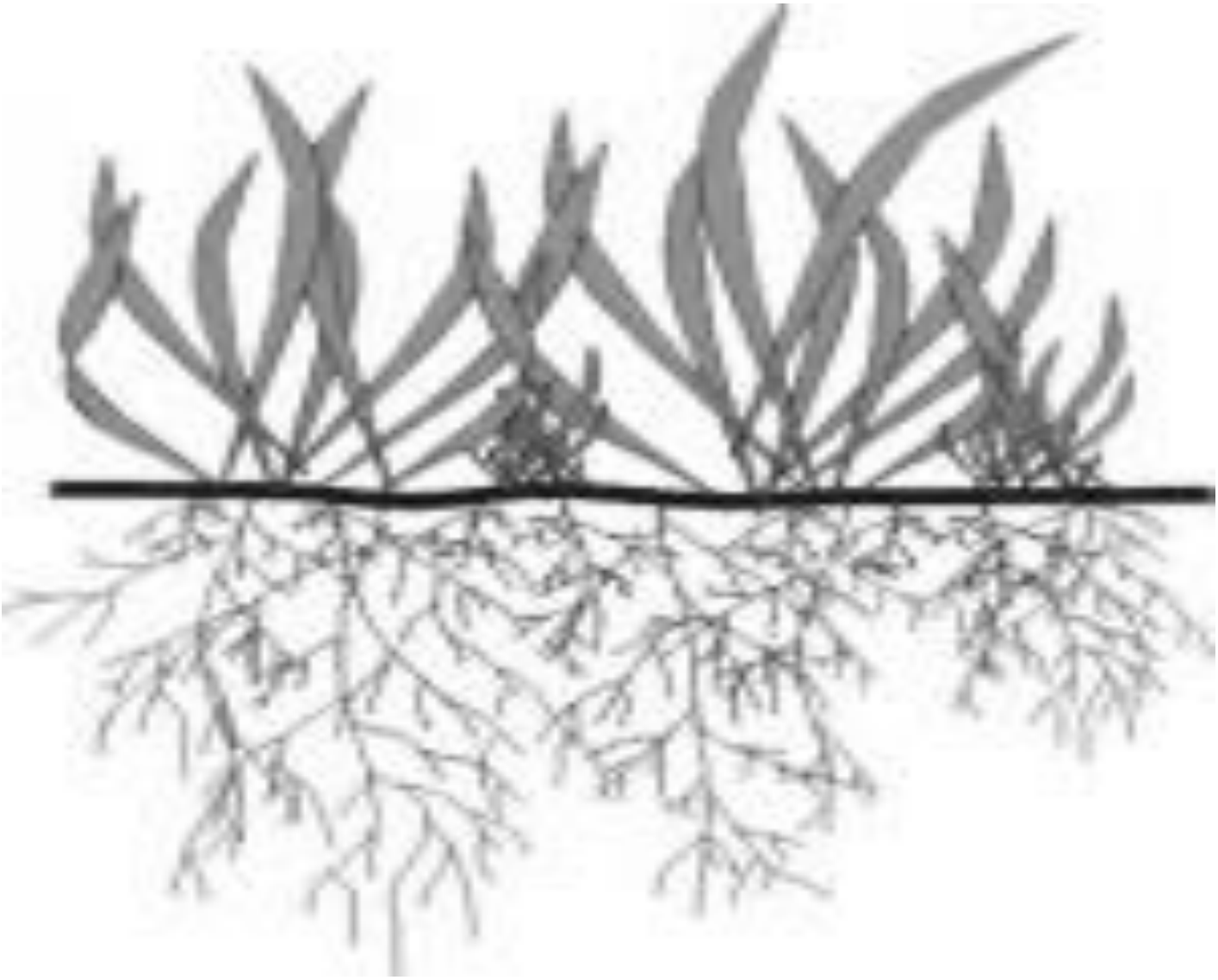
# Roots

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

In order to be successful, roots must keep expanding through the soil profile. Since roots don't live very long, the plant must keep making new roots.

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

Carbohydrates stored in plant roots are used mostly for root growth and maintenance, not for leaf or stem growth.



# Plant Crowns

*The crown is the base 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 start bud growth in the spring*
- *store energy to grow new leaves after the plant is grazed.*
- *are the areas where buds for next year's tillers are formed, maintained and protected through the fall and winter*

(Photo from Tarleton State University website)

**Crowns can be damaged during the winter, drought and overly-wet conditions.**

*If there is not enough litter left around the plant crown in the fall, the crown might be damaged during 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 saturated soils are also fragile.*

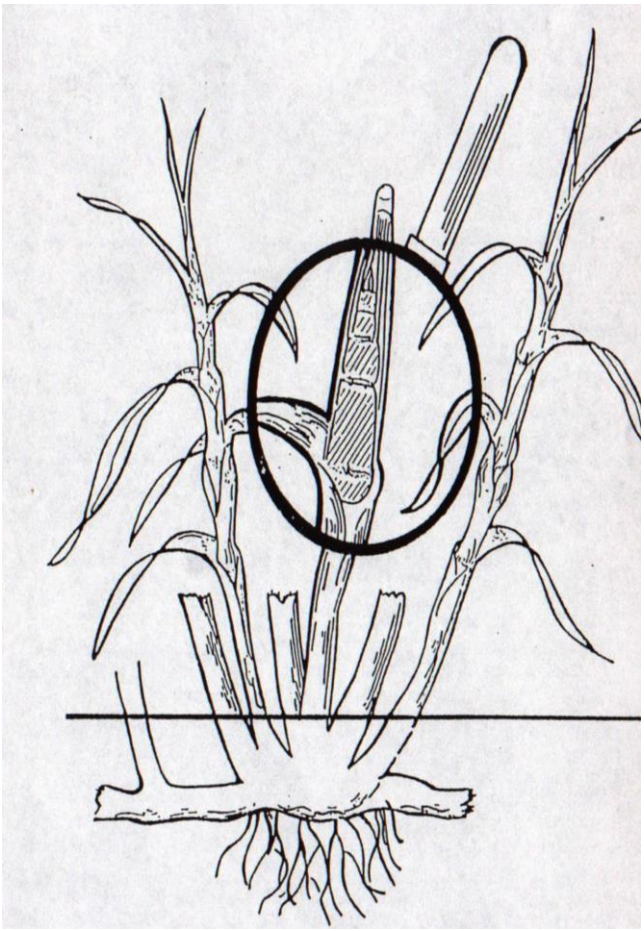
## Plant Growth Structures

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

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

## Growth points:

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

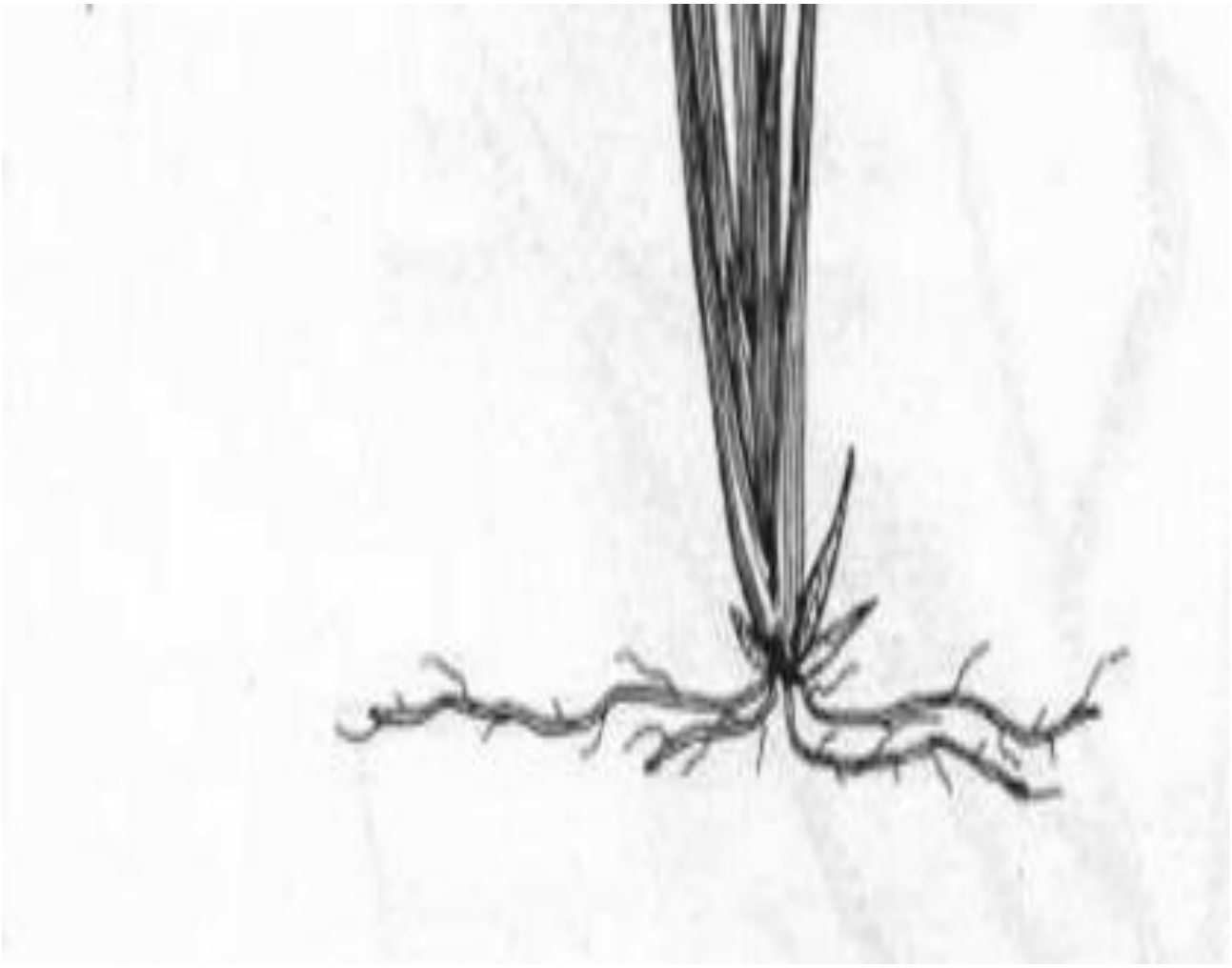


# Buds

Buds are structures that hold and protect growing points/meristems. 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.

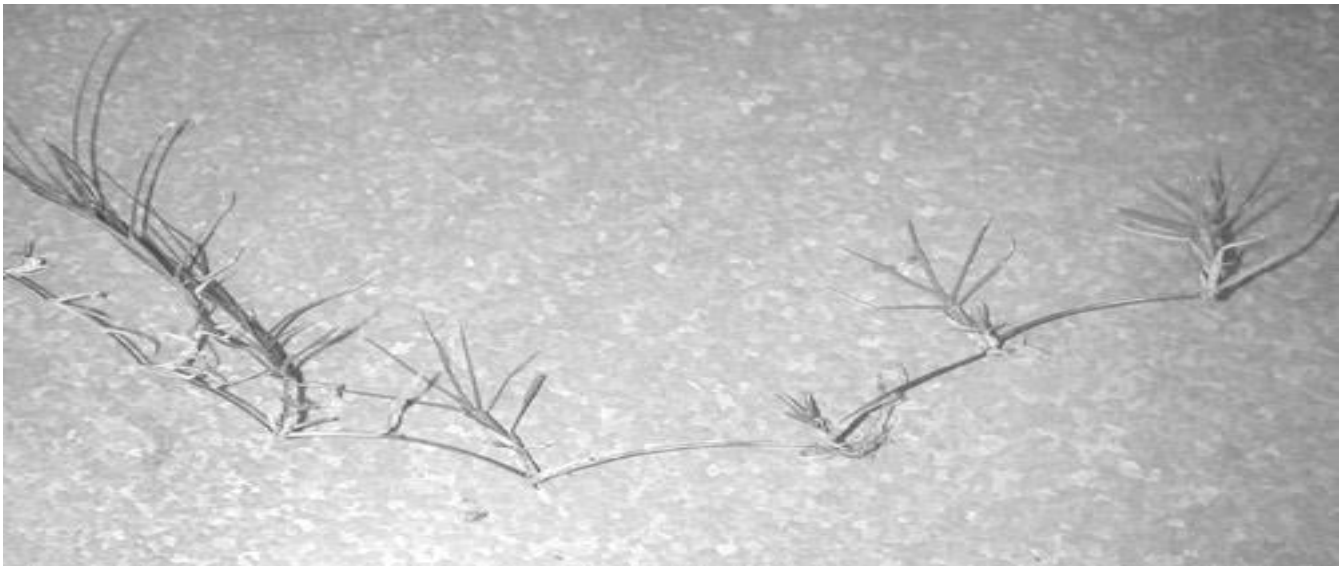


# Rhizomes

Rhizomes start from growth points in the plant crown and develop into stems that run sideways underground. Rhizomes are made of nodes and internodes. New roots are made at the nodes of rhizomes and new shoots (daughter plant) grow from the stem.


# Stolons

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



## Differences in plant growth and development

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

Bunchgrass vs. Sod-forming

Cool season vs. Warm season

Growth curves

(Photo courtesy of USDA-NRCS)

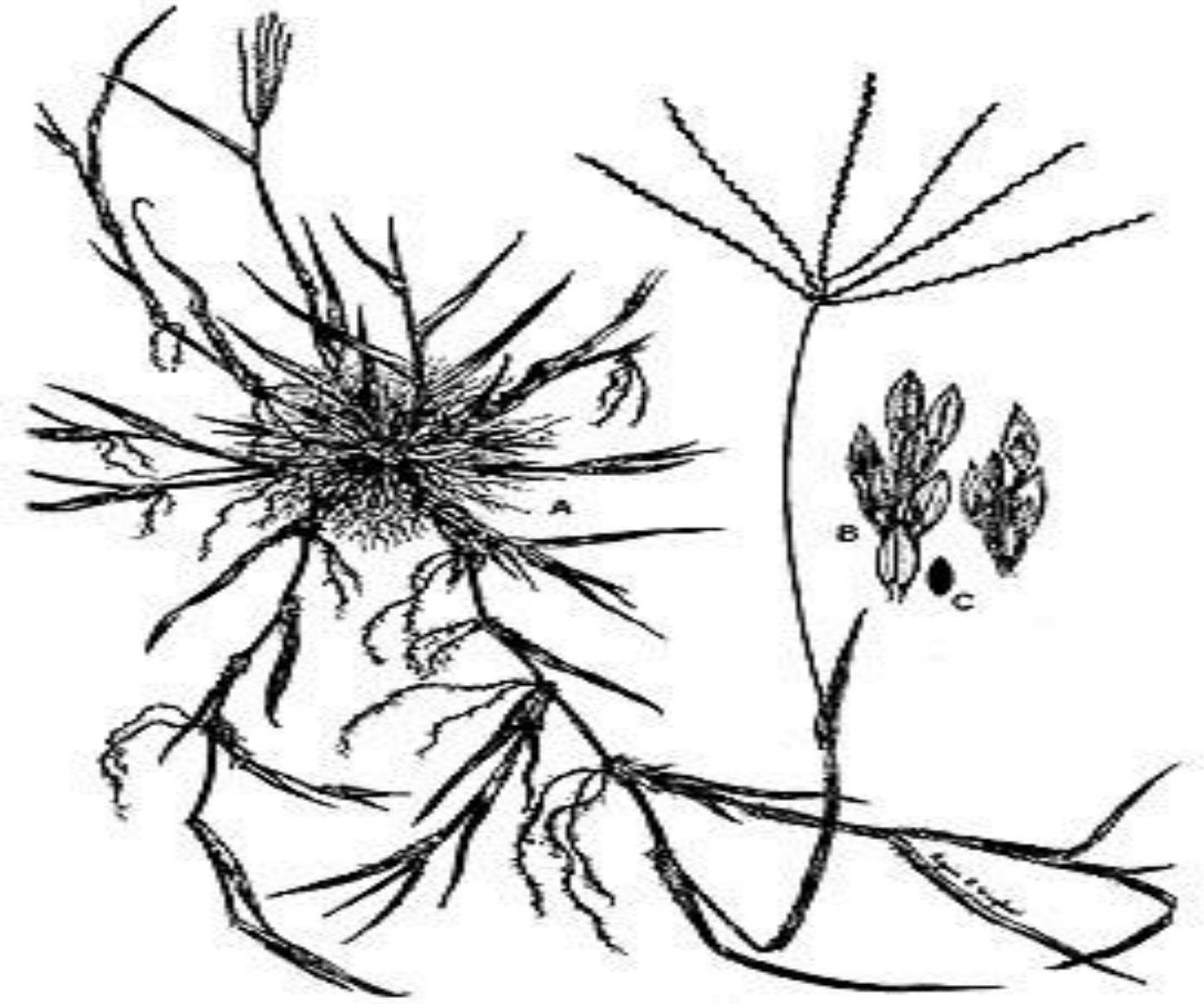
# Bunchgrasses

Bunchgrasses *do not* produce rhizomes or stolon's from adventitious buds. New shoots grow upright, alongside of the neighboring leaf sheaths. Therefore, bunchgrasses have a tufted habit, and do not spread outward. Examples are little bluestem and bluebunch wheatgrass.

(Photo courtesy of UIS Prairie Restoration Project website)

## Sod-forming grasses

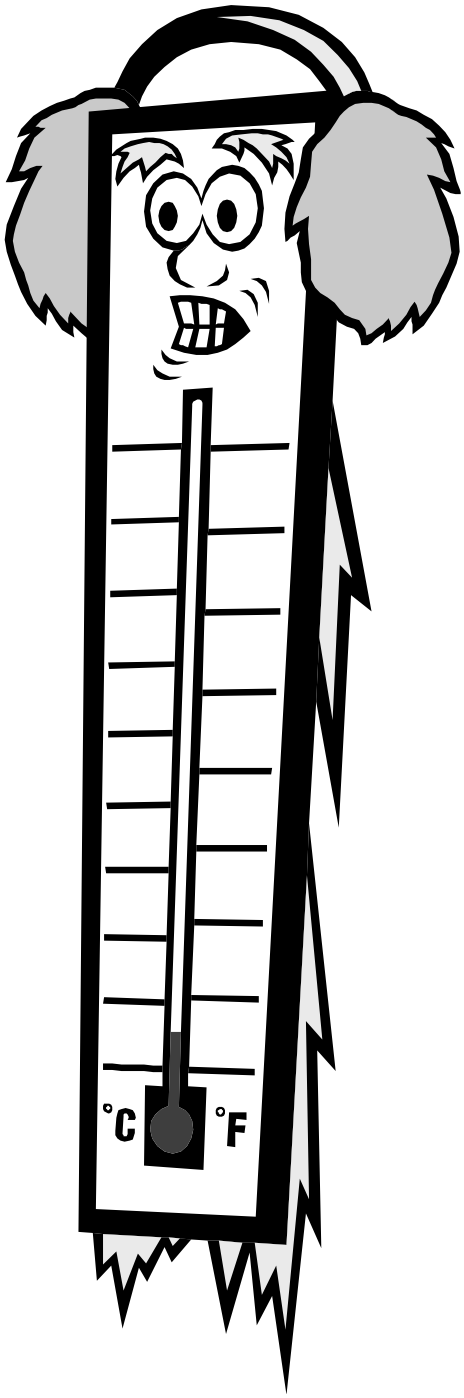
These grasses grow lateral (sideways) stems in the form of rhizomes or stolons from buds that form in plant crowns. In most sod-forming grasses, new shoots grow through the sides of neighboring leaf sheaths. This allows for the plant to spread-out instead of growing up. Examples are crabgrass and stinkgrass. Forbs and shrubs may also have sideways stems. Many noxious weeds are rhizomatous. A strawberry is an example of a forb with stolons.



## 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 structure. 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.

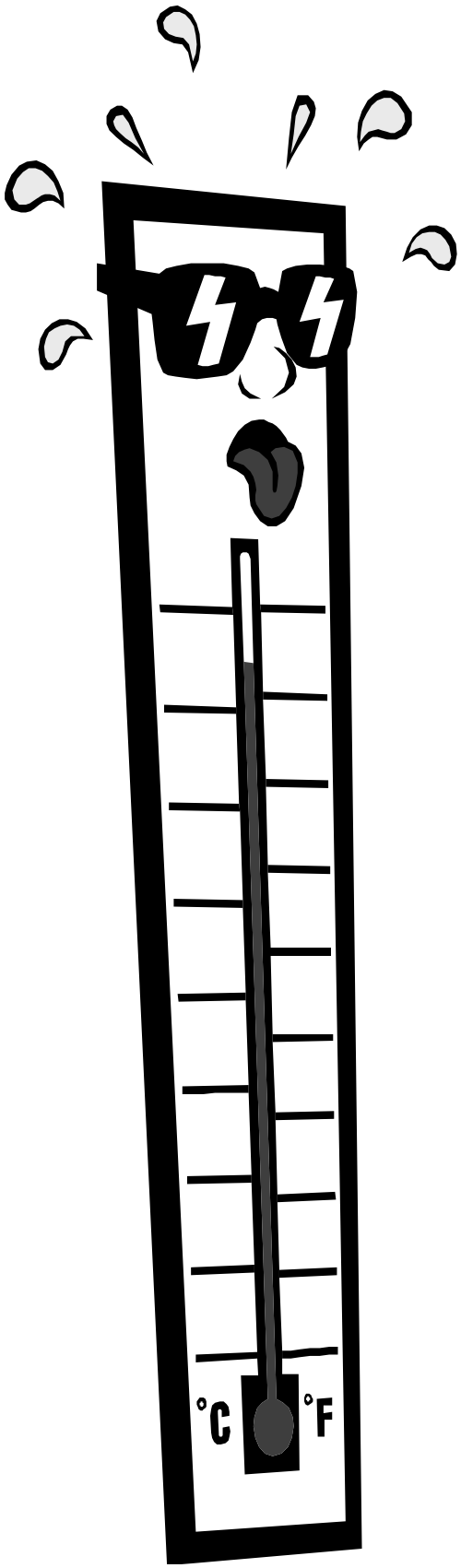
They green-up and bloom early in the spring, when there is more moisture. They occasionally green-up again late in the fall with adequate moisture.

Cool season plants require short days and/or low temperatures in the fall or early spring in order 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 needlegrass, chokecherry and Hood's phlox are all examples of cool season plants.

## Warm season




C4 – photosynthetic pathway.

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

They wait until late summer to grow and flower. They grow best when temperatures are 90 to 95 degrees F, and reach peak production about one month later than cool season plants.

Warm season plants use soil moisture efficiently and are drought tolerant.

Warm season plants have more lignin and fiber than cool season plants. So, they are not as palatable to grazing animals. They don't have as much protein as cool-season grasses, but the protein is utilized better by grazing animals.

Warm season plants are green when cool season plants are mature, so grazing animals may select for the fresher plant growth.

Blue grama, little bluestem, prairie sandreed, big sagebrush and dotted gayfeather are all examples of warm season plants.

# Growth Curves

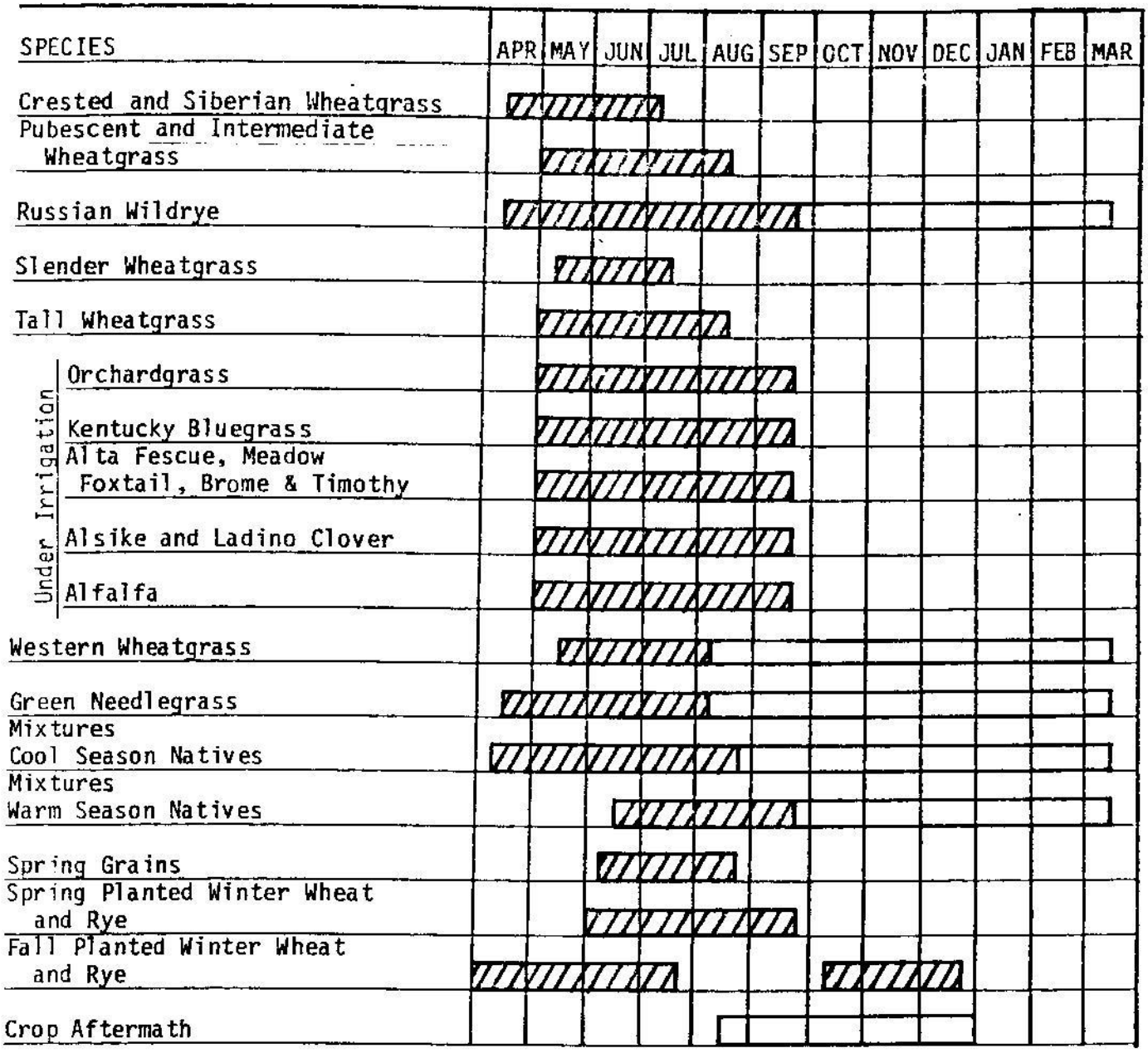
**GROWTH CURVES:** Different plants grow at different times within the growing season. Each species of plant has a unique growth curve. Kids in your class at school grow differently. Some grow more than others. Some grow sooner than others. Plants behave in much the same way. Each species of plant begins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

See the graph on the next page to compare growth curves of various grasses.

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service

MT-JS-ES-111
AGRON (Rev. April 1979)

# PASTURE CALENDAR FOR EASTERN MONTANA




Season of use for optimum gains.

Good for animal maintenance (supplement may be desirable part of the time).

**If you understand how plants grow, you can 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)

## *Grazing use facts and guidelines*

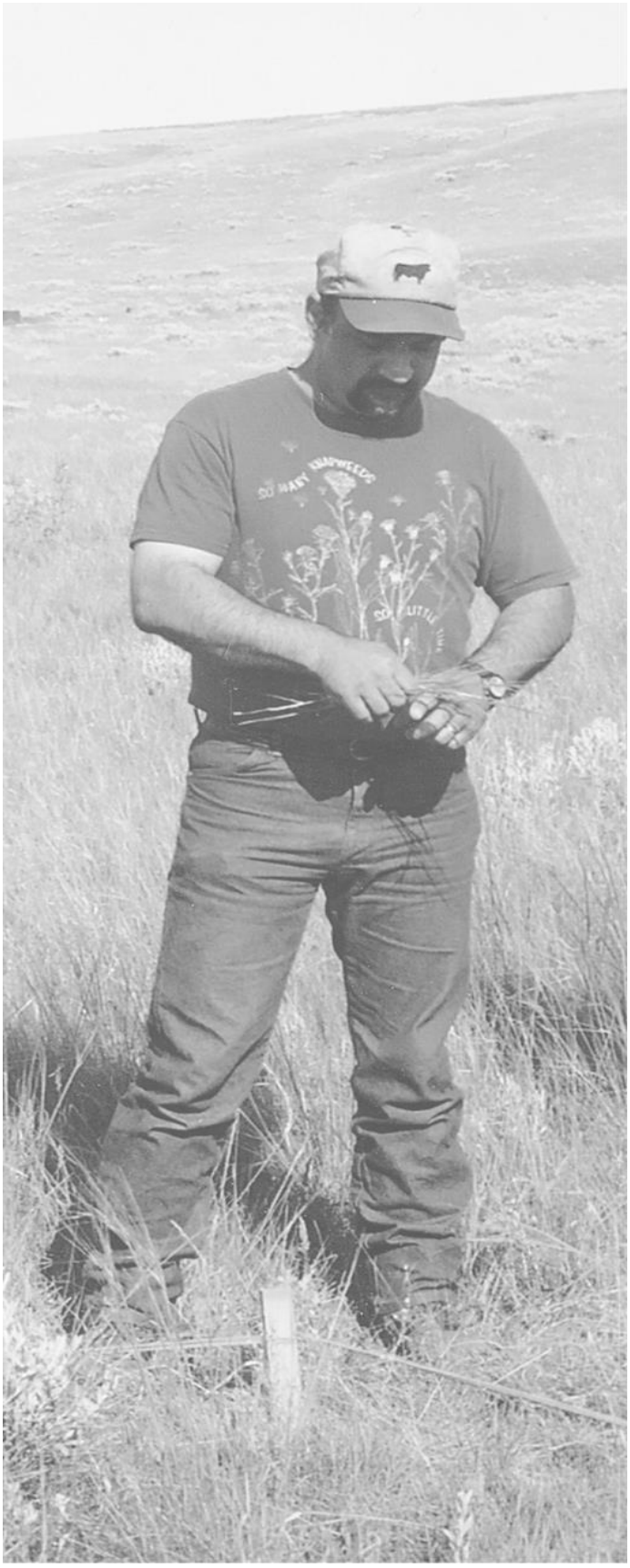
- If *greater than 50%* of the leaf material of perennial grasses is removed, *root growth is reduced.*
- Utilization of 80-90% of leaf tissue stops grass root growth for 12-18 days. .
- Heavy utilization levels (>75%) reduce the ability of grass shoots (tillers) to re-grow.

**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)**

## 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.<br>*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.<br>*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.<br>*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%).<br>*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.<br>*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.** _____

## 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 photosynthesizing. Old leaves cannot photosynthesize very much. ***Therefore, no grazing can also result in reduced plant health and vigor.***

(under-utilized crested wheatgrass stand – Photo courtesy of Rebecca Wolenetz

# WRANGLER STOCKING RATES

# Wrangler 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.

The amount of forage available determines the number of animals that can live on a ranch.

You can figure out how much forage is available by inventorying the ranch's forage resources.

**Feed and forage inventory:**

You need to gather basic information such as:

land use – range, pasture, hay, crop
acres
plant species – ex. pubescent wheatgrass, native range
site productivity

An example of a feed and forage inventory might include this information:

| | |
|---|---|
| spring pasture | 200 acres |
| pasture species | crested wheatgrass |
| production | .7 AUM's/Ac. |

***This information will lead you to a stocking rate.***

## What are stocking rates?

# Stocking rates compare the forage needed to feed a grazing animal to the area available to provide the forage. A stocking rate is labeled in AUMs per acre.

*What is an AUM?*

***915 pounds*** *is an AUM or animal unit month. It is the amount of forage needed to feed a 1000 pound cow with a young calf for 1 month. This number is figured by considering that a 1000 pound cow with calf will eat about 30 pounds of dry matter each day. So, if you take 30 pounds X 30.5 days/month, a cow would need about 915 pounds of forage each month.*

Say that you have one cow and one acre. You have determined that the acre of land produces half of the 915 pound forage requirement (457.5 pounds). Then you would know that a cow could graze that acre for ½ of a month or 15 days. The stocking rate would be .5 AUM's/Ac.

## Stocking rate guidelines

You can determine stocking rates by clipping and weighing the forage in a field or by using stocking rate guides that have been developed by range scientists.

Two tables are provided below. *Table 1* gives approximate stocking rates for the **basic Wrangler ecological sites.** *Table 2* provides basic stocking rate values for introduced pasture, hayland aftermath and crop aftermath. Aftermath is the forage left after crops are harvested. For example, wheat stubble.

| | **Ecological Sites** | **Run-in** *AUM's/Ac.* | **Normal** *AUM's/Ac.* | **Run-off** *AUM's/Ac.* |
|---|---|---|---|---|
| **Similarity Index** | (76-100%) | .55 | .40 | .25 |
| | (51-75%) | .42 | .3 | .18 |
| | (26-50%) | .27 | .2 | .13 |
| | ( 0-25%) | .14 | .1 | .07 |

(Photo courtesy of Ekalaka NRCS)

## Table 2. Approximate stocking rates for a common introduced pasture species, 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 |
| Hayland aftermath | .4 |
| Crop aftermath (small grain stubble) | .2 |

## Example stocking rate scenario:

**Ecological Site** = Normal, Similarity Index 51-75% - 100 acres
**Grazing Animal Class** = Cattle

**Stocking Rate Calculations:**

- 100 Ac. X .3 AUM's/Ac. = 30 AUM's available

(Photo courtesy of Ekalaka NRCS)

**It sounds pretty simple, but there are factors other than formulas that affect stocking rate.**

1. Animal Unit Equivalent – based on class of animal, animal size and maturity
2. Steepness of terrain
3. Distance from water
4. Plant season of use – ex. warm or cool season
5. Grazing system
6. Growing season conditions – ex. drought
7. Animal nutrition

***In this workshop, the Wrangler Division will focus on the first factor, Animal Unit Equivalent.***

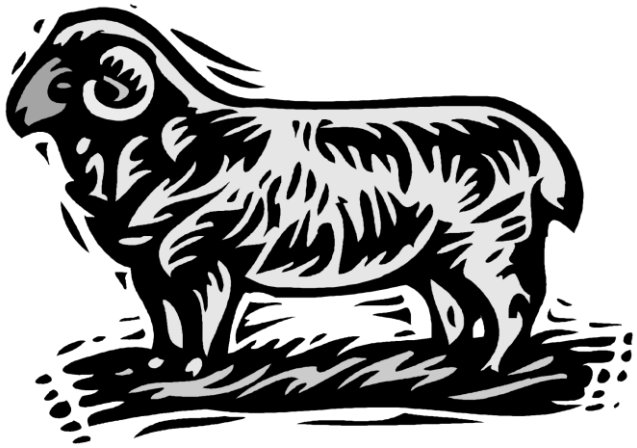
(Photo courtesy of USDA-NRCS)

## Animal Unit Equivalents

The Animal Unit Equivalent ("AUE") is a common denominator for calculating the forage requirements of different kinds 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, 5 mature sheep would eat the same amount of forage as one cow.**



| Kinds/classes of animals | Animal Unit Equivalent | Forage consumed per day | Forage consumed per month |
|---|---|---|---|
| 1000 lb. Cow, with calf, or mature bison | 1.00 | 26 | 790 |
| Bull, mature | 1.35 | 35 | 1067 |
| Cattle, 1 year old, Elk, mature | .60 | 15.6 | 474 |
| Horse, mature | 1.25 | 32.5 | 988 |
| Sheep, deer, antelope | .20 | 5.2 | 158 |

# 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 a normal ecological site with a similarity index of 40%. Using the AUM Factor Table, you determine that the stocking rate for a normal site with a similarity index (SI) of 40% is .2 AUMs/acre.*

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

  1000 acres X .2 AUM'S/acre = 200 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 200 COW/CALF PAIRS ON THE LONE PINE PASTURE?**

  200 AUM'S/200 AU'S = 1 month

- **HOW MANY AUM'S WOULD BE USED BY 250 COW/CALF PAIRS IN THE LONE PINE PASTURE FOR 1 MONTH?**

  250 AU'S X 1 MONTH = 250 AUM'S

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

  200 AUM'S/.2 AU/1 month = 1000 sheep

- **HOW MANY COW/CALF PAIRS 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/1 AU/1 month = 300 cow/calf pairs

Name_____ Chapter _____

# PLANT IDENTIFICATION

**300+ points**

### GRASSES

| | | |
|---|---|---|
| 201 | basin wildrye | *Leymus cinereus* |
| 202 | blue grama | *Bouteloua gracilis* |
| 203 | bluebunch wheatgrass | *Pseudoroegneria spicata* |
| 204 | cheatgrass | *Bromus tectorum* |
| 205 | crested wheatgrass | *Agropyron cristatum* |
| 206 | foxtail barley | *Hordeum jubatum* |
| 207 | green needlegrass | *Nassella viridula* |
| 208 | Idaho fescue | *Festuca idahoensis* |
| 209 | Indian ricegrass | *Achnatherum hymenoides* |
| 210 | Kentucky bluegrass | *Poa pratensis* |
| 211 | needle-and-thread | *Hesperostipa comata* |
| 212 | prairie junegrass | *Koeleria macrantha* |
| 213 | Sandberg bluegrass | *Poa secunda* |
| 214 | smooth brome | *Bromus inermis* |
| 215 | timothy | *Phleum pratense* |
| 216 | western wheatgrass | *Pascopyrum smithii* |

### GRASSLIKES

| | | |
|---|---|---|
| 217 | Baltic rush | *Juncus balticus* |
| 218 | needleleaf sedge | *Carex duriuscula* |
| 219 | threadleaf sedge | *Carex filifolia* |

### FORBS

| | | |
|---|---|---|
| 220 | American vetch | *Vicia americana* |
| 221 | arrowleaf balsamroot | *Balsamorhiza sagittata* |
| 222 | biscuitroot | *Lomatium spp.* |
| 223 | blanketflower | *Gaillardia aristata* |
| 224 | blue flax | *Linum lewisii* |
| 225 | Canada thistle | *Cirsium arvense* |
| 226 | cudweed sagewort | *Artemisia ludoviciana* |
| 227 | curlycup gumweed | *Grindelia squarrosa* |
| 228 | dense clubmoss | *Selaginella densa* |
| 229 | dotted gayfeather | *Liatris punctata* |
| 230 | fleabane | *Erigeron spp.* |
| 231 | hairy goldenaster | *Heterotheca villosa* |
| 232 | Hood's phlox | *Phlox hoodii* |
| 233 | houndstongue | *Cynoglossum officinale* |

### FORBS – Continued

| | | |
|---|---|---|
| 234 | leafy spurge | *Euphorbia esula* |
| 235 | low larkspur | *Delphinium bicolor* |
| 236 | lupine | *Lupinus spp.* |
| 237 | meadow deathcamas | *Zygadenus venenosus* |
| 238 | milkvetch | *Astragalus spp.* |
| 239 | Missouri goldenrod | *Solidago missouriensis* |
| 240 | penstemon | *Penstemon spp.* |
| 241 | prairie coneflower | *Ratibida columnifera* |
| 242 | prairie onion | *Allium spp.* |
| 243 | purple prairieclover | *Dalea purpurea* |
| 244 | pussytoes | *Antennaria spp.* |
| 245 | salsify | *Tragopogon dubius* |
| 246 | scarlet globemallow | *Sphaeralcea coccinea* |
| 247 | segolily mariposa | *Calochortus nuttallii* |
| 248 | spotted knapweed | *Centaurea maculosa* |
| 249 | sticky geranium | *Geranium viscosissimum* |
| 250 | wavyleaf thistle | *Cirsium undulatum* |
| 251 | western yarrow | *Achillea millefolium* |
| 252 | yellow owl's clover | *Orthocarpus luteus* |
| 253 | yellow sweetclover | *Melilotus officinalis* |

### CACTI

| | | |
|---|---|---|
| 254 | pincushion cactus | *Escobaria spp.* |
| 255 | plains pricklypear | *Opuntia polyacantha* |

### HALF-SHRUBS, SHRUBS, & TREES

| | | |
|---|---|---|
| 256 | big sagebrush | *Artemisia tridentata* |
| 257 | broom snakeweed | *Gutierrezia sarothrae* |
| 258 | fringed sagewort | *Artemisia frigida* |
| 259 | ponderosa pine | *Pinus ponderosa* |
| 260 | Rocky Mountain juniper | *Juniperus scopulorum* |
| 261 | rubber rabbitbrush | *Ericameria nauseosa* |
| 262 | silver sagebrush | *Artemisia cana* |
| 263 | western snowberry | *Symphoricarpos occidentalis* |
| 264 | wild rose | *Rosa spp.* |
| 265 | winterfat | *Krascheninnikovia lanata* |

Name_____ Chapter _____

# PLANT ANATOMY 150 points

** 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 | | |
| **2** | Which type of plant is this? | Grass | Grass-Like | Forb | Shrub |
| **3** | Which modified stem does this plant have? | Rhizome | Stolon | Bulb | Corm |
| **4** | Which leaf arrangement does this plant have? | Opposite | Alternate | Whorled | |
| **5** | What root type does this plant have? | Tap | Fibrous | | |
| **6** | Which type of ligule does this plant have? | Absent | Membranous | Hairy/Ciliate | |
| **7** | Which leaf type does this plant have? | Simple | Compound | | |
| **8** | Which leaf venation does this plant have? | Palmate | Parallel | Pinnate | |
| **9** | What shape are this plant's largest leaves? | Linear | Oblanceolate | Ovate | Sagitate |
| **10** | Which seed head arrangement is shown here? | Spike | Raceme | Panicle | |
| **11** | Which leaf margin do these leaves have? | Serrate | Entire | Ciliate | Divided |
| **12** | What is the *upper* leaf surface on this plant? | Glabrous | Pitted | Tomentose | |
| **13** | What stem modification does this plant have? | Prickles | Spines | Tendrils | Thorns |
| **14** | What is this plant's growth form? | Erect | Ascending | Decumbant | |
| **15** | What type of seed head does this plant have? | Corymb | Head | 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** | What is this plant's life span? | Annual | Biennial | Perennial | |
| **21** | Which plant does this key to? | A | B | C | D | E |

6 Points per Plant Anatomy Question + 30 Points for Keying Plant = **150 Points Total**

# Dichotomous Key to Common Grasses

## PLANT ANATOMY

**** 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. 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. 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. Leaves 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 are open and old sheaths persistent. Auricles are well developed and 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 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 are shorter than spikelet. Many florets per spikelet. Awn-tipped lemmas._____E

Name_____ Chapter _____

# ECOLOGICAL SITES 100 points

** Circle your answers on this sheet, then transfer the answers to* **EXAM 2** *on your scantron sheet.*

| | | | A | B | C | D |
|---|---|---|---|---|---|---|
| Test Questions | 1 | What is the soil surface texture? | Clayey | Silty | Sandy | |
| | 2 | What is the soil surface texture? | Clayey | Silty | Sandy | |
| | 3 | What is the soil surface texture? | Clayey | Silty | Sandy | |
| | 4 | What is the soil surface texture? | Clayey | Silty | Sandy | |
| | 5 | What is the soil profile at this site? | Very Shallow | Shallow | Moderately Deep | |
| | 6 | What is the soil profile at this site? | Very Shallow | Shallow | Moderately Deep | |
| | 7 | What type of ecological site is this? | Run-in | Run-off | Normal | |
| | 8 | What type of ecological site is this? | Run-in | Run-off | Normal | |
| Bonus | 9 | Deep soils are defined as restricting plant roots within 20 inches of the surface. True or False? | True | False | | |
| | 10 | A site that receives additional moisture from overflow is? | Normal | Run-off | Run-in | |
| | 11 | Which soil type has the smallest particle size? | Clay | Sand | Silt | |
| | 12 | Which soil texture is considered ideal for agriculture? | Coarse | Fine | Medium | |

15 Points Soil Texture Questions
10 Points Soil Profile Questions
10 Points Ecological Site Questions

**TOTAL = 100 Points**

+ 1 Point per bonus question for tie breakers

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 |