Ecological Systems of Montana

Montana Field Guide

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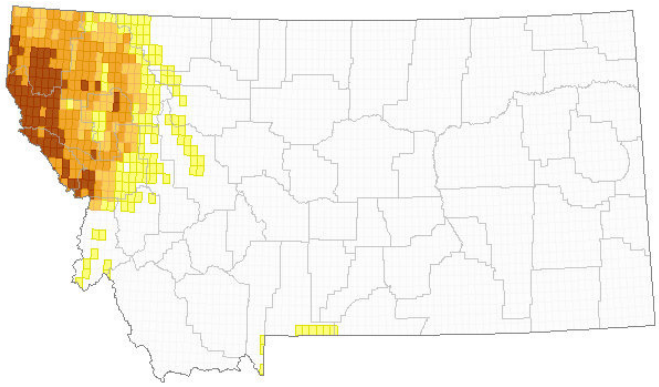
Forest and Woodland Systems
Conifer-dominated forest and woodland (mesic-wet)

Rocky Mountain Mesic Montane Mixed Conifer Forest

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4234



Approximately 6,695 square kilometers are classified as Rocky Mountain Mesic Montane Mixed Conifer Forest in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

Environment

This forest system is found in areas influenced by incursions of mild, wet, Pacific maritime air masses west of the Continental Divide in Montana. Occurrences generally are found on all slopes and aspects but grow best on sites with high soil moisture, such as toeslopes and bottomlands. At the periphery of its distribution, this system is confined to moist canyons and cooler, moister aspects. Generally, these are moist, non-flooded or upland forest sites that are not saturated yearlong. In northwestern Montana, western hemlock and western red cedar forests occur on bottomland and northerly exposures between 609-1,585 meters (2,000-5,200 feet) on sites with an average annual precipitation of 635 millimeters (25 inches).

Similar Systems

- Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
- Rocky Mountain Conifer Swamp
- Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest

Vegetation

These forests are generally dominated by western hemlock, western red cedar, and grand fir. Disturbed sites can and occasionally do return directly to dominance by the climax tree species, but other stands are often a mixture of the climax species with seral tree species such as Douglas-fir (*Pseudotsuga menziesii*), western white pine (*Pinus monticola*), lodgepole pine (*Pinus contorta*), western larch (*Larix occidentalis*) and paper birch (*Betula papyrifera*). Engelmann spruce (*Picea engelmannii*) and subalpinefir (*Abies lasiocarpa*) may be present on the coldest sites,and ponderosa pine (*Pinus ponderosa*) may be present on the warmest and driest sites. In Glacier National Park and the Selway-Bitterroot Wilderness in Montana, western red cedar is dominant in wet ravines, well-drained flats and poorly drained depressions. Both western red cedar and western hemlock are shade-tolerant conifers that occur in similar mesic environments; however, western red cedar extends locally into slightly drier sites and occurs further south and east in Montana. Shade-intolerant grand fir is seral in western hemlock or western red cedar dominated forests and has lower moisture requirements than its associates.

Common shrubs include mountain boxwood (*Paxistima myrsinites*), thinleaf alder (*Alnus incana*), Rocky Mountain maple (*Acer glabrum*), birch leaf spiraea (*Spiraea betulifolia*), common snowberry (*Symphoricarpos albus*), bunchberry dogwood (*Cornus canadensis*), thimbleberrry (*Rubus parviflorus*), rusty leaf menziesia (*Menziesia ferruginea*), and mountain huckleberry (*Vaccinium membranaceum*). Pacific yew (*Taxus brevifolia*) can occur in a tree form in the understory on some occurrences in westernmost Montana and as a prevalent shrub in occurrences in the Swan Valley.

Composition of the herbaceous layer reflects local climate and degree of canopy closure; it is typically highly diverse in all but closed-canopy conditions. Queen's cup beadlily (*Clintonia uniflora*), western foamflower (*Tiarella trifoliata*), pioneer violet (*Viola glabella*), Canadian white violet (*Viola canadensis*), dark woods violet (*Viola orbiculata*) and beargrass (*Xerophyllum tenax*) are most the most common forbs in these forests. Other forbs include baneberry (*Actaea rubra*), pathfinder (*Adenocaulon bicolor*), false sarsaparilla (*Aralia nudicaulis*), lanceleafarnica (*Arnica latifolia*), fragrant bedstraw (*Galium triflorum*), rattlesnake plantain orchid (*Goodyera oblongifolia*), twinflower (*Linnaea borealis),* liverleaf wintergreen (*Pyrola asarifolia*) and western trillium (*Trillium ovatum*). In extreme northwestern Montana, wild ginger (*Asarum caudatum*) is a component on mesic sites with a mild temperature regime.

Ferns and fern allies also form an important component of the understoryand are indicative of the most mesic sites. Species include American ladyfern (*Athryium filix-femina*), western swordfern *(Polystichum munitum*), male fern (*Dryopteris filis-mas*), oak fern (*Gymnocarpium dryopteris*) and horsetails (*Equisetum* species). Bracken fern (*Pteridium aquilinum*) can occur in relatively high coverage (20% or greater) in mature stands, however it can form dense (up to 100%) cover in early seral stands, retarding forest regeneration. Graminoids may be absent or form a very minor component, and may include forest brome (*Bromus vulgaris*), fringed brome (*Bromus ciliatus*), Geyer's sedge (*Carex geyeri*), pinegrass (*Calamagrostis rubescens*), blue wildrye (*Elymus glaucus*), and rough leaf ricegrass (*Oryzopsis asperifolia*).

Dynamic Processes

Western red cedar and western hemlockare capable of remaining dominant within these forests due to their longevity. Because they are highly shade-tolerant, they can reproduce under their own canopy. In the absence of fire, both species can reproduce vegetatively (Pfister et al 1977; Minore 1990). Western red cedar can reproduce vegetatively by branch layering, rooting of fallen branches, and by branch development on fallen trees (Parker,1979). Trees of this species have reached 2,000 years in northern Idaho (Parker, 1986); trees in northwestern Montana have attained ages of at least 500 years.

Typically, stand-replacement fire-return intervals are 150-500 years, with moderate-severity fire intervals of 50-100 years (Arno, 1979). Western red cedar, western hemlock and grand fir are characterized by having thin bark, shallow root systems, low dense branching habits, and highly flammable foliage, making these species susceptible to fire damage. All but the oldest trees are typically killed in fires of moderate intensity. Douglas-fir, western larch and pine regenerate well following fire. Under present conditions, the fire regime is mixed severity and more variable, with stand-replacing fires more common. With vigorous fire suppression, longer fire-return intervals are now common, and multi-layered stands of conifersprovide fuel "ladders," making these forests more susceptible to high-intensity, stand-replacing fires. Wind throw can occur during unusually intense wind storms, because the dominant species typically possess shallow, spreading root systems. Individual trees that have been damaged by root diseases are especially prone to wind throw. In the past, these forests have been priorities for timber production in northwestern Montana. Today, many old-growth stands occur in protected areas.

Forest and Woodland Systems
Conifer-dominated forest and woodland (mesic-wet)

Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland

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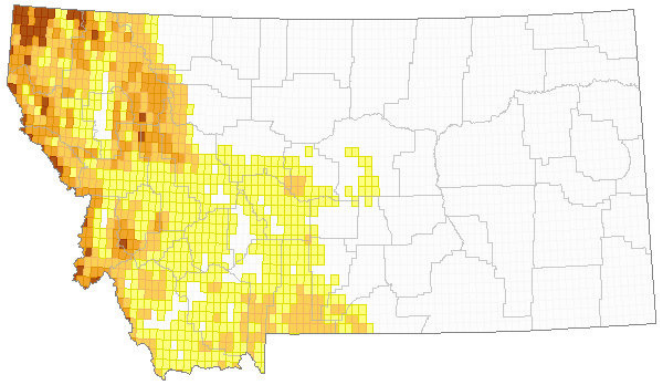

Approximately 6,677 square kilometers are classified as Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

Environment

This system forms a belt at relatively low to high elevations west of the Continental Divide and mid to high elevations east of the Divide throughout the Montana Rocky Mountains and rarely, in the island ranges of north-central and west-central Montana. Elevations range from 884 to 1,981 meters (2,900-6,500 feet) west of the Continental Divide, and 1,585 to 2,682 meters (5,200-8,800 feet) east of the Continental Divide. Soils are derived from a variety of parent materials. They are usually rocky or gravelly with good aeration and drainage, but are usually acidic. Occurrences are typically found in locations with cold-air drainage or ponding, or where snowpacks linger late into the summer, such as north-facing slopes and high-elevation ravines. They can extend down in elevation below the subalpine zone in places where cold-air ponding occurs, especially on north and east aspects.

Similar Systems

- Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
- Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland

Vegetation

Tree canopy characteristics are relatively uniform, with *Picea* and *Abies* dominating either mixed or alone. Engelmann spruce is more tolerant of extreme environmental conditions than subalpine firs, and is usually more dominant in the drier and wettest occurences within this system. Mountain hemlockoccurs as small to large patches within the matrix of this mesic spruce-fir system but only in the most maritime of environments of northwestern Montana, in the coldest and wettest sites.

The understory of *Picea -Abies* forests in northwestern Montana often supports diverse stands of ericaceous plants, such as rusty leaf menziesia, dwarf huckleberry, mountain huckleberry, bilberry and mountain heath. Grouse whortleberry and Labrador tea (*Ledum glandulosum*) are common on mesic sites.Cascade azalea (*Rhododendron albiflorum*) occurs in association with mountain hemlock and subalpine fir in some occurrences in northwestern Montana.Other common shrubs include Rocky Mountain maple (*Acer glabrum*), serviceberry (*Amelanchier alnifolia*), black twinberry honeysuckle, currant (*Ribes* species), thimbleberry, shortfruit willow (*Salix brachycarpa*) and greyleaf willow (*Salix glauca*). In the wettest subalpine fir forests in northwestern Montana, devil's club is a major shrub associate. These sites are usually restricted to ravine bottoms near streams and seeps where the water table remains near the surface all year. The herbaceous layer is typically diverse. Smooth woodrush (*Luzula glabrata var. hitchcockii*), bluejoint reedgrass (*Calamagrostis canadensis*), and pinegrass (*Calamagrostis rubescens*) are the most commonly associated graminoids. On moist sites with seeps or adjacent to running water, a lush herbaceous understory is present. Forb species includebaneberry (*Actaea rubra*), marsh marigold (*Caltha leptosepala*), queen's cup beadlily (*Clintonia uniflora*), bunchberry dogwood (*Cornus canadensis*),starry Solomon's seal (*Maianthemum stellatum*), sidebellswintergreeen (*Orthothilla secunda*), arrowleaf groundsel (*Senecio triangularis*), clasp-leaf twisted stalk (*Streptopus amplexifolius*), foamflower (*Tiarella trifoliata*), western meadow rue (*Thalictrum occidentale*), Sitka valerian (*Valeriana sitchensis*), green false hellebore (*Veratrum viride*), and beargrass (*Xerophyllum tenax*). Ferns and fern allies such ashorsetail (*Equisetum* species), oakfern (*Gymnocarpium dryopteris*) and ladyfern (*Athyrium species*) form dense cover, inespecially wet spruce habitats on flat sites with poor drainage. Moss cover is often high within these forests.

Dynamic Processes

Major disturbances include occasional blowdown, insect outbreaks (30-50 years), mixed-severity fire, and stand-replacing fire (every 150-500 years) (Arno 1980). The more summer-dry climatic areas also have occasional high-severity fires. Insects and diseases can play a major role in the successional direction of these forests. Throughout Montana, subalpine fir and spruce are affected by spruce bud worm attacks, and large stands of these subalpine forests can be killed following several years of drought or unusually mild winters. Following fire, spruce is more successful at establishing on mineral soils. Subalpine fir, in contrast, is better at establishing in the shade and on organic substrates. In forests undisturbed by fire or subjected to spruce budworm attacks, subalpine fir assumes greater dominance. Over a period of 500 years, subalpine fir will largely replace spruce within most habitats of this system, with the exception of the wettest sites.

Forest and Woodland Systems
Conifer-dominated forest and woodland (xeric-mesic)

Great Plains Ponderosa Pine Woodland and Savanna

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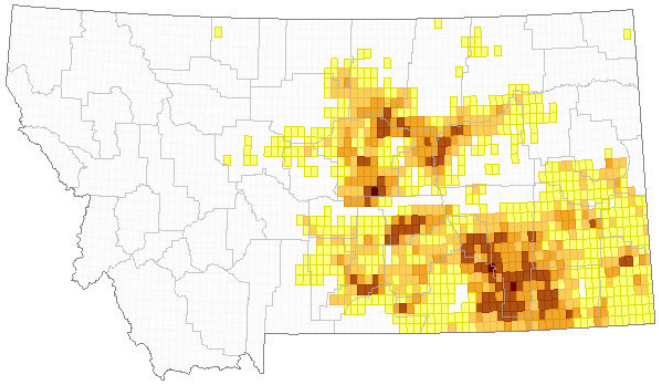

Approximately 9,895 square kilometers are classified as Great Plains Ponderosa Pine Woodland and Savanna in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4
* The system is at risk from insects and fire, but somewhat less so than its counterpart in the western part of the state.

Environment

This system occurs primarily on gentle to steep slopes along escarpments, buttes, canyons, rock outcrops, or ravines and can grade into one of the Great Plains canyon systems or the surrounding prairie system. Elevation ranges from 1,189 meters (3,900 feet) in southeastern Montana to 1,646 meters (5,400 feet) in north-central Montana. In the eastern Little Belts and Snowy Mountains, these woodlands can occur on the upper slopes. Soils typically range from well-drained loamy sands to sandy loams formed in colluvium, weathered sandstone, limestone, scoria, or eolian sand. The understory may be shrub or graminoid dominated, depending on aspect or site.

Similar Systems

- Rocky Mountain Foothill Woodland-Steppe Transition
- Rocky Mountain Ponderosa Pine Woodland and Savanna

Vegetation

Along the Missouri Breaks in north-central Montana, woodlands dominated by Douglas-fir (*Pseudotsuga menziesii*) are found in the same ecological settings as ponderosa pine, and so are included in this system. In the breaks where it occurs, Douglas-firhas a very open canopy over graminoid undergrowth, predominantly composed of bluebunch wheatgrass (*Pseudoroegneria spicata*), with few to no shrubs present. In most of the Missouri Breaks, however, ponderosa pine dominates and Rocky Mountain juniper (*Juniperus scopulorum*) is a common associate. Shrubs associated with ponderosa pine dominated forests include bearberry (*Arctostaphylos uva-ursi*), creeping Oregon grape (*Mahonia repens*), soapweed yucca (*Yucca glauca*), snowberry (*Symphoricarpos* species), chokecherry (*Prunus virginiana*), common juniper (*Juniperus communis*), horizontal juniper (*Juniperus horizontalis*), serviceberry (*Amelanchier alnifolia*), skunkbush sumac (*Rhus trilobata*) and ninebark (*Physocarpus* species*)*. The herbaceous understory can range from a sparse to a dense layer of species typical of the surrounding prairie system. Mixed-grass species are usually common, such as big bluestem (*Andropogon gerardii*), sideoats grama (*Bouteloua curtipendula*), sun sedge (*Carex inops* ssp. *heliophila*), threadleaf sedge (*Carex filifolia*), poverty oatgrass (*Danthonia intermedia),* prairie junegrass (*Koeleria macrantha*), green needlegrass (*Nassella viridula*), roughleaf ricegrass (*Oryzopsis asperifolia*), and western wheatgrass (*Pascopyrum smithii*). Common herbaceous forbs include yarrow (*Achillea millefolium*), pussytoes (*Antennaria* species), boreal sagewort (*Artemisia frigida)*, arrowleaf balsamroot (*Balsamorhiza sagittata*), Indian blanket flower (*Gaillarida aristata*), silky lupine (*Lupinus argenteus*), crazyweed (*Oxytropis* species), alpine sweetvetch (*Hedysarum alpinum), penstemon (Penstemon* species), prairie cinquefoil (*Potentilla gracilis*), goldenrod (*Solidago* species) and smooth aster (*Symphyotrichum laeve*).

Dynamic Processes

Surface fires can be frequent on drier sites and aspects. More mesic sites likely have infrequent stand-replacing fires (every 100-200 years). Grazing by domestic livestock may reduce associated grasses; in cases of extreme overgrazing, cheatgrass (*Bromus tectorum*) may become established. Wind is not generally an issue, except when trees have been damaged by lightning strikes.

Forest and Woodland Systems
Conifer-dominated forest and woodland (xeric-mesic)

Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest

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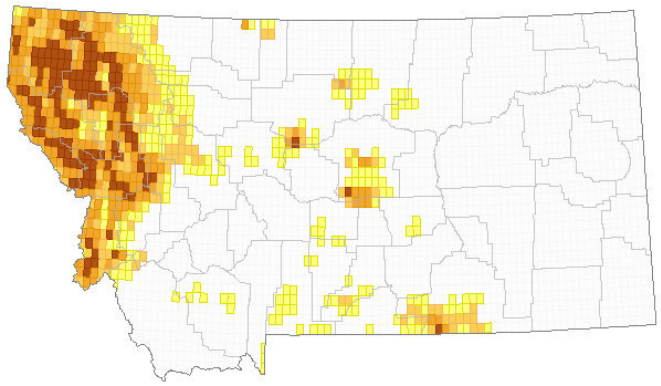
Provisional State Rank: S3



Approximately 10,888 square kilometers are classified as Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Environment

In northwestern and west-central Montana, this ecosystem forms a forest belt on warm, dry to moist sites. It is associated with a submesic climate regime with annual precipitation ranging from 250 to 1,000 millimeters (10-39 inches), with most precipitation occurring during winter, and April through June. Winter snowpacks typically melt off in early spring at lower elevations. Elevations range from valley bottoms to 1,676 meters (5,500 feet) in northwestern Montana and up to 2,286 meters (7,500 feet) on warm aspects in southern Montana. In northwestern and west-central Montana, this ecosystem forms a forest belt on warm, dry to slightly moist sites. It generally occurs on gravelly soils with good aeration and drainage and a neutral to slightly acidic pH. In the western part of the state, it is seen mostly on well-drained mountain slopes and in valleys from lower treeline to up to 1,676 meters (5,500 feet). Immediately east of the Continental Divide, in north-central Montana, it occurs at montane elevations.

Similar Systems

- Rocky Mountain Mesic Montane Mixed Conifer Forest
- Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland

Vegetation

Douglas-fir is the dominant conifer; west of the Continental Divide, occurrences are dominated by a mix of Douglas-fir and long-lived, seral western and other species, including lodgepole pine and western white pine. East of the Continental Divide, larch is absent and lodgepole pine is the co-dominant. Engelmann spruce or white spruce, or their hybrid, becomes increasingly common towards the eastern edge of the Douglas-fir forest belt. Grand fir may occur in this forest type, but is typically confined to relatively warm and moister sites in northwestern and west-central Montana.

Undergrowth is dominated by graminoids, such as bluebunch wheatgrass (*Pseudoroegneria spicata*), Columbia brome(*Bromus vulgaris*),blue wildrye (*Elymus glaucus*), pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), and Ross' sedge (*Carex rossii*). Common forbs that occur in the understory include American pathfinder (*Adenocaulon bicolor*), heartleaf arnica (*Arnica cordifolia*), queen's cup beadlily (*Clintonia uniflora*), twinflower (*Linnaea borealis*), and beargrass (*Xerophyllum tenax*). The shrub understory contains a variety of shrubs, such as Rocky mountain maple (*Acer glabrum*), kinnikinnick (*Arctostaphylos uva-ursi*), common juniper (*Juniperus communis*), oceanspray (*Holodiscus discolor*), mallow ninebark(*Physocarpus malvaceus*), common snowberry (*Symphoricarpos albus*), birch leaf spiraea (*Spiraea betulifolia*), dwarf bilberry (*Vaccinium caespitosum*) or mountain huckleberry (*Vaccinium membranaceum*)on colder, more mesic sites. In the western part of the state, the Douglas-fir/mountain huckleberry association is the most common type found in the Lolo, Bitteroot and Flathead Mountain ranges on relatively cold sites up to 2,073 meters (6,800 feet) (Pfister et al, 1977).

Dynamic Processes

Douglas-fir and all associated seral species regenerate well following fire, and all, with the exception of lodgepole pine, tolerate repeated low intensity surface fires. In the absence of disturbance, the longevity and fire resistance of western larch, along with Douglas-fir, lead to them being co-dominant in many areas of western Montana. Douglas-fir and grand fir continue to regenerate under shaded conditions, and these too may become dominant in undisturbed stands. Presettlement fire regimes may have been characterized by frequent, low-intensity ground fires that maintained relatively open stands of a mix of fire-resistant species. Under present conditions, the fire regime is mixed severity and more variable, with stand-replacing fires more common, and the forests are more homogeneous. With vigorous fire suppression, longer fire-return intervals are now common, and multi-layered stands of conifers provide fuel "ladders," making these forests more susceptible to high-intensity, stand-replacing fires. These are very productive forests which have been priorities for timber production.

Forest and Woodland Systems
Conifer-dominated forest and woodland (xeric-mesic)

Rocky Mountain Foothill Limber Pine - Juniper Woodland

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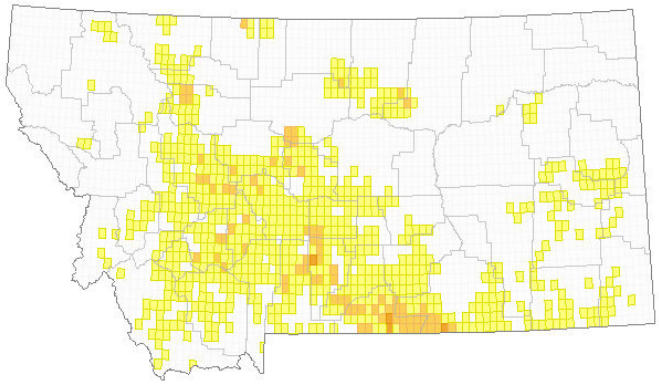


Approximately 780 square kilometers are classified as Rocky Mountain Foothill Limber Pine - Juniper Woodland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S5

Environment

The systems is usually found below continuous forests of Douglas-fir (*Pseudotsuga menziesii*) or lodgepole pine (*Pinus contorta*) in the foothills,and can occur in large stands well within the zone of continuous forests in the northern Rocky Mountains. Along the Northern Rocky Mountain Front, this system is found on west and north facing aspects in the foothills and within the mountains. At lower elevations, it can occur on all aspects and on relatively level terrain. Rocky Mountain juniper stands are often found in complex transitional zones or growing on exposed or severe sites within other forest systems. Climate is characterized by a relatively small amount of precipitation, with the wettest months during the growing season, very low humidity, and wide annual and diurnal temperature ranges. Winter conditions may be very cold but relatively dry, and often include rapid fluctuations in temperature associated with chinook winds.

In Montana, this system occurs grows mainly on limestone substrates, where roots follow the pattern of fractured and weathered rock (Burns and Honkala, 1990). Soils have a high rock component (typically over 50% cover) and are coarse- to fine-textured, often gravelly and calcareous. Soils are generally poorly developed, shallow, have low moisture holding capacity and are easily erodable, so in some occurrences, little topsoil is present. Although the system can be seen on gently rolling terrain, limestone cliffs, and exposed bluffs, it is most often found on rocky ridges and steep rocky slopes, and can survive in extremely windswept areas at both lower and upper tree line. Slopes are typically moderately steep to steep. Elevation ranges from 1,219-2,286 meters (4,000-7,500 feet) (Pfister et al, 1977). In the Beaverhead Mountain range, it occurs at higher elevations (Cooper et al, 1999).

Vegetation

Vegetation is characterized by an open-tree canopy or patchy woodland that is dominated by either limber pine or Rocky Mountain juniper. In the Pryor Mountains Utah juniper (*Juniperus osteosperma*) is sometimes seen at its northernmost extent within this system. Douglas-fir regularly occurs, but ponderosa pine and lodgepole pine are comparatively rare within these forests. Prolonged drought and white pine blister rust (*Cronartium rubicola*) have decimated limber pine along the Rocky Mountain Front (and elsewhere), resulting in a skeleton woodland with scattered Douglas-firs as the only living trees. At the northern end of its range in Montana, limber pine is mostly associated with common juniper (*Juniperus communis*) and creeping juniper (*Juniperus horizontalis*), whereas in the southern end of its range, it is associated with Rocky Mountain juniper. A sparse to moderately dense short-shrub layer is usually present. Within north-central and northwestern Montana, the most common shrubs include bearberry (*Arctostaphylos uva-ursi*)*,* creeping juniper*,* shrubby cinquefoil (*Dasiphora fruticosa* ssp. *floribunda*),and Canadian buffaloberry (*Shepherdia canadensis*). Other shrubs that may be present in west-central and southern Montana includebig sagebrush (*Artemisia tridentata*), black sagebrush (*Artemisia nova*)*,* curl-leaf mountain mahogany (*Cercocarpus ledifolius*)*,* rubber rabbitbrush (*Ericameria nauseosa*), skunkbush sumac (*Rhus trilobata*)*,* Woods' rose (*Rosa woodsii*), common snowberry (*Symphoricarpos albus*), or western snowberry (*Symphoricarpos occidentalis*). Herbaceous layers are generally sparse, but range to moderately dense; they are typically dominated by perennial graminoids such as blue grama (*Bouteloua gracilis*), Idaho fescue (*Festuca idahoensis*), rough fescue (*Festuca campestris*)*,* poverty oatgrass (*Danthonia intermedia*)*,* spike fescue (*Leucopoa kingii*), needle and thread (*Hesperostipa comata),* prairie junegrass (*Koeleria macrantha*), Indian ricegrass (*Oryzopsis hymenoides*)*,* Sandberg's bluegrass (*Poa secunda*), or blue bunch wheatgrass (*Pseudoroegneria spicata*). Common forbs include yarrow (*Achillea millefolium*), fringed sage (*Artemisia frigida*), arrowleaf balsamroot (*Balsamorhiza sagittata*), prairiesmoke (*Geum triflorum*)*,* hymenopappus (*Hymenopappus* species), four-nerve daisy (*Hymenoxys* species), dotted gayfeather (*Liatris punctata)*, stone seed (*Lithospermum ruderale*), silver lupine (*Lupinus argenteus*), pricklypear (*Opuntia* species), crazyweed (*Oxytropis* species), and cushion plants such as draba (*Draba* species), phlox (*Phlox* species), Rocky Mountain douglasia (*Douglasia montana*) and Howard's alpine forget-me-not (*Eritrichium howardii*).

This system often occurs in complex ecotones on severe sites within other forest systems. It often intergrades with Rocky Mountain Dry-Mesic Montane Mixed Conifer, Rocky Mountain Lower Montane, Foothill and Valley Grassland, Mountain Mahogany Woodland and Shrubland, and Montane Sagebrush Steppe.

Dynamic Processes

Major disturbances in this system include fire, soil erosion from over-used range, and biotic vectors. These woodlands often originate with and are likely maintained by fire. Clark's nutcrackers have co-adapted an important mutualism with limber pine, and are the primary harvester and disperser of its seeds. Regeneration on burns is largely from germinants of Clark's nutcracker seed caches. Fire can easily kill young trees because of their thin bark, however, fuel loads in this system are usually light due to open rocky terrain, and usually do not generate severe fire damage.

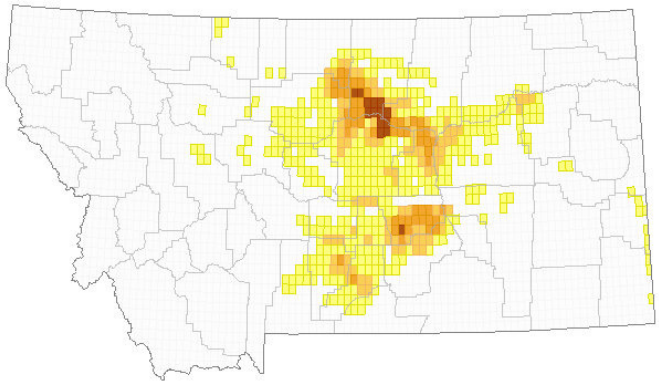
This system occurs on dry, rocky sites that are typified by extreme winter weather and droughty summer conditions that offer marginal conditions for tree growth. Consequently, mortality from abiotic and biotic stresses may be high in some areas. Limber pine is highly susceptible to white pine blister rust *(Cronartium ribicola*) and the pine needle pathogen (*Dothistroma septospora*). It can also be heavily infected or killed by limber pine dwarf-mistletoe (*Arceuthobium cyanocarpum*), and is susceptible to infestation by mountain pine beetles, cone beetles, coneworms, and budworms. The most significant damage due to biotic factors appears to occur at locations on the Lewis and ClarkNational Forest along the northern Rocky Mountain Front, the Gravelly range and sections of the Yellowstone ecosystem in southwestern Montana. Large numbers of trees have very thin crowns and poor terminal growth, and severe mortality is occurring in some areas.

Under natural conditions, Rocky Mountain juniper seedlings become established on moist sites in partial shade (Burns and Honkala 1990). Stands found in southwestern Montana may exhibit a savanna-like character due to the inability of Rocky Mountain juniper to establish on drier micro-sites. Rocky Mountain juniper is generally shallow rooted, and forest health can be negatively affected by heavy grazing, especially on exposed sites with erodible soils. Several insect pests that attack Rocky Mountain juniper, and mistletoes (*Phoradendron* species), a blight caused by *Cercospora sequoiae*, and cedar apple rust (*Gymnosporangium juniper virgiananae*) can be especially problematic (Burns and Honkala 1990).

Forest and Woodland Systems
Conifer-dominated forest and woodland (xeric-mesic)

Rocky Mountain Foothill Woodland-Steppe Transition

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5426



Approximately 2,457 square kilometers are classified as Rocky Mountain Foothill Woodland-Steppe Transition in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* Fire is the greatest threat, but given the proximity of this system to residential areas, fires are likely to be controlled.

Environment

In Montana, this system is found at scattered locations throughout northwestern and west central Montana, at elevations of 914-1,829 meters (3,000-6,000 feet) (Pfister et al, 1977; Mueggler and Stewart, 1980). Occurrences are found on all slopes and aspects; however, moderately steep to very steep slopes or ridgetops on southerly or western aspects are most common. This system can occur in association with cliff and canyon systems. It generally occurs on glacial till, glacio-fluvial sand and gravel, and loamy soils derived from a variety of parent materials. Soils are coarse with good aeration, often thin, and with slightly acidic to slightly basic pH. There is usually an abundance of mineral material consisting of fine and coarse rocks. Consequently, this system is subjected to droughty soil conditions during the growing season. Annual precipitation ranges from 36 to 56 centimeters (14 to 20 inches).

Similar Systems

- Rocky Mountain Ponderosa Pine Woodland and Savanna

Vegetation

Ponderosa pine (*Pinus ponderosa*) or Douglas-fir (*Pseudotsuga menziesii*) are the most common conifers. Limber pine (*Pinus flexilis*) may be present in some occurrences. In transition areas with sagebrush steppe systems, antelope bitterbrush (*Purshia tridentata*), Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), big sagebrush (*Artemisia tridentata* ssp. *tridentata*), and three-tip sagebrush (*Artemisia tripartita*) may be common in fire-protected sites such as rocky areas. Common ninebark (*Physocarpus malvaceus*), common snowberry (*Symphoricarpos albus*), or birch leaf spiraea (*Spiraea betulifolia)* can be abundant in occurrences on northern or eastern aspects, or sites west of the Continental Divide in northwestern Montana. Important grass species include bluebunch wheatgrass (*Pseudoroegneria spicata*), Sandberg's bluegrass (*Poa secunda*), needle and thread (*Hesperostipa comata*), needlegrass (*Achnatherum* species), prairie junegrass (*Koeleria macrantha*) and bottlebrush squirreltail (*Elymus elymoides*).

Common forbs include yarrow (*Achillea millefolium*), nodding onion (*Allium cernuum*), rosy pussytoes (*Antennaria rosea*), hairy golden aster (*Heterotheca villosa*), elk thistle (*Cirsium undulatum*), fleabane (*Erigeron* species), buckwheat (*Eriogonum* species), Indian blanket flower (*Gaillardia aristata*), stoneseed (*Lithospermum ruderale*), silky lupine (*Lupinus sericeus*), silky crazyweed (*Oxtropis sericea*), and Hood's phlox (*Phlox hoodii*). Arrowleaf balsamroot (*Balsamorhiza sagittata*) can be abundant in some occurrences.

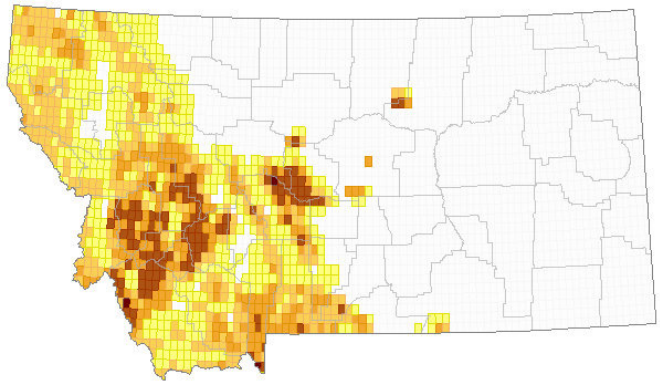
Dynamic Processes

Dry conditions and droughty soils that limit tree establishment are the driving factors in this system. Tree growth is likely episodic, with regeneration episodes in years with available moisture. Tree density is limited in some areas by available growing space due to the rocky conditions of the site. Tree canopy will never reach woodland density due to the interaction of climate and edaphic factors, even in the absence of fire. This system burns occasionally, but the vegetation is sparse enough that fires are typically not carried through the stand. Fire frequency is estimated to be 30 to 50 years. However, the invasion of cheatgrass (*Bromus tectorum*) is changing fire frequency, spread, and severity. Trees that occupy this edge environment and exhibit resistance to abiotic and biotic stressors are important genetic resources to maximize adaptive potential to current and continued environmental change.

Forest and Woodland Systems
Conifer-dominated forest and woodland (xeric-mesic)

Rocky Mountain Lodgepole Pine Forest

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4237



Approximately 12,036 square kilometers are classified as Rocky Mountain Lodgepole Pine Forest in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3

Environment

This system generally occurs on dry to intermediate sites with a wide seasonal range of temperatures and long precipitation-free periods in summer. Snowfall is heavy and supplies the major source of soil water used for growth in early summer. Vigorous stands occur where the precipitation exceeds 533 millimeters (21 inches). These lodgepole forests are typically associated with rock types weathering to acidic substrates, such as granite and rhyolite. In west-central Montana ranges such the Big Belts and the Rocky Mountain Front, these forests are found on limestone substrates. These forests are especially well developed on the broad ridges and high valleys near and east of the Continental Divide. Succession proceeds at different rates, moving relatively quickly on low-elevation, mesic sites and particularly slowly in high-elevation forests such as those along the Continental Divide in Montana.

Similar Systems

- Rocky Mountain Poor Site Lodgepole Pine Forest

Vegetation

These forests are dominated by lodgepole pine with shrub, grass, or barren understories. At montane elevations east of the Continental Divide, lodgepole pine stands succeed to Douglas-fir (*Pseudotsuga menziesii*) forests. In western Montana, there are a number of commonly occurring tree species in later seral stages, including Douglas-fir, western larch (*Larix occidentalis*), western white pine (*Pinus monticola*), western red cedar (*Thuja plicata*), grand fir (*Abies grandis*) and western hemlock (*Tsuga heterophylla*). In the subalpine zone, Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*) and mountain hemlock (*Tsuga mertensiana*) commonly succeed lodgepole pine following stand mortality (Pfister et al.,1977). In the productive habitats of western Montana, lodgepole pine stands often decline in a wave of mortality, usually before they are 120 years old.

The shrub stratum may be conspicuous to absent. Common species include bearberry (*Arctostaphylos uva-ursi*), snowbrush ceanothus (*Ceanothus velutinus*), twinflower (*Linnaea borealis*), creeping Oregon grape (*Mahonia repens*), antelope bitterbrush (*Purshia tridentata*), birch leaf spiraea (*Spiraea betulifolia),*Canadian buffaloberry (*Shepherdia canadensis*), dwarf huckleberry (*Vaccinium caespitosum*), grouse whortleberry (*Vaccinium scoparium),* mountain huckleberry (*Vaccinium membranaceum*), snowberry (*Symphoricarpos species*) and currant (*Ribes* species).

Herbaceous layers are generally sparse, but can be moderately dense, and are typically dominated by perennial graminoids such as Columbia needlegrass (*Achnatherum nelsonii*), pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), Ross' sedge (*Carex rossii*), California oatgrass (*Danthonia californica*), blue wildrye (*Elymus glaucus*), and Idaho fescue (*Festuca idahoensis*). Common forbs include yarrow (*Achillea millefolium*), arnica (*Arnica spp.),* American pathfinder (*Adenocaulon bicolor*), queen's cup beadlily (*Clintonia uniflora*), silky lupine (*Lupinus sericeus*) and beargrass (*Xerophyllum tenax*). Saprophytic species such as coralroot orchid (*Corallorhiza spp.),* Indian pipe (*Moneses uniflora)*, pinesap (*Monotropa hypopithys)*, and pinedrops (*Pterospora andromedea*) are often associated with lodgepole pine forests.

Dynamic Processes

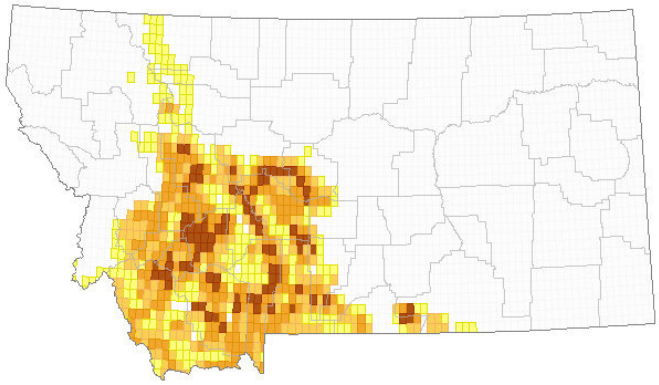
Lodgepole pineis an aggressive colonizer and shade-intolerant conifer which usually occurs in lower subalpine forests in the major ranges of the western United States. Establishment is episodic and linked to stand-replacing disturbances, primarily fire. Historically, the frequency of fires varied between 50 and 400 years and their severity resulted in a diverse mosaic of age classes and species mixtures. In the Northern Rockies, severe fires typically have created large expanses of even-aged, pure or mixed species stands of lodgepole pine. Trees with closed, serotinous cones appear to be strongly favored by fire, and allow rapid colonization of fire-cleared substrates (Burns and Honkala, 1990). The incidence of serotinous cones varies within and between varieties of lodgepole pine, but is most prevalent in Rocky Mountain populations. Lodgepole pinestands exhibiting a multi-aged population structure, with regeneration occurring, exhibit a higher proportion of trees bearing non-serotinous cones. Trees with non-serotinous cones may predominate in persistent or climax Rocky Mountain lodgepole pine forests. If serotiny is expressed in these stands, cone polymorphism exists and allows regeneration after non-fire disturbances.

In fire-generated stands of similar age, trees become susceptible to mountain pine beetle (*Dendroctonus ponderosae*) and lodgepole pine dwarf mistletoe (*Arceuthobium americanum*) infestations at approximately the same time, resulting in large-scale infestations and mortality. In this system, very large scale, stand-replacing fires have occurred frequently throughout Montana during the past 20 years.

Forest and Woodland Systems
Conifer-dominated forest and woodland (xeric-mesic)

Rocky Mountain Montane Douglas-fir Forest and Woodland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4266



Approximately 9,795 square kilometers are classified as Rocky Mountain Montane Douglas-fir Forest and Woodland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

Environment

East of the Continental Divide, this ecosystem forms a forest belt on cold, dry to mesic sites in the montane zone. It is found on moderately dry mountain slopes and benches. It generally occurs on gravelly soils with good aeration and drainage and a neutral to slightly acidic pH. This system is subjected to a dry to sub-mesic continental climate. Individual trees and forests can attain great age on some sites (500-1500 years), due to mixed severity fire regimes. It often occurs at the lower treeline immediately above valley grasslands, or sagebrush steppe and shrublands.

Similar Systems

- Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland

Vegetation

This system is dominated by Douglas-fir (*Pseudotsuga menziesii*) forests. Limber pine (*Pinus flexilis*) can co-occuron calcareous substrates, and lodepole pine (*Pinus contorta*) is often frequent in these stands at higher elevations. Engelmann spruce (*Picea engelmannii*) is found in some stands within the upper montane zone, occurring just below or intergrading with whitebark pine (*Pinus albicaulis*) forests. Common understory shrubs include common ninebark (*Physocarpus malvaceus*), common juniper (*Juniperus communis*), Rocky Mountain juniper (*Juniperus scopulorum*) birch-leaf spiraea (*Spiraea betulifolia*), snowberry (*Symphoricarpos* species), creeping Oregon grape (*Mahonia repens*) and Canadian buffaloberry (*Shepherdia canadensis*). Dwarf huckleberry (*Vaccinium caespitosum*) or mountain huckleberry (*Vaccinium membranaceum*) are foundon colder, mesic sites. Common graminoids include pinegrass (*Calamagrostis rubescens*), Ross' sedge (*Carex rossii*), and Geyer's sedge (*Carex geyeri*). Bluebunch wheatgrass (*Pseudoroegneria spicata*) and Idaho fescue (*Festuca idahoensis*) are often common on sites adjacent to upper elevation montane grasslands. The Douglas-fir/pinegrass (C*amogrostis rubescens*) type is the most ubiquitous association found within this system in Montana. Common forbs within these forests include yarrow (*Achillea millefolium)*, lanceleaf arnica (*Arnica latifolia*), pussytoes (*Antennaria racemosa)*, wild strawberry (*Fragaria virginiana*), twinflower (*Linnaea borealis*), and beargrass (*Xerophyllum tenax*).

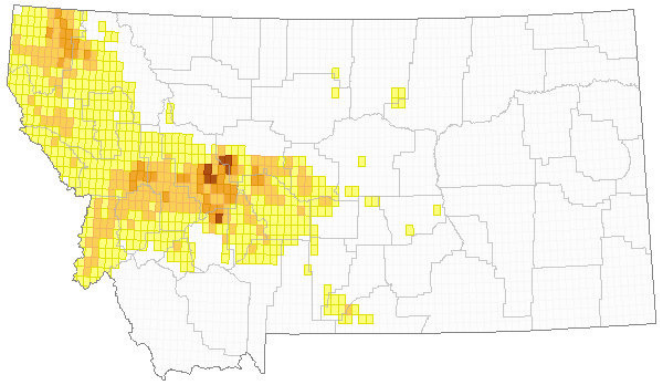
Dynamic Processes

This system experiences 100- to 500-year fire disturbance intervals, but can be more frqeuent in some stands. Douglas-fir regenerates well following fire and is tolerant of repeated, low-intensity surface fires. In the absence of disturbance, Douglas-fir is the only species that continues to regenerate under shaded conditions, and becomes dominant in undisturbed stands. Pre-settlement fire regimes may have been characterized by frequent, low-intensity ground fires that maintained relatively open stands. Under present conditions, the fire regime is mixed severity and more variable, with stand-replacing fires more common, and the forests are more homogeneous. With vigorous fire suppression, longer fire-return intervals are now common, and multi-layered stands provide fuel "ladders," making these forests more susceptible to high-intensity, stand-replacing fires. In some areas, these forests have been priorities for timber harvesting and grazing. In recent years, these forests have been subjected to prolonged periods of drought, creating conditions where stands are susceptible to outbreaks of Douglas-fir tussock moth (*Orgyia pseudotsugata*) and Douglas-fir bark beetle (*Dendroctonus pseudotsugae*).

Forest and Woodland Systems
Conifer-dominated forest and woodland (xeric-mesic)

Rocky Mountain Ponderosa Pine Woodland and Savanna

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4240



Approximately 2,440 square kilometers are classified as Rocky Mountain Ponderosa Pine Woodland and Savanna in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

Environment

In western and central Montana, this ecosystem forms a belt on warm, dry, exposed sites between grasslands and Douglas-fir (*Pseudotsuga menziesii*) forests. Elevations range from 1,066 to 1,676 meters (3,500-5,500 feet) (Pfister et al, 1977). This system can occur at higher elevations in central Montana. It is generally found on gravelly soils with good aeration and drainage and a neutral to slightly acidic pH.

Similar Systems

- Great Plains Ponderosa Pine Woodland and Savanna
- Rocky Mountain Foothill Woodland-Steppe Transition

Vegetation

Ponderosa pine is the dominant conifer. Douglas-fir and western larch may be present in the tree canopy in the more western areas, but are usually absent. In central Montana, limber pineand horizontal juniperare often components. Although the understory for ponderosa pine forests is often shrubby in other states, in Montana, habitats are mostly dominated by grasses, although antelope bitterbrush, snowberry, serviceberry (*Amelanchier alnifolia*), bearberry (*Arctostaphylos uva-ursi*), common juniper (*Juniperus communis*) and skunkbush occur in forests on benchlands and rocky slopes in the central portion of the state. Understory vegetation is more typically fire-resistant grasses and forbs that resprout following surface fires. High shrub cover, understory trees, and downed logs are uncommon. These more open stands support grasses such as bluebunch wheatgrass (*Pseudoroegneria spicata*), which is usually dominant, prairie junegrass (*Koeleria macrantha*) and needle and thread (*Hesperostipa comata*), as well as dryland sedges likethreadleaf sedge (*Carex filifolia*) and sun sedge (*Carex inops* ssp. *heliophila*). On more mesic sites,bluebunch wheatgrass occurs as the dominant graminoid species with Idaho fescue (*Festuca idahoensis*) and rough fescue (*Festuca campestris*). In central Montana, soapweed yucca (*Yucca glauca*), Pennsylvania sedge (*Carex pennsylvanica*), grama (*Bouteloua spp.*) and bluestem (*Andropogon spp.*) occur on especially dry sites. Common herbaceous forbs include yarrow (*Achillea millefolium*), pink pussytoes (*Antennaria rosea*), arrowleaf balsamroot (*Balsamorhiza sagittata),* Indian blanket flower (*Gaillardia aristata*), and silky lupine (*Lupinus sericeus*).

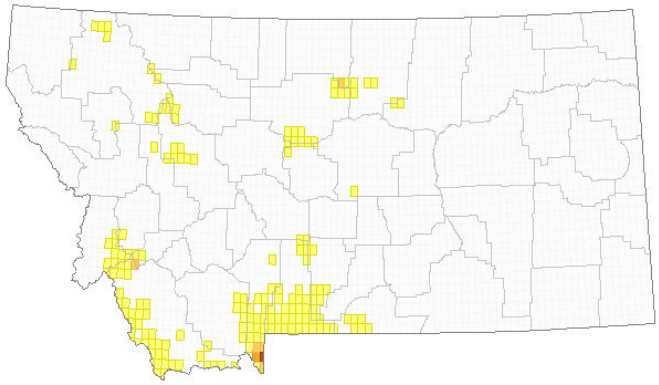
Dynamic Processes

Under natural conditions, ponderosa pine woodlands and grasslands are maintained by frequent surface fires (Arno, 1980). The threat of stand-replacing fires is high in areas where periodic fire has been suppressed. A study at the Sawmill Resource Natural Area in the Bitterroot National Forest found an average fire return interval of 13 years prior to the initiation of systematic fire suppression policies. In the absence of fire, forest density increases, and fire-intolerant species like Douglas-fir become more common (Gayton et al., 2006). Grazing by domestic livestock may reduce bunchgrasses, and in cases of intensive overgrazing, cheatgrass (*Bromus tectorum*) may be dominant in the understory. Wind is not generally an issue, except when trees have been damaged by lightning strikes.

Forest and Woodland Systems
Conifer-dominated forest and woodland (xeric-mesic)

Rocky Mountain Poor Site Lodgepole Pine Forest

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4267



Approximately 101 square kilometers are classified as Rocky Mountain Poor Site Lodgepole Pine Forest in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3

Environment

This system generally occurs on dry to intermediate sites with a wide seasonal temperature range and long precipitation-free periods in summer. Snowfall is heavy and supplies the major source of soil water used for growth in early summer. The nutrient-poor soils include excessively well-drained pumice deposits; glacial till and alluvium on valley floors where there is cold air accumulation; warm and droughty shallow soils over fractured quartzite bedrock; and shallow moisture-deficient soils with a significant component of volcanic ash. Soils supporting these forests are typically well-drained, gravelly, coarse-textured, acidic, and rarely formed from calcareous parent materials.

Similar Systems

- Rocky Mountain Lodgepole Pine Forest

Vegetation

These forests are dominated by lodgepole pine (*Pinus contorta*) withsparse undergrowth. At the closed canopy stage of stand development, undergrowth may be totally lacking. Some open stands with very sparse understories can experience a form of mixed-severity burning along downed logs when there are insufficient fuels between logs to carry fire. Depending on the arrangement and loading of logs to living trees, either mortality or fire-scarring may occur.

The shrub layer may be conspicuous to absent. Common species include bearberry (*Arctostaphylos uva-ursi*), snowbrush ceanothus (*Ceanothus velutinus*), twinflower (*Linnaea borealis*), creeping Oregon grape (*Mahonia repens*), antelope bitterbrush(*Purshia tridentata*), birch leaf spiraea (*Spiraea betulifolia),* Canadian buffaloberry (*Shepherdia canadensis*), dwarf huckleberry (*Vaccinium caespitosum*), grouse whortleberry (*Vaccinium scoparium*)*,* snowberry (*Symphoricarpos species*) and currant (*Ribes*species).

Herbaceous layers are generally sparse, but can be moderately dense, and are typically dominated by perennial graminoids such as Columbia needlegrass (*Achnatherum nelsonii*), pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), Ross' sedge (*Carex rossii*), bottlebrush squirrel tail (*Elymus elymoides*), California oatgrass (*Danthonia californica*), blue wildrye (*Elymus glaucus*), and Idaho fescue (*Festuca idahoensis*)*.* Common forbs include yarrow (*Achillea millefolium*), arnica (*Arnica spp.*)*,* silky lupine (*Lupinus sericeus*), phlox (*Phlox spp.*), buckwheat (*Eriogonum spp.),* and beargrass (*Xerophyllum tenax*).

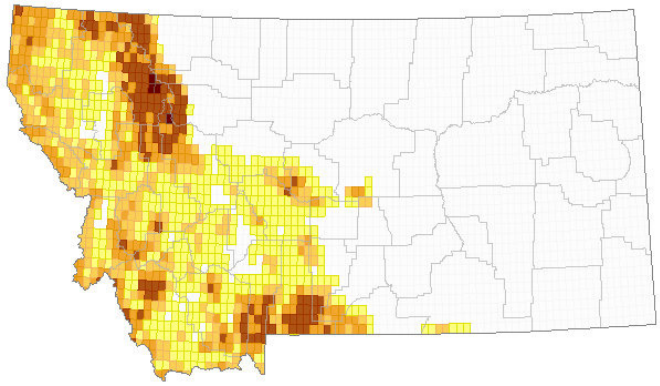
Dynamic Processes

Establishment of lodgepole pine is episodic and linked to stand-replacing fire. Some open subalpine stands with very sparse understories often experience a form of mixed-severity burning. Trees with closed, serotinous cones appear to be strongly favored by stand-replacing fire, and allow rapid colonization of fire-cleared substrates (Burns and Honkala, 1990). These forests often exhibit a multi-aged population structure, with non-fire regeneration, and often exhibit a higher proportion of trees bearing non-serotinous cones. Trees with non-serotinous cones may predominate in these persistent or climax lodgepole pine forests. If serotiny is expressed in these stands, cone polymorphism exists and allows regeneration after non-fire disturbance. In some occurrences, stand-replacing fires within this system have occurred more frequently during the past 20 years.

Forest and Woodland Systems
Conifer-dominated forest and woodland (xeric-mesic)

Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4242



Approximately 12,579 square kilometers are classified as Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3

Environment

This system forms a belt at relatively low to high elevations west of the Continental Divide and mid to high elevations east of the Divide throughout the Montana Rocky Mountains and island ranges of north-central and west-central Montana. Soils are derived from a variety of parent materials, and are usually rocky or gravelly with good aeration and drainage, but are usually acidic. Occurrences are typically found in locations with cold-air drainage or ponding, or where snowpacks linger late into the summer, such as north-facing slopes and high-elevation ravines. They can extend down in elevation below the subalpine zone in places where cold-air ponding occurs, especially on north and east aspects. Dry to mesic spruce-dominated forests range from 884 to 1,585 meters (2,900-5,200 feet) west of the Continental Divide, and 1585 to 2,073 meters (5,200-6,800 feet) east of the Continental Divide in the northern and central portions of the state. They can be found at elevations up to 2,896 meters (9,500 feet) in southwestern Montana.

Similar Systems

- Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
- Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland

Vegetation

Tree canopy characteristics are relatively uniform, with Engelmann spruce and subalpine fir dominating, either mixed or alone. In northern Montana, Engelmann spruce hybridizes with its boreal counterpart, white spruce. Spruce is more tolerant of extreme environmental conditions than subalpine fir, and is usually more dominant in the drier and wettest habitats within this system. Douglas-fir, lodgepole pine, and western larch (west of the Continental Divide) are seral but often present in these forests. Mountain hemlock (*Tsuga mertensiana*) occurs as small to large patches within the matrix of this mesic spruce-fir system, but only in the coldest and wettest environments of northwestern Montana.

The understory of these forests often supports diverse stands of ericaceous shrubs, such as rusty leaf menziesia (*Menziesia ferruginea*), dwarf huckleberry (*Vaccinium caespitosum),* mountain huckleberry (*Vaccinium membranaceum*), dwarf bilberry (*Vaccinium myrtillus*) and mountain heath (*Phyllodoce* species). Grouse whortleberry (*Vaccinium scoparium)* is common on mesic sites. Cascade azalea (*Rhododendron albiflorum*) occurs in association with mountain hemlock and subalpine fir in some mesic occurrences in northwestern Montana.Other common shrubs include Rocky Mountain maple (*Acer glabrum*), serviceberry (*Amelanchier alnifolia*),Utah honeysuckle (*Lonicera utahensis*), ninebark (*Physocarpus malvaceus*),currant (*Ribes*species), thimbleberry (*Rubus parviflorus*)*,* birch leaf spiraea (*Spiraea betulifolia)* and common snowberry (*Symphoricarpos albus*)*.* On the driest sites in the Bighorn Mountains,big sagebrush (*Artemisia tridentata*) may be present.Smooth woodrush (*Luzula glabrata* var. *hitchcockii*)is the most common graminoid on mesic sites at higher elevations. Pinegrass (*Calamagrostis rubescens),* Geyer's sedge (*Carex geyeri*), and Ross' sedge (*Carex rossi*) are common on drier sites*.* Forb diversity varies depending on moisture conditions. Species includebaneberry *(Actaea rubra*), arnica (*Arnica* species),Columbia clematis *(Clematis occidentalis*), queen's cup beadlily (*Clintonia uniflora*), bunchberry dogwood (*Cornus canadensis*), fragrant bedstraw (*Galium triflorum*), twinflower (*Linnaea borealis*), clasp-leaf twisted stalk (*Streptopus amplexifolius*), western meadow rue (*Thalictrum occidentale*) and beargrass (*Xerophyllum tenax*)*.*

Dynamic Processes

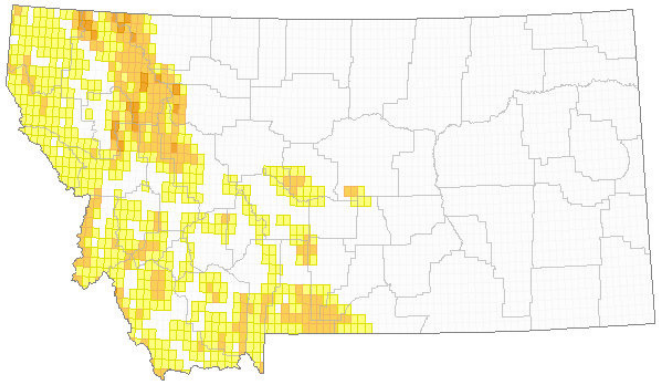
Major disturbances include occasional blowdown, insect outbreaks (30-50 years), mixed-severity fire, and stand-replacing fire (150-500 years). The more summer-dry climatic areas also have occasional high-severity fires. Insects and diseases can play a major role in the successional direction of these forests. Throughout Montana, subalpine fir and spruce are affected by spruce budworm attacks, and large stands of these subalpine forests can be killed following several years of drought or unusually mild winters.

Following fire, spruce is more successful at establishing on mineral soils. Subalpine fir, in contrast, is better at establishing in the shade and on organic substrates. In forests undisturbed by fire or subjected to spruce budworm attacks, subalpine fir assumes greater dominance. Over a period of 500 years, subalpine fir will largely replace spruce within most habitats of this system.

Forest and Woodland Systems
Conifer-dominated forest and woodland (xeric-mesic)

Rocky Mountain Subalpine Woodland and Parkland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4233



Approximately 1,894 square kilometers are classified as Rocky Mountain Subalpine Woodland and Parkland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S2

* Blister rust, insects and drought are all affecting these forests. Although decline has not been as widespread as with some other ecological systems, it is expected to continue, especially if winters are mild.

Environment

In Montana, these forests form a belt throughout the Montana Rocky Mountains and island ranges. Near the upper elevational limits, these forests and parklands are bordered by alpine meadows and tundra. On especially dry sites east of the Continental Divide, these forests are sometimes bordered by subalpine grasslands. Forests and parklands are diverse in composition and structure due to widely diverse high elevation terrain and extreme climatic conditions. At the upper limits of tree growth, stands and krummholz mats can persist for hundreds of years. This system occurs up to 1,981-2,195 meters (6,500-7,200 feet) in northwestern Montana, 2,225-2438 meters (7,300-8,000 feet) in west-central Montana and island ranges, and 2,469-2,682 meters (8,100-8,800 feet) in southwestern Montana. Soils and parent materials are variable. Alpine larch stands typically develop on granitic and quartzite substrates with little soil development or occasionally on sedimentary materials. Surface soils are usually gravelly loams with large amounts of rock present (Pfister et al., 1977). Whitebark pine-subalpine fir communities can occur on a wide range of parent materials, including calcareous bedrock substrates. Soils are typically gravelly silt loams and silts that range from slightly basic to slightly acidic. Duff layers in both forest types are typically less than 2.5 centimeters (1.0 inch) (Pfister et al., 1977). This forest and woodland system occurs on landforms such as ridgetops, mountain slopes, glacial trough walls and moraines, talus slopes, landslides and rockslides, and cirque headwalls and basins. Snow accumulation is high in basins, but ridgetops have little snow accumulation because of high winds and sublimation. In this harsh, often wind-swept environment, trees are stunted and flagged from damage associated with wind, blowing snow and ice crystals, especially at the upper elevational ecotone.

Similar Systems

- Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
- Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland

Vegetation

These forests or patches often originate when Engelmann spruce, alpine larch, or whitebark pine colonize a sheltered site. Alpine larch/subalpine fir communities are prevalent on cool, north- and east-facing exposures west of the Continental Divide. Whitebark pine/subalpine fir communities occur on adjacent, warmer exposures and aspects. Subalpine fir colonizes in the shelter of these speciesand may form a dense canopy by branch layering. This species is capable of remaining dominant within these subalpine and treeline forests due to its longevity and ability to regenerate vegetatively. In the absence of disturbance, it continues to regenerate under shaded conditions. Seed crops are erratic at the lower elevational limit of this system and are virtually absent at treeline. The most common subalpine forest association in Montana is whitebark pine-subalpine fir.

The understories of these forests are usually sparse, but moister sites support mats of ericaceous plants, such as tall huckleberry (*Vaccinium membranaceum*), dwarf bilberry (*Vaccinium myrtillus*), or most often, grouse whortleberry (*Vaccinium scoparium*). Mountain heath (*Phyllodoce* species) and white mountain heather (*Cassiope mertensiana*) are commonon sites with more organic matter accumulation. A few taller shrubs such as alpine currant (*Ribes montigenum*), short fruited willow (*Salix brachycarpa*), and planeleaf willow (*Salix planifolia*) may also be present.The herbaceous layer is sparse under dense shrub or tree canopies, but may be dense where the shrub canopy is open or absent. Purple mountain hairgrass (*Vahlodea atropurpurea*), Hitchcock's woodrush *(Luzula glabrata* var. *hitchcockii*), alpine bluegrass (*Poa alpina*), Sandberg's bluegrass (*Poa secunda*), alpine timothy (*Phleum alpinum*), pinegrass (*Calamagrostis rubescens*), Parry's rush (*Juncus parryi*) and sedges (*Carex* species) are the most common graminoids. A wide diversity of forbs are present in open meadows among or adjacent to these forests, typically including species such as arnica (*Arnica* species), subalpine wandering daisy (*Erigeron peregrinus)*, arrowleaf groundsel (*Senecio triangularis)*, aster (*Symphyotrichum species),* sibbaldia (*Sibbaldia procumbens*), glacier lily (*Erythronium grandiflorum*), rhexi-leaf paintbrush (*Castilleja rhexifolia*), western windflower (*Anemone occidentalis*), alpine St. John's wort (*Hypericum formosum)*, diverse leaf cinquefoil (*Potentilla diversifolia*), and penstemon (*Penstemon* species).

Alpine larch stands generally occur at or near upper treeline in north-facing cirques or on slopes where snowfields persist until June or July (Arno and Habeck, 1972). Typical stands are often isolated pockets of open, parklike groves. Alpine larch is considered a pioneer species in these high, north-facing aspects on rocky sites with little soil development, and due to its longevity (up to 1,000 years), is persistent on these sites. Typically, undergrowth in alpine larch stands can be limited due to high rock cover and limited soil development, but will often includes pink mountain heath (*Phyllodoce empetriformis*), Hitchcock's woodrush and subalpine fir.

Dynamic Processes

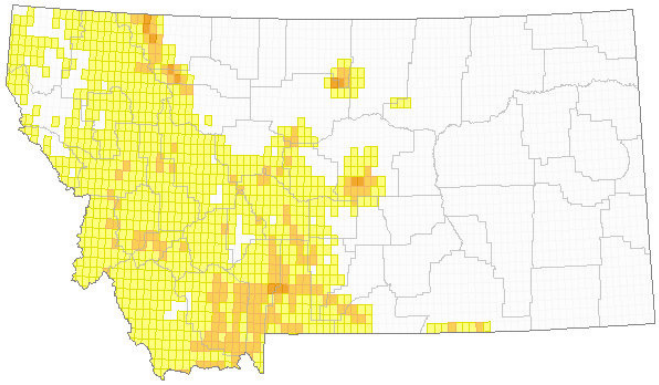
Major disturbances in this system include fire, avalanches, and biotic vectors. Historically, stand-replacing fires occurred infrequently in this system, at least where open woodlands limited fire severity and spread (Arno, 1980). These tree species are very susceptible to fire.Whitebark pine and subalpine firhave some tolerance to low and moderate severity fire if old individual trees have developed thick bark.Lightning damage to individual trees is common, but sparse canopies and rocky terrain historically limited the spread of fire. More recently, stand-replacing fires caused by lightning strikes are becoming more common, especially in areas of steep terrain. In precipitous mountain areas that receive heavy snowfall, avalanches are common and can remove broad swaths of subalpine forest.

Insects and disease can play a major role in the successional direction of these forests. Whitebark pine is affected by white pine blister rust and mountain pine beetle and is experiencing marked decline. Subalpine firis becoming more prevalent in these forests due to high blister rust mortality. Blister rust mortality is especially high in northwestern Montana, where the moister Pacific maritime climate at high elevations is more conducive to infection than the drier air in the southern mountain ranges. Throughout Montana, both subalpine fir and spruce are affected by spruce bud worm attacks, and large stands of these subalpine forests can be killed following several years of drought or unusually mild winters. Warming climate patterns can result in increases of tree seedling recruitment and density at the upper elevation limit of this ecological system (Klasner and Fagre, 2002).

Forest and Woodland Systems
Deciduous dominated forest and woodland

Aspen Forest and Woodland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4104



Approximately 1,710 square kilometers are classified as Aspen Forest and Woodland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3

Environment

Climate is temperate with a relatively long growing season, typically cold winters and deep snow. Mean annual precipitation is greater than 38 centimeters (15 inches) and typically greater than 51 centimaters (20 inches), except in semi-arid environments where occurrences are restricted to mesic, microsites such as seeps or areas below large snow drifts. Stands can occur on gentle to moderate slopes, in swales, or on level sites. At lower elevations, occurrences are found on cooler, north aspects and mesic sites. Soils are usually deep and well developed, with rock often absent from the soil. Soil texture ranges from sandy loam to clay loams.

Similar Systems

- Aspen and Mixed Conifer Forest

Vegetation

This system includes aspen stands with a relatively closed canopy of trees 5-20 meters (16 to 66 feet) tall. In Montana, most aspen clones are smaller than in the Central Rocky region. Clones can be stable and long-lived or seral to Douglas-fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*) or spruce (*Picea* species) dominated forests (Habeck, 1967). Stable climax aspen forest also occurs in southwestern Montana (Pfister et al, 1977). Conifers that may be present but are never codominant include subalpine fir, Engelmann spruce (*Picea engelmannii*), white spruce (*Picea glauca*), ponderosa pine (*Pinus ponderosa*), and Douglas-fir. Conifer species may contribute up to 25% of the tree canopy before the occurrence is reclassified as a mixed occurrence. This system can be interpreted in some instances to be the seral phase of the Inter-Mountain Basins Aspen-Mixed Conifer Forest & Woodland. In Glacier County, this system differs in height growth, which is controlled by recurring Chinook winds.

Depending on available soil moisture and other factors like disturbance, the understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by graminoids or forbs. Common shrubs include Rocky Mountain maple (*Acer glabrum*), serviceberry (*Amelanchier alnifolia*), creeping Oregon grape (*Mahonia repens*), chokecherry (*Prunus virginiana*), rose (*Rosa spp.*), thimbleberry (*Rubus parviflorus*), and snowberry (*Symphoricarpos spp.*). The herbaceous layers may be lush and diverse. Common graminoids may include mountain brome (*Bromus carinatus*), pinegrass (*Calamagrostis rubescens*), Ross' sedge (*Carex rossii*), blue wildrye (*Elymus glaucus*), slender wheatgrass (*Elymus trachycaulus*) and bearded fescue (*Festuca subulata*). Common mesic understory forbs include yarrow (*Achillea millefolium*), sharptooth angelica (*Angelica arguta*), Engelmann aster (*Eucephalus engelmannii*),larkspur *(Delphinium* species), aspen daisy (*Erigeron speciosus*), Richardson's geranium (*Geranium richardsonii*), common cow parsnip (*Heracleum maximum*), western sweet cicely (*Osmorhiza occidentalis*), western meadow rue (*Thalictrum occidentale*), stinging nettle (*Urtica dioica*) and western valerian (*Valeriana occidentalis*). Bracken fern (*Pteridium aquilinum*) is present in some stands.Exotic grasses such as the perennials Kentucky bluegrass (*Poa pratensis*), common timothy (*Phleum pratense*) and smooth brome (*Bromus inermis*) are often common in occurrences disturbed by grazing.

Dynamic Processes

Occurrences in this ecological system often originate with, and are likely maintained by, stand-replacing disturbances such as crown fire, disease and windthrow, or logging by humans or beaver. Boles are killed by ground fires, but they can quickly and vigorously resprout by root suckers in high densities. Stems are relatively short-lived (70-120 years), and the system will generally succeed to longer-lived conifer forest if undisturbed. Occurrences are favored by fire in the conifer zone (Mueggler, 1988). In Montana, seed production is erratic and infrequent. Natural seedling establishment is limited to years of viable seed production. Seedling recruitment is limited to sites where there is adequate soil moisture following dispersal in early summer. Following the Yellowstone fires of 1988, quaking aspen seedlings established on many suitable sites. These sapling and young tree stands are subjected to heavy elk browsing and will not reach full maturity.

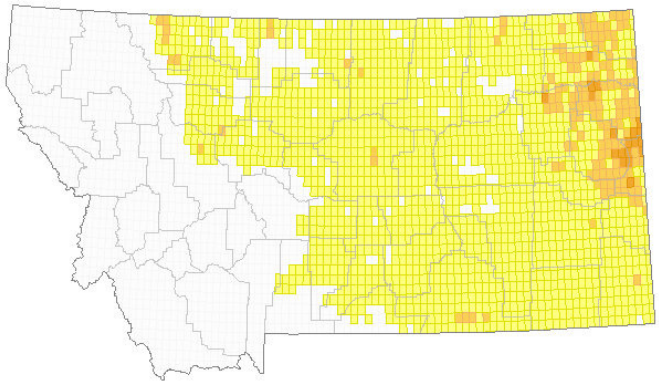
Quaking aspen is dioecious; clones are either male or female. Reproduction is largely clonal. Some clones are thought to be centuries old and have the potential to be large in size. Stems are produced from a common root system; new stems are produced on the outside, advancing in front of the clone, with older trees in the center. The root system persists as stems die and are replaced. Clones can be distinguished by morphological differences in flowering and leaf emergence phenology, leaf size and shape, branching habit, bole character, and gender. Quaking aspen reproduces vegetatively by sprouting from stumps and root crowns, and by forming suckers (adventitious shoots on roots). The ability of *Populu*s to regenerate by suckers can vary widely among clones (Schier et al, 1985).

In recent years, many aspen stands have exhibited mortality from biotic vectors. These pathogens mainly infect clones already stressed by drought, insects, wind damage, heavy livestock and wildlife use and similar factors.

Forest and Woodland Systems
Deciduous dominated forest and woodland

Great Plains Wooded Draw and Ravine

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4328



Approximately 2,003 square kilometers are classified as Great Plains Wooded Draw and Ravine in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* Drought and change in species composition, along with grazing, are the greatest threats

Environment

Wooded draws and ravines are best developed under conditions that favor snow entrapment, development of deeper soils, and concentration of moisture. These conditions are typical of ravines formed by ephemeral and intermittent streams and on toeslopes and north-facing backslopes. Uplands are generally mixed grass prairies and shrublands. Generally, these systems are less than 50 meters (165 feet) wide, although the linear extent may be considerable. Soils are usually deep loams. Flooding is very short in duration when it occurs, as water is rapidly channeled downslope.

Vegetation

In Montana, this community is composed mostly of small trees, although larger diameter trees can occur at the foot of the ravine where there is greater available soil moisture. In some areas of the western Great Plains, in higher elevation draws and ravines, Rocky Mountain juniper can dominate the canopy. Aspen, paper birch or boxelder maple are commonly present in portions of the northwestern Great Plains. Throughout central and eastern Montana, green ash or chokecherry are the typical dominants, although Douglas hawthorne is occasionally seen as a dominant in south-central Montana, especially around the Pryor Mountains. Boxelder maple and American elm (*Ulmus rubra* or *Ulmus americana*) are often present. In many parts of Montana, particularly in disturbed occurrences, the understory is a dense shrub layer of western snowberry (*Symphoricarpos occidentalis*). In less disturbed sites, the understory is two-layered, with a shrub layer of chokecherry and other *Prunus* species, as well as hawthorne species, silverberry (*Elaeagnus commutata*), current (*Ribes* species), Woods' rose (*Rosa woodsii*), and silver buffaloberry (*Shepherdia argentea*). The lowest layer is dominated by sedges (*Carex* species) and grasses such as northern reedgrass (*Calamagrostis stricta),* western wheatgrass (*Pascopyrum smithii*)*,* bluebunch wheatgrass (*Pseudoroegneria spicata*), and thickspike wheatgrass (*Elymus lanceolatus*). Common forbs include American licorice (*Glycyrrhiza lepidota*), yarrow (*Achillea millefolium*), meadow rue (*Thalictrum dasycarpum*), and bedstraw (*Galium* species). Exotics such as Russian olive (*Elaeagnus angustifolia*), yellow sweetclover (*Meliotus officinalis*) and Kentucky bluegrass (*Poa pratensis*) are often found throughout these systems, especially in agricultural areas.

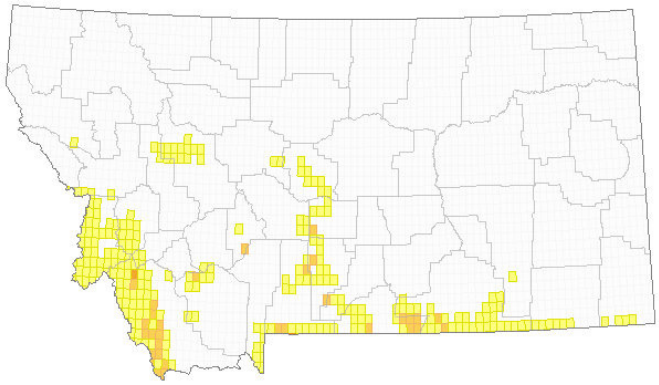
Dynamic Processes

Both domestic animals and wildlife use these systems readily, leading to trampling of vegetation and an increase in shrub domination. Fire is a secondary influence.

Forest and Woodland Systems
Deciduous dominated forest and woodland

Mountain Mahogany Woodland and Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4303



Approximately 281 square kilometers are classified as Mountain Mahogany Woodland and Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4
* This system is patchy and not common, but because occurrences are so dispersed, threats are also dispersed.

Environment

This ecological system occurs as small- to large-patch stands on dry and rocky soils associated with moderately steep to very steep slopes, although occurrences on flat to gently sloping surfaces are also found in Montana. It is most prevalent on limestone outcrops where extensive stands develop, although it also occurs on other parent materials, generally as small patches. It can occur on all aspects but is most prevalent on south and southwestern aspects. This system's observed elevation range within the state is 1,060-2,260 meters (3,500-7,400 feet). Climate within its distribution range in Montana is typical of mid-continental regions with long severe winters and hot, dry summers. This system is important winter range for deer and elk.

Similar Systems

- Rocky Mountain Foothill Limber Pine - Juniper Woodland

Vegetation

This shrubland system is dominated by curl-leaf mountain mahogany (*Cercocarpus ledifolius*). Rocky Mountain juniper (*Juniperus scopulorum*) occurs throughout this system's range and Utah juniper (*J. osteosperma*) occurs in the Pryor Mountains. Conifers such as Douglas-fir (*Pseudotsuga menziesii*), limber pine (*Pinus flexilis*) and ponderosa pine (*P. ponderosa*) may also occur in some stands. Ponderosa pine stands within this system are mostly found in eastern Montana. Other co-dominant shrubs include mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), antelope bitterbrush (*Purshia tridentata*), and rubber rabbitbrush (*Ericameria nauseosa*). Other low shrubs such as snakeweed (*Gutierrezia sarothrae*) and fringed sage (*Artemisia frigida*) are common. Undergrowth is dominated by bunchgrasses, usually bluebunch wheatgrass (*Pseudoroegneria spicata*), needle and thread (*Hesperostipa comata*), and Indian ricegrass (*Achnatherum hymenoides*).Other low shrubs such as broom snakeweed (*Gutierrezia sarothrae*) and fringed sage (*Artemisia frigida*) are common (Mueggler and Stewart, 1980).

Bluebunch wheatgrass (*Pseudoroegneria spicata*) is the dominant grass throughout this system, although needle and thread (*Hesperostipa comata*) and Indian ricegrass (*Achnatherum hymenoides*) may be co-dominant on more xeric occurrences. Mesic occurrences are frequently dominated or co-dominated by Idaho fescue (*Festuca idahoensis*). Prairie junegrass (*Koeleria macrantha*) is a minor component. Due to the rocky and shallow substrates, undergrowth cover is relatively sparse, often with less than 20% cover. Common forbs include rosy pussytoes (*Antennaria rosea*), sulphur buckwheat (*Eriogonum umbellatum*), few-seed draba (*Draba oligosperma*), tufted fleabane (*Erigeron cespitosus*), Hood's phlox (*Phlox hoodii*), and stoneseed (*Lithospermum ruderale*). Cacti such as plains pricklypear (*Opuntia polyacantha*)and Missouri foxtail cactus (*Mammillaria missouriensis*) are present on especially xeric sites. Within this system, cheatgrass (*Bromus tectorum*) or other annual bromes and invasive weeds can be abundant.

Dynamic Processes

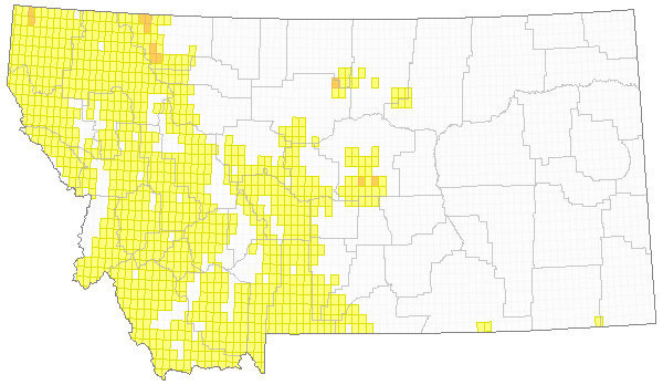
Curl-leaf mountain mahogany is easily killed by fire at all intensities. Some shrubs may re-sprout following low-intensity fires, but these are typically low in vigor and do not persist. Regeneration is by seedling recruitment. High-intensity fires kill all standing shrubs and may also eliminate the seed bank on these sites. However, a lack of continuous fuels, sparse undergrowth, open stand structure, and low downed wood accumulations contribute to a low fire frequency within this system. Particularly in areas where fire has been suppressed, the absence of fire in curl-leaf mountain mahogany habitats has increased curl-leaf mountain mahogany abundance and successful regeneration in some areas of central, southwestern, and southeastern Montana (Gruell, 1982).

Curl-leaf mountain mahogany provides food and cover for a variety of wildlife species such as deer and elk. Some livestock (domestic goats, sheep, and cattle) use it in spring, fall, and/or winter, but rarely in the summer. In other areas of this system's geographic range, heavy grazing practices have been observed to lead to a decrease in associated grasses and an increase in the spread of cheatgrass (*Bromus tectorum*) (Young, 1989). Thus, sites invaded by cheatgrassare changing the dynamics of this system by increasing fire potential, severity, and spread.

Forest and Woodland Systems
Mixed deciduous/coniferous forest and woodland

Aspen and Mixed Conifer Forest

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=4302



Approximately 201 square kilometers are classified as Aspen and Mixed Conifer Forest in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3/S4
* The system is at risk from aspen decline in general. Shifting climate may reduce range even more.

Environment

In Montana, this system is found on montane slopes, where climate is dry and cold during winter months. Most precipitation occurs during late spring and early summer months. Distribution is primarily limited to areas of deeper soils with adequate soil moisture. Occurrences at high elevations are restricted by cold temperatures, and are generally only found on warmer southern aspects. By contrast, at lower elevations, aspen is restricted by lack of moisture and is found on cooler north aspects and mesic microsites. Soils are typically deep and well-developed, with rock often absent from the soil. Soil texture ranges from sandy loam to clay loam.

Similar Systems

- Aspen Forest and Woodland

Vegetation

The tree canopy is composed of a mix of deciduous and coniferous species, co-dominated by aspen (*Populus tremuloides*) and conifers, including Douglas-fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), lodgepole pine (*Pinus contorta*) and ponderosa pine (*Pinus ponderosa*). Common understory shrubs include serviceberry (*Amelanchier alnifolia*), creeping Oregon grape (*Mahonia repens*), chokecherry (*Prunus virginiana*), Woods' rose (*Rosa woodsii*), birch-leaf spiraea (*Spiraea betulifolia*), and snowberry (*Symphoricarpos* species). Graminoid composition varies depending on available site moisture, but often includes mountain brome (*Bromus carinatus*), pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), blue wild rye (*Elymus glaucus*), and needlegrasses (*Achnatherum* and *Nassella* species). Common forbs include yarrow (*Achillea millefolium*), heart-leafarnica (*Arnica cordifolia)*, aspen daisy (*Erigeron speciosus*), northern bedstraw (*Galium boreale*), silver lupine (Lupinus *argenteus*), starry Solomon's seal (*Maianthemum stellatum*), and meadow rue (*Thalictrum* species). Exotic species such as Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*) and common dandelion (*Taraxacum officinale*) are frequentin areas impacted by grazing.

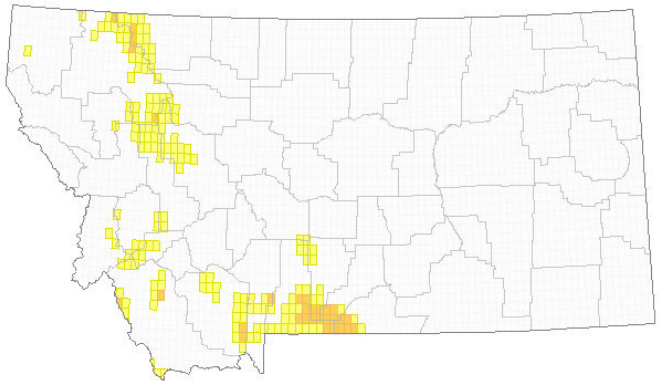
Dynamic Processes

Quaking aspen is seral in this system, and in the absence of fire, the system will succeed to conifer-dominated forest (Mueggler, 1988). The natural fire-return interval is approximately 20 to 50 years for seral occurrences, and 100 years for late-seral occurrences (Hardy and Arno 1996). Young conifer species are susceptible to fire, but older individuals can withstand low-intensity ground fires. In Montana, aspen seed production is erratic and infrequent. Natural seedling establishment is rare due to limited years of viable seed dispersal and the long, moist conditions required for initial germination and first-year establishment.

Alpine Systems
Alpine Grassland and Shrubland

Alpine Dwarf-Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5207



Approximately 280 square kilometers are classified as Alpine Dwarf-Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4
* Climate change is the major threat over the long term.

Environment

This system is found in areas of level or concave glacial topography with late-lying snow and subirrigation from surrounding alpine slopes. Elevation ranges from as low as 1,981 meters (6,500 feet) in northwestern Montana to 3,200 meters (10,500 feet) in southwestern Montana. Sites are characterized as snow bed communities, which form in concave, depressional areas that retain snow until mid to late summer. It can occur on all aspects but is most common on north and east facing aspects. Soil temperatures remain colder than in the surrounding alpine meadow throughout the growing season. Soils have become relatively stabilized in these sites, and are moist but well-drained, strongly acidic, and often with substantial peat layers. Vegetation in these areas is controlled by snow retention, wind desiccation, and a short growing season, usually only 60 to 90 days.

Similar Systems

- Alpine Fell-Field
- Alpine-Montane Wet Meadow

Vegetation

This system is composed of dwarf shrublands of ericaceous dwarf-shrubs or dwarf, alpine willows forming a low shrubland ground cover less than 0.5 meters (1.6 feet) in height. The ericaceous shrub community is dominated by western moss heather, white arctic mountainheather, yellow mountain heath, pink mountain, and alpine bog laurel. Grouse whortleberry, bilberry, or mountain huckleberry are often found within the heath shrublands, especially in northwestern Montana. Common graminoids and forbs include showy sedge (*Carex spectabilis*), shortstalk sedge (*Carex podocarpa*), Rocky Mountain sedge (*Carex scopulorum*), Hitchcock's woodrush (*Luzula glabrata* var. *hitchcockii*) and Piper's woodrush (*Luzula piperi*). Forbs such as alpine pussytoes (*Antennaria* species), arnica (*Arnica* species), Indian paintbrush (*Castilleja* species), glacier lily (*Erythronium grandiflorum)*, alpine Saint John's wort (*Hypericum formosum*), viviparous bistort (*Polygonum viviparum*) and Rocky Mountain groundsel (*Packera cymbalarioides*) are found within the heath-dominated shrubland.

Willow dominated communities form localized thickets on more level areas or around the perimeter of depressional areas. These depressional areas can have greater peat development. Dwarf, mat-forming species such as arctic willow (*Salix arctica*) and snow willow (*Salix reticulata*) are common associates. Other willow bed communities composed of shrubs that are less than .5 metrs (1.6 feet) tall include undergreen willow (*Salix commutata*), grayleaf willow (*Salix glauca*), plane leaf willow (*Salix planifolia*), and, in areas underlain by calcareous parent material, shortfruit willow (*Salix brachycarpa*) (Bamberg and Major, 1968). Sedges and rushes dominate in the depressional or level areas and are usually the last to emerge after snowmelt. These areas are species poor and are dominated by black sedge (*Carex nigricans*), Drummond's rush (*Juncus drummondii*) and tufted hairgrass (*Deschampsia cespitosa*) or purple mountain hairgrass (*Vahlodea atropurpurea*). Sibbaldia (*Sibbaldia procumbens*), Ross' avens (*Geum rossii*), and marsh marigold (*Caltha leptosepala*) often occur in openings in the peat (Cooper et al., 1997). Alpine dwarf shrublands occur as distinct patch types within Rocky Mountain Alpine Fell-Fields or adjacent to Rocky Mountain Alpine-Montane Wet Meadows or at the upper elevational limit of Rocky Mountain Subalpine Woodlands and Parklands.

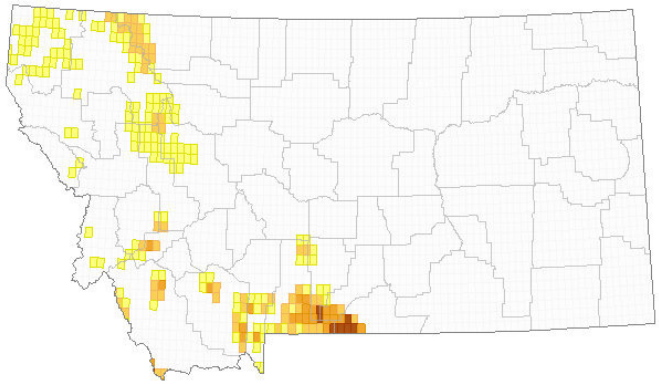
Dynamic Processes

The fire disturbance interval is typically very long (500 years or greater) within this system. Historically, stand-replacing fires occur infrequently in adjacent associated subalpine woodlands (Arno, 1979). Lightning strikes can cause fire within these systems, although severity and spread is usually variable. Other disturbances include high elevation mining, heavy recreational use, and grazing.

Alpine Systems
Alpine Grassland and Shrubland

Alpine Turf

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=7117



Approximately 1,191 square kilometers are classified as Alpine Turf in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank:
* This system may experience a decline as disappearance of perennial snow restricts moisture.

Environment

In Montana, alpine turf communities are well represented throughout the Northern Rocky Mountains and island mountain ranges. Elevation ranges from as low as 6,600 ft in northwestern Montana to 10,500 feet in southwestern Montana. Turf communities form on gentle to moderate upper slopes, flat ridges, valleys, basins, and gentle summit ridges where soil has become relatively stabilized and the water supply persists until fall. At these elevations, the growing season typically ranges from 60 to 90 days. During the growing season, these areas are subjected to windy conditions and widely variable diurnal temperatures. Freezing temperatures and snow can occur throughout the summer months. During winter months, turf communities are subjected to very cold temperatures, high winds, and heavy accumulations of snow. Snow pack accumulation is dependent on topography. Snow pack is higher in alpine basins whereas ridges and summits can be blown free of snow due to high winds and sublimation. In Montana, soils are derived a variety of parent materials, and can be acidic or calcareous. The A horizon is typically less than 10 cm deep. Soils are typically rocky or gravelly with good aeration and drainage.

Similar Systems

- Alpine Fell-Field

Vegetation

Turf communities are composed of a diversity of rhizomatous sedges, rushes, woodrushes, grasses and forbs that form a dense turf that is rarely greater than 12 cm (5 inches) tall. Depending on slope protection, soil development, snow depth, turf communities can range from dry to mesic. In northwestern Montana, dry turf communities are dominated by graminoids. Common species include alpine bluegrass (*Poa alpina*), alpine timothy (*Phleum alpinum*), alpine fescue (*Festuca brachyphylla*), dunhead sedge (*Carex phaeocephala*), spiked woodrush (*Luzula spicata*), Piper's woodrush (*Luzula piperi*), and Hayden's sedge (*Carex haydeniana*).

Alpine forb cover is usually less than 40% in the drier expression of alpine turf communities. Common species include forbs include diverse leaf cinquefoil (*Potentilla diversifolia)*, alpine goldenrod (*Solidago multiradiata*), moss campion (*Silene acaulis*), Parrot's beak lousewort (*Pedicularis contorta*), arnica (*Arnica* species), Eschscholtz's buttercup (*Ranunculus eschscholtzii*). Woody, mat forming arctic willow (*Salix arctica*) often forms high cover in dry turf communities. In more well developed turf communities, forb diversity increase and can reach greater than 40% percent cover. Additional species include arnica (*Arnica* species), alpine pussytoes (*Antennaria* species), subalpine wandering daisy (*Erigeron peregrinus)*, one-stem fleabane (*Erigeron simplex*), sibbaldia (*Sibbaldia procumbens)*, glacier lily (*Erythronium grandiflorum)*, rhexi-leaf paintbrush (*Castilleja rhexifolia)*, western anemone (*Anemone occidentalis)*, alpine Saint John's wort (*Hypericum formosum)*, elegant death camas (*Zigadenus elegans*), alpine bistort (*Polygonum bistortoides*), and viviparous bistort (*Polygonum viviparum*). Higher levels of organic matter contribute to greater graminoid diversity including purple mountain hairgrass (*Deschampsia atropurpurea*) and beautiful sedge (*Carex spectabilis*).

In northwestern Montana, the more mesic expressions of turf communities form on gentle slopes and basins where subirrigation from permanent snow fields and higher levels of organic matter accumulation occur in the soils. Although infrequent, they support additional species including single spike sedge (*Carex scirpoidea*), curly sedge (*Carex ruprestris*), hair sedge (*Carex capillaris*) and Payson's sedge (*Carex paysonis*).

In southwestern Montana, the graminoid component of turf includes dunhead sedge, Hayden's sedge, showy sedge, single spike sedge, spiked woodrush, black and white sedge(*Carex albo-nigra*), two-tipped sedge (*Carex lachenalii*), spike sedge (*Carex nardina)*, and Drummond's rush (*Juncus drummondii*). Grasses such as alpine blue grass, alpine timothy, alpine fescue, and spike trisetum (*Trisetum spicatum*) constitute the rest of the graminoid layer. Other common species include blackroot sedge, curly sedge, Parry's rush (*Juncus parryi*), Idaho fescue (*Festuca idahoenisis*), spike fescue (*Festuca kingii*), and purple reedgrass (*Calamagrostis purpurascens*) (Cooper et al., 1999).

Southwestern Montana alpine turf communities include additional forb species more common in the middle Rocky Mountain region. Species include alpine forget-me-not (*Eritrichium nanum*), Ross avens (*Geum rossii*)*,* common alp lily (*Lloydia serotina*), and sheep cinquefoil (*Potentilla ovina*). Fern allies such as lesser spike moss (*Selaginella densa*) can be common. Moss and lichen cover is typically very low within well developed turf, but is higher in areas with the stoniest soils adjacent to fell fields and scree slopes with late persisting snowfields. Mat forming, woody species such as arctic willow, arctic dryad, snow willow (*Salix nivalis*), and within the island mountain ranges, bearberry (*Arctostaphylos uva-ursi*) are usually present within the turf.

Throughout its range in Montana, this system intergrades with scree and talus and alpine fell field communities in areas with decreasing levels of soil development. Turf development can still be evident but is discontinuous due to high rock content and very shallow soil development. In these areas, the turf community intergrades with fellfield species and early colonizers such as arctic dryad (*Dryas octopetala*), yellow sweetvetch (*Hedysarum sulphurescens*), shrubby cinquefoil (*Dasiphora fruticosa*), silver lupine (*Lupinus argenteus*), crazyweed (*Oxytropis* species) and milkvetch (*Astragalus* species). These nitrogen-fixing species accumulate litter within the mats, thus facilitating additional species colonization from the adjacent turf community. Species within the stoniest soils typically include yarrow (*Achillea millefolium*), penstemon (*Penstemon* species), phacelia (*Phacelia* species), alpine fireweed (*Chamerion latifolium)*, explorer's gentian (*Gentiana calycosa*), twinflower sandwort (*Minuartia obtusiloba*), moss campion,alpine goldenrod and aster (Symphyotrichum species). Many of the cushion species are very long lived, well adapted to limited available water during growth and possess a deep, fleshy taproot. These species will persist for decades within the turf as it develops. Early successional graminoids in these areas include Dunhead sedge, Hayden's sedge, Drummond's rush, alpine bluegrass, slender wheatgrass, Sandberg's bluegrass, and spike trisetum. These same species frequently colonize disturbed areas within the turf community such as grizzly bear diggings and ground squirrel burrows.

Imbedded within this system is a mosaic of alpine plant communities that vary in composition depending on soil development, snow retention, subterranean hydrology and localized topography. Snow bed communities dominated by ericaceous dwarf shrubs and willows often occur in as well as alpine wet meadows dominated by tufted hairgrass (*Deschampisa cespitosa*).

Alpine turf communities are often bordered by subalpine forest krummolz mats and the upper elevational limit of subalpine forests. The most common forest association in Montana is whitebark pine-subalpine fir (*Pinus albicaulis*-

Abies lasiocarpa).In scattered locations on north and east facing aspects, turf communities are bordered by alpine larch(*Larix lyallii*)forests.

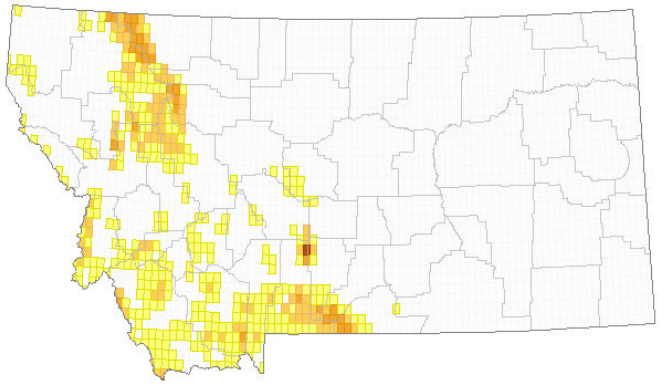
Dynamic Processes

Historically, stand-replacing fires occurred infrequently in adjacent associated subalpine woodlands (Arno 1980). Lightning strikes can cause fire within these systems, although severity and spread is usually limited and variable. Major disturbances in this system include high elevation mining, heavy recreational use, and grazing. Changing climatic patterns will impact this system and the distribution of peripheral species, northern Rocky Mountain endemics and rare species that occur within it.

Alpine Systems
Alpine Sparse and Barren

Alpine Bedrock and Scree

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=3135



Approximately 1,429 square kilometers are classified as Alpine Bedrock and Scree in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S5

Environment

These steep, wind-scoured, loose talus and scree fields and exposed bedrock are often blown free of snow during winter, exposing plants to severe environmental stress. Soil development is very limited, and soils are usually gravelly and rocky. Soils are derived from a variety of parent materials, and can be acidic or calcareous. Organic matter is typically only found in very limited quantities in pockets among boulders, or in fractures or the leeside of the bedrock slabs. This system is characterized by a very cold climate and high winds during winter, and by high winds, high UV radiation and high surface daytime temperatures during summer months, especially on south and west facing aspects. Unstable scree and talus, isolated boulder pockets and exposed bedrock constitute at least half of the cover.

Similar Systems

- Alpine Fell-Field
- Alpine Ice Field

Vegetation

Plant cover is usually less than 10% with exposed, unstable scree, talus and bedrock constituting the remainder of cover. Most scree and bedrock inhabiting plants are highly adapted to this xeric environment and occur as singular plants among the exposed rocks or in bedrock fractures. These species are typically cushioned, matted or succulent, or grow as flat rosettes, often with thick leaf cuticles or a dense cover of hairs. Diverse crustose and foliose lichen cover is high (often greater than 50%) on exposed talus and bedrock. Common lichen genera include *Rhizocarpon*, *Xanthoria*, *Lecidea*, and *Umbilicaria* species. Mosses are typically found in bedrock fractures and the leeside of bedrock slabs and chutes below the summits, especially on the north and east facing aspects.

Forbs occur singly or in small patches among the exposed talus and scree and in fractures of the bedrock or the leeside of bedrock where organic matter has accumulated. In northwestern Montana, common forbs include yarrow (*Achillea millefolium*), elliptic leaf penstemon (*Penstemon ellipticus*), phacelia (*Phacelia* species), alpine sky pilot (*Polemonium viscosum*), alpine spring beauty (*Claytonia megarhiza*), alpine sandwort (*Minuartia species*), cut-leaf daisy (*Erigeron compositus*), draba (*Draba* spp.), boreal crazyweed (*Oxtropis borealis*), silky crazyweed (*Oxytropis sericea*), wooly groundsel (*Senecio canus*), alpine arnica (*Arnica alpina*), moss campion (*Silene acaulis*), spotted saxifrage (*Saxifraga bronchialis*), alpine buckwheat (*Eriogonum ovalifolium*), alpine forget-me-not (*Myosotis alpestris*) and Siberian aster (*Symphyotrichum sibiricus*). Woody species such as arctic dryad (*Dryas octopetala*), shrubby cinquefoil (*Dasiphora fruticosa*) and rock willow (*Salix vestita*) occur in bedrock fractures or the lee side of bedrock and boulders. Saxifrages and ferns also occur in these protected microsites.

Several northern Rocky Mountain endemic species, Montana species of concern, and potential species of concern inhabit this system. In Montana, some arctic species reach their southernmost range limit within this system, while some middle and southern Rocky Mountain species reach their northernmost range limit, particularly in southwestern ranges of the state.

Graminoid cover is usually very low and often occurs within patches and mats of forbs or woody species. In northwest Montana, common species include Dunhead sedge (*Carex phaeocephala*), spike sedge (*Carex nardina)*, curly sedge (*Carex ruprestris*), single spike sedge (*Carex scirpoidea)*, black and white sedge (Carex albonigra), spiked woodrush (*Luzula spicata*), Drummond's rush (*Juncus drummondii*), alpine blue grass (*Poa alpina*), spike trisetum (*Trisetum spicatum*) and slender wheatgrass (*Elymus trachycaulus*). In southwestern Montana, other species are common, such as blackroot sedge (*Carex elynoides*), Parry's rush (*Juncus parryi*), Idaho fescue (*Festuca idahoenisis*), spike fescue (*Festuca kingii*), and sheep fescue (*Festuca ovina*) (Cooper et al. 1999).

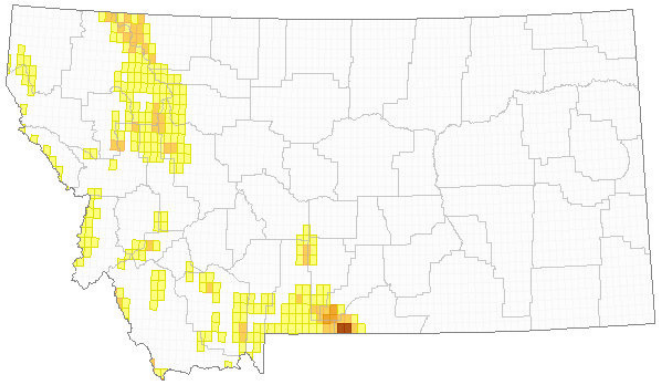
Dynamic Processes

Historically, stand-replacing fires occurred infrequently in adjacent associated upper elevation subalpine woodlands (Arno, 1980). Lightning strikes can cause fire within these systems, although severity and spread is usually very limited. Changing climatic patterns will impact this system and the range of the peripheral species, northern Rocky Mountain endemics and rare species occurring within it.

Alpine Systems
Alpine Sparse and Barren

Alpine Fell-Field

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=7116



Approximately 479 square kilometers are classified as Alpine Fell-Field in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S5

* This system is likely to increase as perennial ice and snow disappears. Dessication and loss of alpine turf may also increase this system's occupancy.

Environment

Elevation ranges from as low as 1,981 meters (6,500 feet) in northwestern Montana to 3,200 meters (10,500 feet) in southwestern Montana. These wind-scoured fell-fields are often free of snow in the winter, occurring on ridgetops and exposed saddles and subjecting the vegetation to severe environmental stress. Soils on these windy, unproductive sites are shallow, stony, low in organic matter, and poorly developed; wind deflation often results in a gravelly pavement. This system is characterized by a very cold climate during winter, high winds, high ultraviolet radiation and high surface temperatures during summer days, and a very short growing season. Exposed, stable scree and isolated boulders constitute at least half of the cover. Soil development is very limited, and derived from a variety of parent materials. It is usually gravelly or rocky, and can be acidic or calcareous. Organic matter is only found in limited quantities within vegetation ribbons and patches of dwarf, woody species.

Similar Systems

- Alpine Bedrock and Scree
- Alpine Dwarf-Shrubland

Vegetation

Ribbons of nitrogen-fixing arctic dryad (*Dryas octopetala*), shrubby cinquefoil (*Dasiphora fruticosa*) and alpine leguminous species occur on slopes subject to downward movement due to frost heaving. Common alpine legumes include silver lupine (*Lupinus argenteus*), yellow sweetvetch (*Hedysarum sulphurescens*), alpine milkvetch (*Astragaulus alpinus*), Bourgov's milkvetch (*Astragaulus bourgovii*), boreal crazyweed (*Oxtropis borealis*), silky crazyweed (*Oxytropis sericea*), and in southwestern Montana, alpine clover (*Trifolium* species). These ribbons or stair-step vegetation patterns form perpendicular to the slope. Plants accumulate litter within the mats and improve soil fertility, thus facilitating additional species colonization within the mats. Plant cover can be low to moderate (15 to 50%) but plants are is rarely more than 9 centimeters (3.6 inches) high.

Other forbs can occur with the mats, singly or in small patches among the exposed rocks. In northwestern Montana, common forbs include yarrow (*Achillea millefolium*), penstemon (*Penstemon* species), phacelia (*Phacelia* species), alpine fireweed (*Chamerion latifolium)*, moss campion (*Silene acaulis*),twinflower sandwort (*Minuartia obtusiloba*), alpine goldenrod (*Solidago multiradiata*), sky pilot (*Polemonium viscosum*), cut-leaf daisy (*Erigeron compositus*), draba (*Draba* species), arnica (*Arnica alpina*), alpine pussytoes (*Antennaria* species), one-stem fleabane (*Erigeron simplex*), sibbaldia (*Sibbaldia procumbens*), diverse leaf cinquefoil (*Potentilla diversifolia*), moss campion (*Silene acaulis*), lousewort (*Pedicularis* species), elegant death camas (*Zigadenus elegans*), alpine bistort (*Polygonum bistortoides*), rock jasmine buckwheat (*Eriogonum androsaceum*), alpine buckwheat (*Eriogonum ovalifolium*), viviparous bistort (*Polygonum viviparum*), alpine forget-me-not (*Myosotis alpestris*) and Siberian aster (*Symphyotrichum sibiricus*). Many of the cushion species are very long lived, and are often well-adapted to limited available water because of deep, fleshy taproots. These species can persist for decades. Other low, mat forming woody species such as arctic willow (*Salix arctica*), snow willow (*Salix nivalis*), rock willow (*Salix vestita*), and in the island mountain ranges, bearberry (*Arctostaphylos uva-ursi*), are usually present among the exposed rocks. Several northern Rocky Mountain endemic species, species of concern, and potential species of concern inhabit alpine fell-field communities

Cover of sedges, rushes, woodrushes and grasses is usually lower than forb cover, but often includes species such as Dunhead sedge (*Carex phaeocephala*), spike sedge (*Carex nardina*), curly sedge (*Carex ruprestris*), northern single spike sedge (*Carex scirpoidea*), black and white sedge (*Carex albonigra*), spiked woodrush (*Luzula spicata*), Piper's woodrush (*Luzula piperi*), Drummond's rush (*Juncus drummondii*), alpine blue grass (*Poa alpina*), spike trisetum (*Trisetum spicatum*) and slender wheatgrass (*Elymus trachycaulus*). In southwestern Montana fell-field communities, other species such as blackroot sedge (*Carex elynoides*), Parry's rush (*Juncus parryi*), Idaho fescue (*Festuca idahoenisis*), spike fescue (*Festuca kingii*) and sheep fescue (*Festuca ovina*) become common (Cooper et al., 1999). Diverse crustose and foliose lichen cover is often high on exposed rocks. Fern allies such as lesser spikemoss (*Selaginella densa*) can be locally abunant in some areas.

Adjacent to this system is a mosaic of alpine plant communities that vary in composition depending on soil development, snow retention, subterranean hydrology and localized topography. Alpine turf and snow bed communities occur on more level or concave sites with greater soil development adjacent to fell-fields. Alpine bedrock, talus and unstable scree fields and ice fields often occur adjacent to this system around mountain summits. Fell-fields are often bordered by subalpine forest krummolz mats and small patches of subalpine forests growing at their upper elevational limit on protected sites. The most common forest association in Montana is whitebark pine-subalpine fir (*Pinus albicaulis-Abies lasiocarpa*). In scattered locations on north and east facing aspects, fell-fields can be bordered by small patches of alpine larch (*Larix lyallii*).

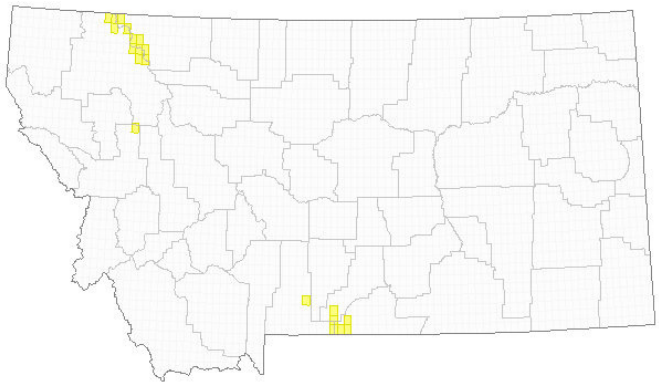
Dynamic Processes

Historically, stand-replacing fires occurred infrequently in adjacent associated upper elevation subalpine woodlands (Arno 1980). Lightning strikes can cause fire within fell-fields, although severity and spread is usually variable. Major disturbances can include fire, high elevation mining, heavy recreational use, and grazing. Changing climatic patterns will impact this system and the distribution of peripheral species, northern Rocky Mountain endemics and rare species that occur within it.

Alpine Systems
Alpine Sparse and Barren

Alpine Ice Field

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=3130



Approximately 5 square kilometers are classified as Alpine Ice Field in the 2013 Montana Land Cover layers.
Grid on map is based on USGS 7.5 minute quadrangle map boundaries.

Provisional State Rank: S2

* In Montana, climate change, especially during the past 50 years, has resulted in rapid shrinking or elimination of more than half the glaciers in Glacier National Park. At current rates of change, the remaining glaciers are expected to be gone by 2030 or sooner.

Environment

In Montana, this system is well-represented on the higher mountain summits and associated glacial fields and basins below the summits in Glacier National Park. Permanent snowfields are usually found in protected basins and on north and east facing aspects in the Beartooth-Absarokas. Organic matter is usually only found in limited quantities in pockets among boulders, in fractures of exposed bedrock or on the windward leeside of bedrock slabs. This system is characterized by a very cold climate, heavy snow accumulation during winter, high winds, and a growing season of 60 days or less.

Similar Systems

- Alpine Bedrock and Scree
- Alpine Fell-Field

Vegetation

Generally, there is little to no vascular plant cover within this system and usually less than 10% cover. Plants colonize in pockets in the fractures of the bedrock or in protected pockets within steep chutes below the summits. Lichen cover is variable, but can be high in some areas. Bedrock that has recently been exposed due to recent glacial retreat is barren.

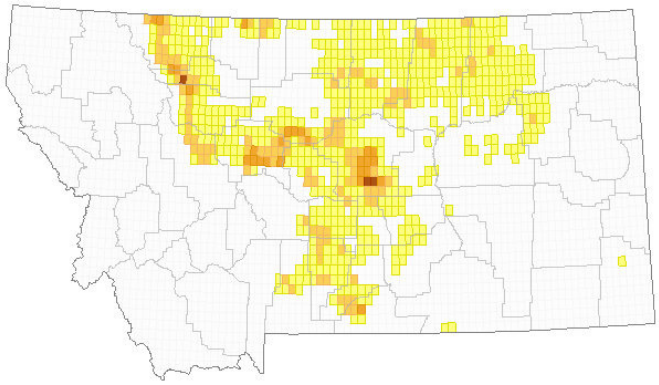
Dynamic Processes

Alpine ice fields form when rates of snow accumulation exceed rates of melting. When climate cools and/or snowfall increases dramatically, as it did during the Little Ice Age of 1500-1850, icefields expand and advance. Conversely, when snowmelt exceeds snow accumulation because of warmer and/or drier conditions, ice fields retreat from their terminus and become thinner.

Shrubland, Steppe and Savanna Systems
Deciduous Shrubland

Great Plains Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5262



Approximately 1,597 square kilometers are classified as Great Plains Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* Overgrazing and oil/gas development are the largest threats to this ecosystem; invasives are secondary and largely accompany the first two.

Environment

In Montana, this ecosystem forms within the northwestern Great Plains fescue (*Festuca* spp.) dominated prairie east of the Continental Divide into the western wheatgrass (*Pascopyrum smithii*) mixed grass prairie in the north-central Great Plains. Climate is semi-arid, and the growing season is short. It can occur on all aspects but is more common on mesic sites with moderately shallow or deep, fine to sandy loam soils. Often it is located on slopes near breaklands and on the edge of coulees, or on upper terraces of rivers and streams. Soils can be moderately shallow to deep, fine to sandy loam soils.

Similar Systems

- Great Plains Mixedgrass Prairie

Vegetation

This system differs from Great Plains Mixed Grass Prairie in that natural shrub cover is greater than 10%, and in some cases may be greater than 50%. It is typically dominated by shrub and dwarf-shrub species such as serviceberry, skunkbush sumac, snowberry, shrubby cinquefoil, silverberry, and horizontal juniper. Silver sage shrublands may occur on flat alluvial deposits on floodplains, terraces or benches, and alluvial fans. Silver buffaloberry or western snowberry shrublands can also be found along stream terraces, rolling uplands, and badlands, or where moisture is more plentiful than on the surrounding landscape, such as in swales, ravines, near streams, and on northwest- to east-facing slopes. Common graminoids include threadleaf sedge (*Carex filifolia*), Idaho fescue (*Festuca idahoensis*), rough fescue (*Festuca campestris*), western wheatgrass, Kentucky bluegrass (*Poa pratensis*), prairie junegrass (*Koeleria macrantha*), blue grama (*Bouteloua gracilis*) and bluebunch wheatgrass (*Pseudoroegneria spicata*). Kentucky bluegrass (*Poa pratensis*) and common timothy (*Phleum pratense*) are common introduced grasses in the northwestern part of the system's range. Common forbs include yarrow (*Achillea millefolium*), Indian blanket flower (*Gaillarida aristata*), prairiesmoke (*Geum triflorum*), sweetvetch (*Hedysarum* species), Pennsylvania pellitory (*Parietaria pensylvanica*), lupine (*Lupinus species*), scarlet guara (*Gaura coccinea*), red globe-mallow (*Sphaeralcea coccinea*), cinquefoil (*Potentilla* species),and goldenrod (*Solidago species*).

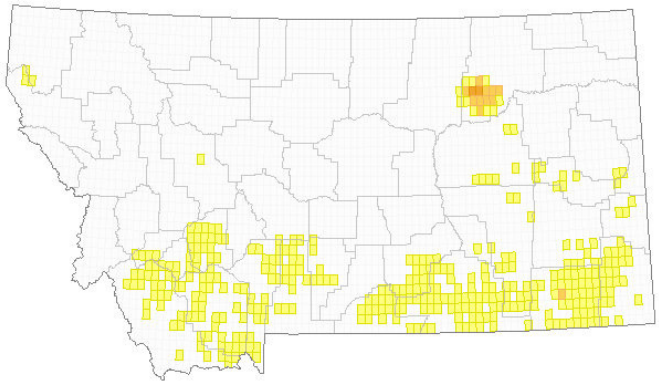
Dynamic Processes

Fire and grazing constitute the primary dynamics affecting this system, although drought has also been an impact in the past decade. All shrub species regenerate well following low to moderate intensity fires by re-sprouting from the root systems. In areas where this system occurs in patches within a mixed grass prairie matrix, heavy grazing impacts can limit productivity of associated graminoids and forbs, leading to the increasing spread of introduced grasses and invasive forbs.

Shrubland, Steppe and Savanna Systems
Deciduous Shrubland

Rocky Mountain Lower Montane-Foothill Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5263



Approximately 151 square kilometers are classified as Rocky Mountain Lower Montane-Foothill Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S5
* This system may increase under drought and climate change scenarios, as intermittent streams become more ephemeral.

Environment

This is a widespread large or small-patch shrubland that is found throughout Montana. It occurs in the foothills and lower slopes of mountain ranges, along higher creeks, and in draws and ravines of high plateaus on the Great Plains. The elevational range is 680 to 2,652 meters (2,234-8,700 feet). Shrub cover ranges from 30 to 100 percent, and is generally higher in drainage bottoms and on lowermost slopes, and lower on upper slopes. The communities in this system grow at the interface between larger riparian areas and the adjacent upland shrublands and forests, usually occurring as small dense thickets, narrow bands, or irregular patches. They often occupies draws, ephemeral creeks in steep narrow-bottomed canyons, and shallow ravines. The system can occur on slopes below seeps and springs, as small pockets on higher terraces, as narrow bands along the high-water mark of steep banks and incised channels, or at the base of cliffs adjacent to rivers. Slope varies from flat to very steep, with variable aspects, and can be associated with rock outcrops and talus. Stands are typically found on very well-drained, rocky soils but occasionally have finer soils. Soil texture ranges from sandy loam to clay loam.

Similar Systems

- Rocky Mountain Montane-Foothill Deciduous Shrubland

Vegetation

Stands can be dominated by one species but are often a mix of three to six shrub species, which can be as abundant or even more abundant than the dominant species. In Montana, for example, chokecherry is frequently the dominant shrub species and on some sites, American plum may be solely present or co-dominant. Other shrubs associated with *Prunus*-dominated shrublands include currant, skunkbush sumac, western snowberry, serviceberry, elderberry, birchleaf spiraea andboreal sagewort. Antelope bitterbrush, creeping Oregon grape, and Woods' rose may be present in some stands, along with scattered Rocky Mountain juniper.

In drainage bottoms, herbaceous cover is usually less than 10 percent. On slopes, shrubs typically occur within grasslands, and graminoid cover can be greater than 75 percent. Graminoid species include mountain brome (*Bromus carinatus*), needle and thread (*Hesperostipa comata*), basin wildrye (*Leymus cinereus*), and bluebunch wheatgrass (*Pseudoroegneria spicata*). Mesic sites support forb species such ascow parsnip (*Heracleum maximum*) and starry Solomon's seal (*Maianthemum stellatum*). Smooth brome (*Bromusinermis*), cheatgrass (*Bromus tectorum*), Kentucky bluegrass (*Poa pratensis*), and Canadian thistle (*Cirsium arvense*) are introduced species.

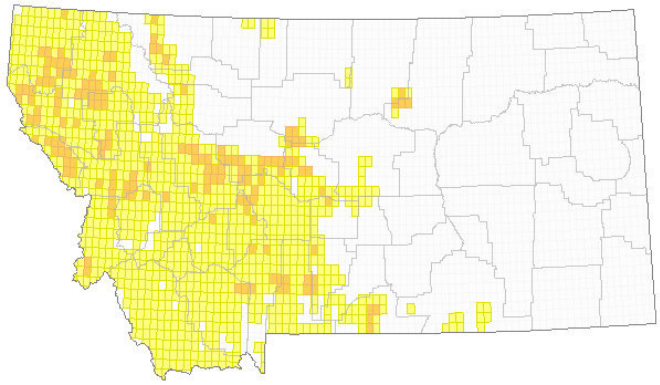
Dynamic Processes

Fire impacts these shrublands at a frequency of every 50 to 100 years, but these systems will persist for longer periods. All shrub species regenerate following low to moderate intensity fires by re-sprouting from the root systems. Fire suppression may have allowed an invasion of trees into some of these shrublands, but in many cases sites are too xeric for tree growth. Under present conditions, the fire regime is mixed severity and more variable, with stand-replacing fires being more common in adjacent forested habitats. Heavy grazing impacts can limit productivity of associated graminoids and forbs, leading to the increasing spread of introduced grasses and invasive forbs.

Shrubland, Steppe and Savanna Systems
Deciduous Shrubland

Rocky Mountain Montane-Foothill Deciduous Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5312



Approximately 1,276 square kilometers are classified as Rocky Mountain Montane-Foothill Deciduous Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S5
* This is a widespread and resilient system, occupying a broad range within the national forests and parks. Species composition may change under drought or warming scenarios, but the system should remain relatively stable.

Environment

These shrublands typically occur below treeline, within the matrix of surrounding low-elevation grasslands and sagebrush shrublands. They are usually found on steep slopes of canyons, toeslopes and occasionally on valley bottom lands. These communities can occur on all aspects.

Similar Systems

- Rocky Mountain Lower Montane-Foothill Shrubland
- Rocky Mountain Subalpine Deciduous Shrubland

Vegetation

In northwestern and west-central Montana, this system forms within Douglas-fir (*Pseudotsuga menziesii)* and ponderosa pine (*Pinus ponderosa)* forests and adjacent to fescue grasslands and big sagebrush (*Artemisia tridentata*) shrublands. In northwestern Montana, these shrublands commonly occur within the upper montane grasslands and forests along the Rocky Mountain Front. Immediately east of the Continental Divide, this system is found within montane grasslands and steep canyon slopes. Most sites have shallow soils that are either loess deposits or volcanic clays. The system often develops at the heads of dry drainages, and on toeslopes in the moist shrub-steppe and steppe zones. Common ninebark (*Physocarpus malvaceus*), bittercherry (*Prunus emarginata*), chokecherry (*Prunus virginiana*), rose (*Rosa* spp.), smooth sumac (*Rhus glabra*), Rocky Mountain maple (*Acer glabrum*), serviceberry (*Amelanchier alnifolia),* oceanspray (*Holodiscus discolor*), birchleaf spiraea (*Spiraea betulifolia*), and common snowberry (*Symphoricarpos albus*) are the most common dominant shrubs. Canadian buffaloberry (*Shepherdia canadensis*), and snowbrush ceanothus (*Ceanothus velutinus*) are important nitrogen fixing shrubs in this system; these are more common in recently burned areas. In mesic areas, Douglas hawthorn (*Crataegus douglasii*), thimbleberry (*Rubus parviflorus*), prickly currant (*Ribes lacustre*), and alder buckthorn (*Rhamnus alnifolia*) are common, especially on north and east facing aspects.

Common graminoids found in this shrubland community include Idaho fescue (*Festuca idahoensis*), rough fescue (*Festuca campestris*), pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), prairie junegrass (*Koeleria macrantha*), and bluebunch wheatgrass (*Pseudoroegneria spicata*). Some of the more common forbs include Indian blanketflower (*Gaillarida aristata*) praire cinquefoil (*Potentilla gracilis*), nineleaf biscuitroot (*Lomatium triternatum*), and arrowleaf balsamroot (*Balsamorhiza sagittata*).

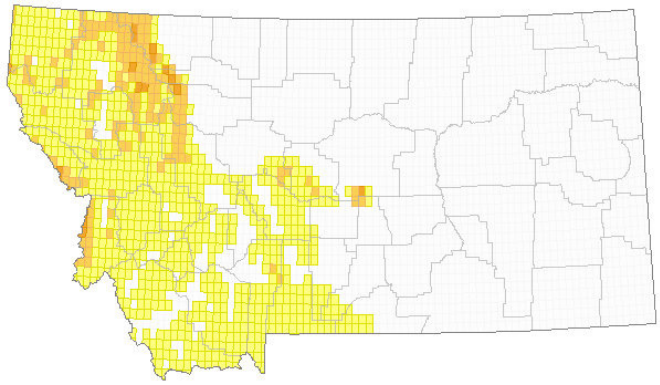
Dynamic Processes

Fire, flooding and erosion all affect these shrublands, but they generally persist on sites for long periods (up to 500 years). All shrub species regenerate well following low to moderate intensity fires by re-sprouting from the root systems. Under present conditions, the fire regime is mixed severity and more variable, with stand-replacing fires being more common in adjacent forested habitats. Heavy grazing impacts can limit productivity of associated graminoids and forbs, allowing the spread of introduced grasses and invasive forbs.

Shrubland, Steppe and Savanna Systems
Deciduous Shrubland

Rocky Mountain Subalpine Deciduous Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5326



Approximately 1,574 square kilometers are classified as Rocky Mountain Subalpine Deciduous Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S5

* This system is protected through most of its range. Climate effects are uncertain over the long term, but transitions from grassland to shrubland are possible, and this system should rmeina stable in size.

Environment

In northwestern and west-central Montana, this ecosystem forms within upper montane Douglas-fir and Engelmann spruce-subalpine fir forests on steep slopes and ravines. Soils are derived from a variety of parent materials, but are usually acidic. Soils are usually shallow, rocky or gravelly with good aeration and drainage. Occurrences are typically found in locations with cold-air drainage or ponding, or where snowpacks linger late into the summer, such as north-facing slopes and high-elevation ravines. They can extend down in elevation to the montane zone in places where cold-air ponding occurs, especially on north and east aspects. In northwestern Montana, these systems are found at elevation from 1,524-1,950 meters (5,000 -6,400 feet) west and immediately east of the Continental Divide and up to 2,682 meters (8,800 feet) in southwestern Montana

Similar Systems

- Rocky Mountain Montane-Foothill Deciduous Shrubland

Vegetation

These shrubland communities develop on steep mountain slopes, at the heads of cirque basin drainages, and on upper elevation toeslopes within the mesic montane and subalpine forest zones. Common shrub species include rusty-leaf menziesia, black twinberry, alder buckthorn, prickly currant, thimbleberry, Sitka alder, cascade mountain ash, sitka mountain ash, and thinleaf huckleberry. Extensive stands of mountain huckleberry are important summer and fall foraging areas for grizzly and black bears.

On some sites in northwestern Montana, rusty leaf menziesiaand Sitka alder can form nearly impenetrable stands. Drier aspects of this community can also support stands of thimbleberry, Canadian buffaloberrry (*Shepherdia canadensis*), birchleaf spiraea (*Spiraea betulifolia*), and deerbrush ceanothus (*Ceanothus velutinus*).

The herbaceous understory can be sparse on sites with dense shrub cover. Common graminoids include bluejoint reedgrass (*Calamagrostis canadensis*), pinegrass (*Calamagrostis rubescens*), sedges (*Carex* species), and blue wildrye (*Elymus glaucus*). Common forbs and ferns include beargrass (*Xerophyllum tenax*), fireweed (*Chamerion angustifolium*), and bracken fern (*Pteridium aquilinum*), reflecting the mesic nature of many of these shrublands. Other forb species include baneberry (*Actaea rubra*), arnica (*Arnica* species), queen's cup beadlily (*Clintonia uniflora*), boreal bedstraw (*Galium triflorum*), twinflower (*Linnaea borealis*), clasp-leaf twisted stalk(*Streptopus amplexifolius*), and western meadow rue (*Thalictrum occidentale*). Post-fire communities are often dominated by fireweed, yarrow (*Achillea millefolium*), nettle-leaf giant hyssop (*Agastache urticifolia*), aster (*Symphyotrichum spp.),* goldenrod (*Solidago spp.*), and pearly everlasting (*Anaphalis margaritacea*).

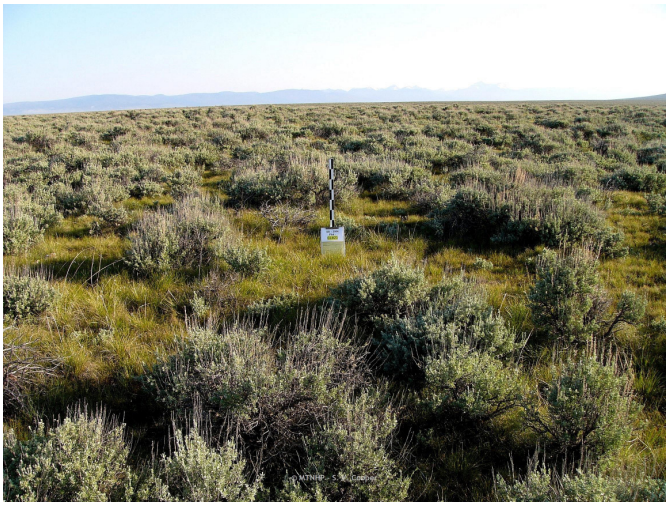
Dynamic Processes

Fire impacts these shrublands, but they typically persist on sites for long periods (up to 500 years). All shrub species regenerate well following low to moderate intensity fires by re-sprouting from the root systems. Under present conditions, the fire regime is of mixed severity and more variable than in the past, with stand-replacing fires being more common in associated forested habitats. Areas that are dry in summer also have occasional high-severity fires. Insects and diseases can play an indirect but major role in the successional direction of these shrublands by killing adjacent associated forests. Throughout Montana, subalpine fir and spruce are affected by spruce bud worm attacks and large stands of these subalpine forests can be killed following several years of drought or unusually mild winters.

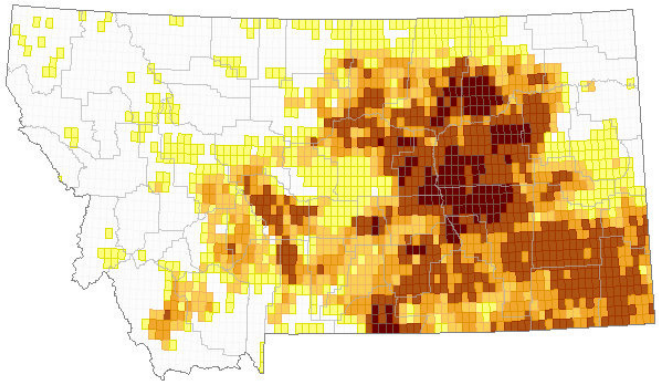
Shrubland, Steppe and Savanna Systems
Sagebrush Steppe

Big Sagebrush Steppe

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5454



Provisional State Rank: S5



Approximately 45,747 square kilometers are classified as Big Sagebrush Steppe in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Environment

This system occurs as extensive matrix types on level to gently rolling plains, plateaus, sideslopes and toeslopes, and as small and large patches in dissected landscapes such as breaks and badlands. Soils are alkaline and are developed from various parent materials that have weathered to predominantly heavy-textured, clay-rich Aridisols, and in more mesic conditions, Mollisols. In central Montana, this system differs slightly, with more summer rain than winter precipitation, more precipitation annually, and it occurs on glaciated and non-glaciated landscapes. Across the Montana distribution, soils are typically deep and non-saline, often with a microphytic crust. In southeastern Montana, these sites are associated with heavy soils. In north-central Montana, soils tend to be shallower often with gravelly or claypan surfaces.

Similar Systems

- Big Sagebrush Shrubland
- Montane Sagebrush Steppe

Vegetation

In Montana, this system is dominated by Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*). Other shrubs present may include basin big sagebrush (*Artemisia tridentata ssp. tridentata*), silver sagebrush (*Artemisia cana*), greasewood (*Sarcobatus vermiculatus*), saltbush (*Atriplex* species), rubber rabbitbrush (*Ericameria nauseosa*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and antelope bitterbrush (*Purshia tridentata*). Overall shrub cover is less than 10 percent.

Perennial herbaceous components typically contribute greater than 25% vegetative cover and consist mostly of rhizomatous and bunch-form graminoids, with a diversity of perennial forbs. In Montana, the dominant graminoid in this system is western wheatgrass (*Pascopyrum smithii*). Other species include Indian ricegrass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*),Sandberg's bluegrass *(Poa secunda*), or bluebunch wheatgrass (*Pseudoroegneria spicata*). Dryland rhizomatous sedges such as threadleaf sedge (*Carex filifolia)* and needleleaf sedge (*Carex duriuscula*) are very common and important in the eastern distribution of this system in Montana and Wyoming.

Common forbs include Hood's phlox (*Phlox hoodii*), sandwort (*Arenaria* species), prickly pear (*Opuntia* species), scarlet globemallow (*Sphaeralcea coccinea*), purple prairie clover (*Dalea purpurea*), gayfeather (*Liatris punctata*), and milkvetch (*Astragalus* species). Within this system, cheatgrass (*Bromus tectorum*), Japanese brome (*Bromus japonicus*) and other invasive weeds can be abundant where there is frequent disturbance.

Dynamic Processes

The natural fire regime of this ecological system maintains a patchy distribution of shrubs, so the general aspect of the vegetation is steppe grassland. Shrubs may increase following heavy grazing and/or with fire suppression. Response to grazing can be variable, depending on the type of grazer and the season in which grazing occurs. Needle and thread (*Hesperostipa comata*) can increase in abundance in response to either grazing or fire. Microphytic crust is very important in this ecological system and is easily damaged under all grazing regimes.In central and eastern, complexes of prairie dog towns are common in this ecological system, and can be a significant disturbance.

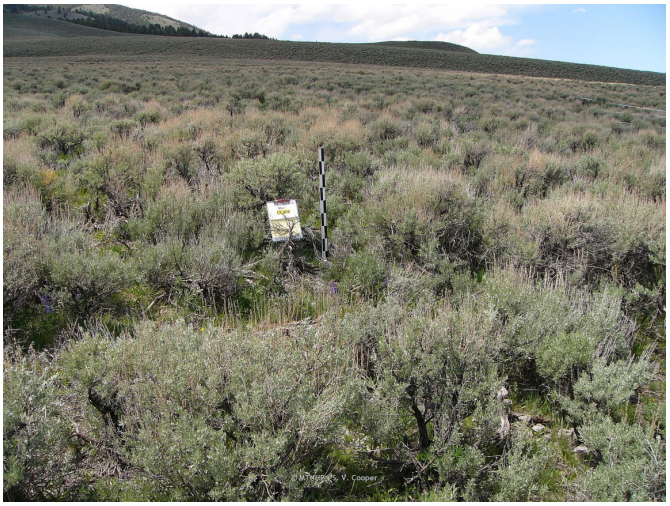
Big sagebrush is easily killed by fire at all intensities, and when exposed to fire, plants do not resprout (Wright et al. 1979). In southwestern Montana, Wambolt and others (2001) found that fire in big sagebrush is stand replacing, killing or removing most of the aboveground vegetation, and that recovery to pre-burn cover (of sagebrush) takes at least 20 years. In Montana, Wyoming big sagebrush may require a century or longer to recover from fire (Lesica et al. 2005).

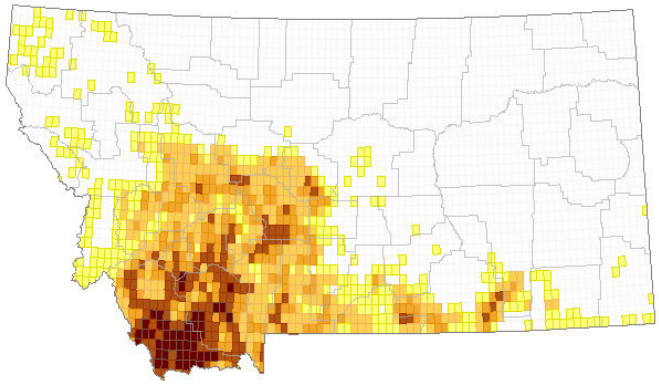
Heavy grazing practices can also lead to a decrease in associated grasses and an increase in the spread of annual bromes. Sites infested with annual bromes are changing the dynamics of this system by increasing fire potential, severity and spread.

Shrubland, Steppe and Savanna Systems
Sagebrush Steppe

Montane Sagebrush Steppe

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5455





Approximately 16,425 square kilometers are classified as Montane Sagebrush Steppe in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S5

Environment

This ecological system occurs at montane to subalpine zones. In southwestern Montana, this system is found from 1,844 meters to 3,200 meters (6,050-10,500 feet) (Lesica et al, 2005). Much of the precipitation occurs as snow at a range of 40.3 cm (15 in.) in valley locations to upwards of 74.3 cm (35 in) along the mountain crests. Temperatures are continental with large annual and diurnal variations. In general, this system shows an affinity for mild topography, fine soils, and some source of subsurface moisture. Soils are generally moderately deep to deep, well-drained, and loam, sandy loam, clay loam, or gravelly loam textural classes. Soils often have a substantial volume of coarse fragments, and are derived from a variety of parent materials. This system primarily occurs on deep-soiled to stony flats, ridges, nearly flat ridgetops, and mountain slopes, but at high elevation, may be restricted to south- or west-facing slopes. In Wyoming and Montana, three tip sagebrush (*Artemisia tripartita* ssp. *tripartita*) associations are part of this system, occurring at higher elevations than the similar Inter-Mountain Basins Big Sagebrush Steppe ecological system.

Similar Systems

- Big Sagebrush Shrubland
- Big Sagebrush Steppe

Vegetation

In Montana, most of this system is dominated by mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*). Mountain big sagebrush occurs in all regions, although tends to be found only on on the highest mesas. Silver sagebrush (*Artemisia cana ssp. viscidula*) and subalpine big sagebrush (*Artemisia tridentata ssp. spiciformis*) can be co-dominant on some sites. Three tip sagebrush is found only in southwestern and west-central Montana where it functions primarily as a seral component, increasing in frequency following fire. Antelope bitterbrush (*Purshia tridentata*) may codominate, but as a codominant is of very limited occurrence, being found primarily on intrusive volcanics in western and west-central Montana. Both subspecies of little sagebrush (*Artemisia arbuscula* ssp*. arbuscula*, and *A. arbuscula ssp. longiloba*) dominated shrublands occur sporadically within this system in southwestern Montana, which is the most northerly extent of their distribution. Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*) dominated sites may be included in this system if they occur in the montane zone, which is most reliably indicated by the presence of Idaho fescue (*F. idahoensis*). These relatively uncommon sites occur above 1,280 m (4,200 feet) on the mesas of eastern Montana and the dry valleys of southwestern Montana.

Other shrubs may be present, but usually at low cover values (5-10%). Species inlcude rubber rabbitbrush (*Ericameria nauseosa*), and green rabbitbrush (*Chrysothamnus viscidiflorus*), wax currant (*Ribes cereum*), Woods rose *(Rosa woodsii*), deerbrush ceanothus (*Ceanothus velutinus*), snowberry (*Symphoricarpos* species) and serviceberry (*Amelanchier alnifolia*). In ares where sage has been eliminated by human activities like burning, disking or poisoning, these other shrubs may dominate the steppe system. This can be seen around Garrison and Deer Lodge, where the sage steppe ecological system contains only minimal amounts of sage.

The herbaceous layer is usually well represented. Graminoids that can be abundant include rough fescue (*Festuca campestris*), Idaho fescue (*Festuca idahoensis*), bottlebrush squirreltail (*Elymus elymoides*), pinegrass (*Calamagrostis rubescens*), needlegrass (*Achnatherum* species), spike fescue (*Leucopoa kingii*), poverty otagrass *(Danthonia intermedia*), western wheatgrass (*Pascopyrum smithii*), mountain brome (*Bromus carinatus*), slender wheatgrass (*Elymus trachycaulus*), prairie junegrass(*Koeleria macrantha*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Sandberg's bluegrass (*Poa secunda*), and are variety of dry, upland sedges such as threadleaf sedge (*Carex filifolia*) and Geyer's sedge (*Carex geyeri*) (Mueggler and Stewart, 1988).

Forb diversity is frequently is moderate to high, commonly exceeding 30 species in a 400 m^2 macroplot. Species may include arrowleaf balsamroot (*Balsamorhiza sagittata*), Indian paintbrush (*Castilleja* species), cinquefoil (*Potentilla*species), fleabane (*Erigeron species*), phlox (*Phlox* species), milkvetch (*Astragalus* species), prairie smoke (*Geum triflorum*), lupine (*Lupinus* species), buckwheat (*Eriogonum* species), yarrow (*Achillea millefolium*), rosy pussytoes (*Antennaria rosea*), wild strawberry (*Fragaria virginiana*), and western sagewort (*Artemisia ludoviciana*). Missouri pricklypear (*Opuntia polycantha*) is common on sites in southwestern Montana (Cooper et al, 1999).

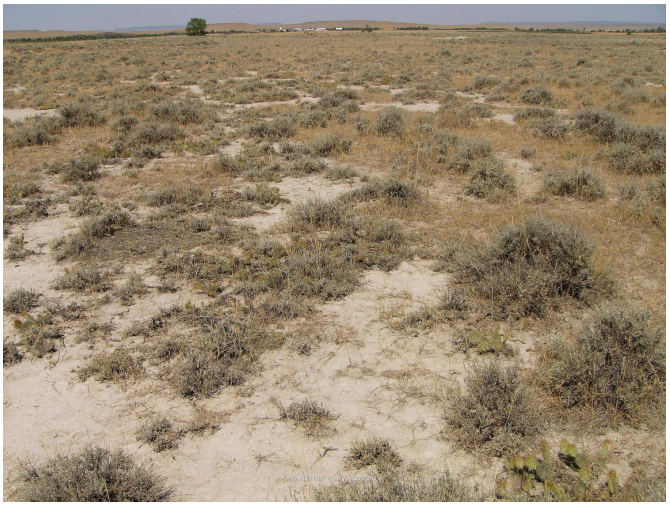
Dynamic Processes

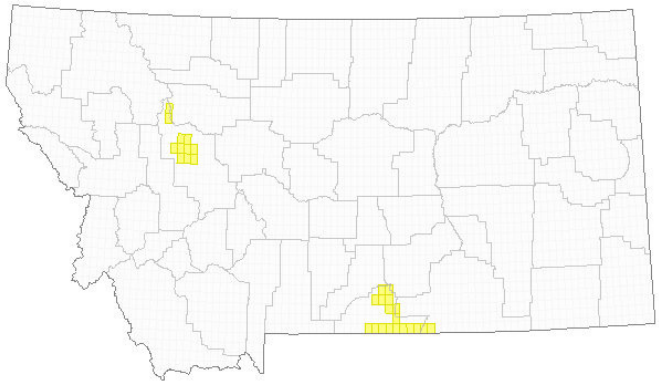
The natural fire regime of this ecological system has been greatly altered, and therefore shrub cover can be highly variable. Big sagebrush is easily killed by fire at all intensities, and when exposed to fire, plants do not re-sprout (Wright et al, 1979). In southwestern Montana, Wambolt and others (2001) and Lesica and others (2005) have also shown that fire in big sagebrush is stand replacing, killing or removing most of the aboveground vegetation, and that recovery to pre-burn cover (of sagebrush) may require 15 or more years for basin big sagebrush, and on average approximately 32 years for mountain big sagebrush (Lesica et al 2005, Cooper et al. 2007).

Shrubland, Steppe and Savanna Systems
Sagebrush-dominated Shrubland

Big Sagebrush Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5257





Approximately 5 square kilometers are classified as Big Sagebrush Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3

* The range of this system includes areas where there may be extensive oil and gas development. Annual bromes are also increasing the risk of catastrophic fire.

Environment

This system occurs as an extensive matrix on level to gently rolling plains, on toeslopes and in valley bottoms, as well as in small and large patches in dissected landscapes such as breaks and badlands. It is found in broad basins between mountain ranges, on plains and on foothills between 670 and 1,066 meters (2,200-3,500 feet). It can occur on all aspects. Soils are shallow, fine to coarse textured, well drained and non-saline, developed from various parent materials that have weathered to predominantly heavy-textured, clay-rich Aridisols, and in more mesic conditions, Mollisols. In southeastern Montana, these sites are associated with heavy soils developed from shales and mudstones. In north-central Montana, soils tend to be shallower, often with gravelly or claypan surfaces.

Similar Systems

- Big Sagebrush Steppe
- Montane Sagebrush Steppe

Vegetation

In Montana, this system occurs as a result of historic and current overgrazing practices and can be considered a disclimax expression of sagebrush steppe. These shrublands are dominated by big sagebrush (*Artemisia tridentata* ssp. *tridentata*) and/or more commonly, Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). In some occurrences there are scattered Rocky Mountain juniper (*Juniperus scopulorum*), greasewood (*Sarcobatus vermiculatus*), and saltbush (*Atriplex* species). Rubber rabbitbrush (*Ericameria nauseosa*) and green rabbitbrush (*Chrysothamnus viscidiflorus*) may codominate in recently burned stands.

By definition, perennial herbs contribute less than 25% of the vegetative cover (NatureServe 2009) and consist mostly of graminoids, which can vary greatly in composition, depending on the surrounding vegetation type. Dominant grasses can be either rhizomatous or bunch grasses. Perennial forb diversity is quite variable depending on site and treatment; with livestock use the number of introduced species can easily exceed eight on a given site. Common graminoid species can include Indian ricegrass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis),* threadleaf sedge (*Carex filifolia*), thickspike wheatgrass (*Elymus lanceolatus*), needle and thread (*Hesperostipa comata*)*,* basin wildrye (*Leymus cinereus*), western wheatgrass (*Pascopyrum smithii*)*,* Sandberg's bluegrass (*Poa secunda*), or bluebunch wheatgrass(*Pseudoroegneria spicata*). Bluebunch wheatgrass- bunchgrass dominated sites are most prevalent in western Montana. Sod-forming species such as thickspike wheatgrass and western wheatgrass are more common in the eastern portion of the state. Common forbs include yarrow (*Achillea millefolium)*, arrowleaf balsamroot (*Balsamorhiza sagittata*), scarlet globe mallow (*Sphaeralcea coccinea*), American vetch (*Vicia americana*), and plains prickly pear (*Opuntia polyacantha*) on especially xeric sites. Within this system, cheatgrass (*Bromus tectorum*) or other annual bromes and invasive weeds can be abundant.

Dynamic Processes

The natural fire regime of sagebrush systems maintains a patchy distribution of shrubs, so in disturbance-free areas, steppe systems would be typical.. However, shrubs increase following heavy grazing and/or with fire suppression. Heavy grazing can lead to a decrease in native bunchgrasses and an increase in exotic grasses such as Kentucky bluegrass (*Poa pratensis*) and other species.

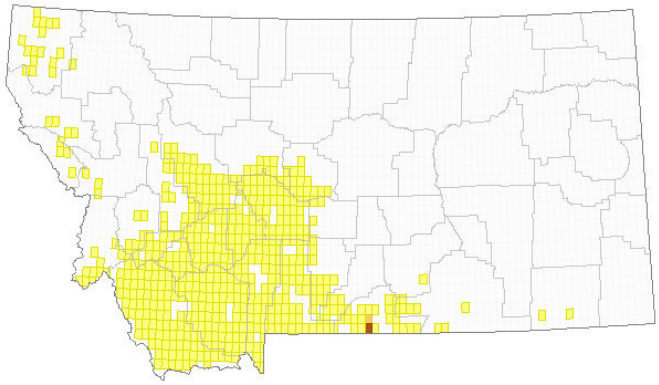
Big sagebrush is easily killed by fire at all intensities, and when exposed to fire, plants do not re-sprout (Wright and others 1979). In southwestern Montana, researchers have found that fire in mountain big sagebrush is stand replacing, killing or removing most of the aboveground vegetation, and that recovery to pre-burn cover (of sagebrush) takes at least 20 years (Wambolt et al. 2001, Lesica et al. 2005). In Montana, Wyoming big sagebrush may require a century or longer to recover from fire (Lesica et al. 2005).

Heavy grazing practices have also led to a decrease in native grasses and an increase in the spread of annual bromes in some areas of Montana. Sites infested with annual bromes are changing the dynamics of this system by increasing fire potential, severity and spread.

Shrubland, Steppe and Savanna Systems
Sagebrush-dominated Shrubland

Low Sagebrush Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5209



Approximately 102 square kilometers are classified as Low Sagebrush Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* The area of occupancy may be overestimated in ReGAP, as it is difficult to distinguish this specific ecological system from other sage types with a low-growth habit. However, it appears to be reasonably widespread.

Environment

This system occurs in southwest and south-central Montana on sites that are gently to moderately sloping, especially on dry, windswept hills and ridges that may be oriented to any aspect. Elevation ranges from to 1,143 meters (3,750 feet) in the Pryor Mountains and 1,219 meters (4,000 feet in) the Canyon Ferry area and up to 2,195 meters (7,200 feet) in southwestern Montana. Soils are shallow, gravelly and are often high in calcium carbonate. Rock and gravel cover much of the unvegetated ground surface, with some bare ground and litter. In Montana, soils are typically shallow to moderately deep, rapidly drained and derived from limestone. This system also occurs on granitic intrusions with overlying calcareous substrates. Soils are usually silts or clays. In southwestern Montana, soils are clays with a restrictive layer that inhibits root growth and creates a perched water table.

Similar Systems

- Big Sagebrush Shrubland

Vegetation

This system is characterized as steppe vegetation, occurring in areas where precipitation is limiting for tree growth. Vegetation is characterized by a low-shrub canopy dominated by black sage. In Montana, the black sage dominated steppe system grades into the Rocky Mountain Limber Pine-Juniper Woodland system in central and southern Montana.

Other shrubs are generally present, although with very low cover, including green rabbitbrush (*Chrysothamnus viscidiflorus*), little sagebrush (*Artemisia arbuscula* ssp. *longiloba*), spiny hopsage (*Grayia spinosa),* snowberry (*Symphoricarpos longiflorus*), and broom snakeweed (*Gutierrezia sarothrae)*. In southwestern Montana, little sagebrush is the dominant low shrub. Wyoming big sagebrush can be present within this system on some occurrences. In these cases, this system can grade into or be interpreted as Big Sagebrush Shrubland.

Graminoids usually dominate the diverse herbaceous layer, with bluebunch wheatgrass (*Pseudoroegneria spicata*) being the most common. Other species present can include Indian ricegrass (*Achnatherum hymenoides*), threadleaf sedge (*Carex filifolia*), slender wheatgrass (*Elymus trachycaulus*), needle and thread (*Hesperostipa comata)*, prairie junegrass (*Koeleria macrantha)*, western wheatgrass (*Pascopyrum smithii*) and Sandberg's bluegrass (*Poa secunda*). The invasive cheatgrass (*Bromus tectorum*) frequently invades this system. Forb cover is generally low and includes cushion species and other low forbs such as Hood's phlox (*Phlox hoodii)*, tapertip hawksbeard (*Crepis acuminata*), milkvetch (*Astragalus* species), stemless mock goldenweed (*Stenotus acaulis*), spreading phlox (*Phlox diffusa*), boreal sagewort (*Artemisia frigida*), and mariposa lily (*Calochortus* species).

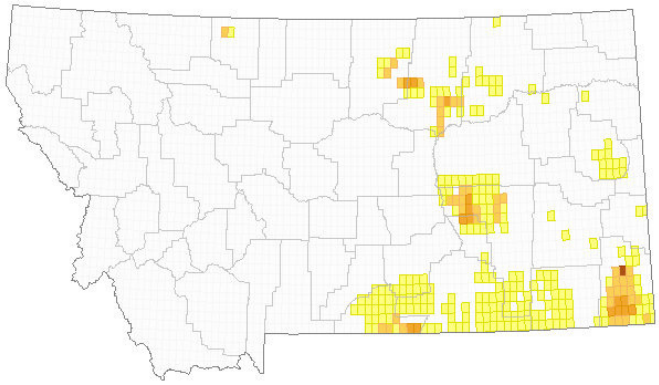
Dynamic Processes

This association usually occurs in a patchy mosaic with other types of sagebrush shrublands. Black sage and little sagebrush shrublands generally occur on the driest, most windswept sites with the shallowest soils relative to shrublands dominated by other sagebrush species. This species is easily killed by fire at all intensities, and when exposed to fire, plants do not re-sprout (Wright et al, 1979). Heavy grazing practices also lead to a decrease in associated grasses and an increase in the spread of cheatgrass. Sites invaded by cheatgrass are changing the dynamics of this system by increasing fire potential, severity and spread.

Shrubland, Steppe and Savanna Systems
Scrub and Dwarf Shrubland

Mat Saltbush Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5203



Approximately 664 square kilometers are classified as Mat Saltbush Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* Oil and gas drilling, bentonite mining and OHV use are main threats, but they are not widespread.

Environment

Mat saltbush shrublands occur on clay or silt soils that are saline and alkaline. In Montana, substrates are generally derived from marine shales.

Vegetation

This system typically supports dwarf-shrublands composed of relatively pure stands of Gardner's saltbush (*Atriplex gardneri*), and in south-central Montana, birdfoot sagebrush (*Artemisia pedatifida*). Other dominant or codominant dwarf-shrubs may include longleaf wormwood (*Artemisia longifolia*) or bud sagebrush (*Picrothamnus desertorum*), occasionally with a mix of other low shrubs, such as winterfat (*Krascheninnikovia lanata*) or shortspine horsebrush (*Tetradymia spinosa*). Shadscale saltbush (*Atriplex confertifolia*) or fourwing saltbush (*Atriplex canescens*) may be present. Wyoming sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) can occur in patches within this system on more favorable substrates that are less saline or alkaline. The herbaceous layer is typically sparse. Perennial forbs are infrequent and scattered in the undergrowth. Common species include smooth woody aster (*Xylorhiza glabriuscula*) and scarlet globe mallow (*Sphaeralcea coccinea*). Annual species of saltbush (*Atriplex*), povertyweed (*Monolepis*), goosefoot (*Chenopodium*) and seepweed (*Suadea*) are frequently present. Perennial grasses have the highest herbaceous cover. Indian ricegrass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*), squirrel tail (*Elymus elymoides*), thickspikewheatgrass (*Elymus lanceolatus ssp. lanceolatus*), western wheatgrass (*Pascopyrum smithii*), Sandberg's bluegrass (*Poa secunda*), or alkali sacaton (*Sporobolus airoides*) are the most common species found in this system. In less saline areas, there may be inclusions of grasslands dominated by needle and thread (*Hesperostipa comata*), saline wild rye (*Leymus salinus*), western wheatgrass, or bluebunch wheatgrass (*Pseudoroegneria spicata*). There may also be inclusions of non-saline, gravelly barrens or rock outcrops dominated by cushion plants such as Hooker's sandwort (*Arenaria hookeri*) and Hood's phlox (*Phlox hoodii*) without dwarf-shrubs. Under disturbance, cheatgrass (*Bromus tectorum*) or other annual bromes can become abundant.

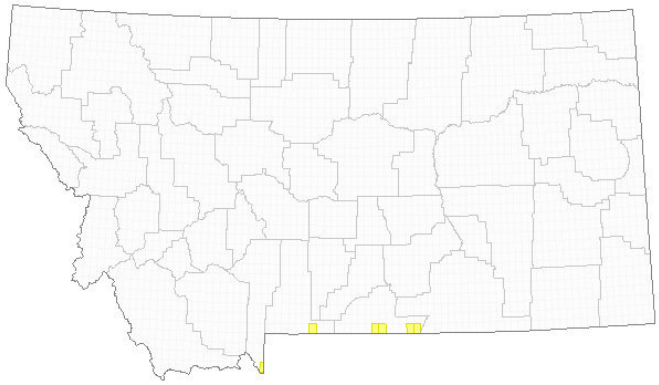
Dynamic Processes

The harsh environmental conditions of these systems slow down community dynamics. Following disturbance, the same species or species similar in stature or appearance often succeed each other. Fire frequency was historically very low in this system. Heavy sheep grazing practices can significantly impact vigor and cover of the principal shrub species, leading to an increase of cheatgrass and other exotic annual forbs. Sites infested with cheatgrass are changing the dynamics of this system by increasing fire potential, severity and spread.

Shrubland, Steppe and Savanna Systems
Scrub and Dwarf Shrubland

Mixed Salt Desert Scrub

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5258



Approximately 1 square kilometers are classified as Mixed Salt Desert Scrub in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S1

* This is a very limited system within Montana, with small patches occuring in the Wyoming Basin ecoregion. Its state rank is based on its limited distribution; nationally it is more secure.

Environment

This is typically a system of extreme climatic conditions, with warm to hot summers and freezing winters. In Montana, annual precipitation is generally 30 centimeters (12 inches) or less. Precipitation usually occurs in spring after snowmelt as intermittent spring rains and sometimes during late summer or fall. Soils are shallow to moderately deep, poorly developed, and a product of an arid climate with little precipitation. Soils are often alkaline or saline, poorly developed Entisols.

Similar Systems

- Active and Stabilized Dune

Vegetation

Vegetation is composed of one or more saltbush (*Atriplex*) species, such as shadscale saltbush (*Atriplex confertifolia*) or fourwing saltbush (*Atriplex canescens*). Some occurrences contain a mixture of saltbush species and Wyoming sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). Spiny hopsage (*Grayia spinosa*) tends to occur on silty coppice dunes. Other shrubs may include winterfat (*Krascheninnikovia lanata*), green rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbit brush (*Ericameria nauseosa*), broom snakeweed (*Gutierrezia sarothrae*),budsage brush (*Picrothamnus desertorum*), shortspine horse brush (*Tetradymia spinosa*) andsoapweed yucca (*Yucca glauca*).Prickly pear (*Opuntia* species) may be present in some occurrences. Trees are not usually present, but some scattered RockyMountain juniper (*Juniperus scopulorum*) may be found.

Graminoids dominate the sparse, or sometimes moderately dense, herbaceous understory. Species present depends on habitat, the alkalinity/salinity of site and past land use, and may includeIndian ricegrass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*), western wheatgrass (*Pascopyrum smithii*), Sandberg's bluegrass (*Poa secunda*), alkali sacaton (*Sporobolus airoides*), needle and thread (*Hesperostipa comata*), saline wild rye (*Leymus salinus*), bluebunch wheatgrass (*Pseudoroegneria spicata*) and

Inland saltgrass (*Distichlis spicata*). Forb cover is generally very low. Annual native species are common on recently disturbed sites within this system and include species such as plantain (*Plantago* species), sixweeks fescue (*Vulpia octoflora*), or Nuttall's povertyweed (*Monolepis nuttalliana*). Halophytic annuals include western glasswort (*Salicornia rubra*)and seepweed (*Suaeda* species). Perennial forbs may include boreal sagewort (*Artemisia frigida*), scarlet globe mallow (*Sphaeralcea coccinea*),and blazing star (*Mentzelia* species). Exotic annuals such as Russian thistle (*Salsola kali*) and cheatgrass (*Bromus tectorum*) are frequently found in this system.

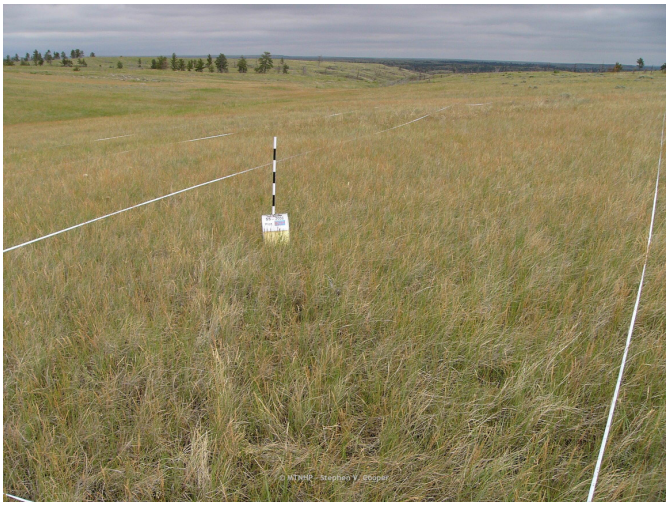
Dynamic Processes

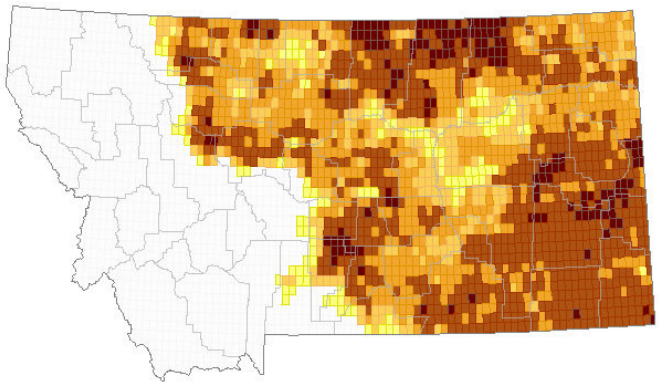
Species of the salt-desert shrub complex have different degrees of tolerance to salinity and aridity, and so tend to sort themselves out along a moisture/salinity gradient (West 1982). The harsh environmental conditions of these systems slow down community dynamics. The same species or species similar in stature or appearance often succeed each other after disturbances. Fire frequency was historically very low in this system. Heavy sheep grazing practices can significantly impact vigor and cover of the principal shrub species, leading to an increase of annual bromes (*Bromus* species) and other exotic annual forbs. Sites invaded with exotic annuals are changing the dynamics of this system by increasing fire potential, severity and spread.

Grassland Systems
Lowland/Prairie Grassland

Great Plains Mixedgrass Prairie

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=7114





Approximately 67,251 square kilometers are classified as Great Plains Mixedgrass Prairie in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4
* This system has been fragmented by section roads, and isovergrazed in places, but it is widespread.

Environment

This system is found on uplands, slopes, and creek bottoms throughout the northwestern Great Plains. Precipitation ranges from 250 to 460 millimeters (10 to 16 inches) with most of the precipitation occurring during late spring and early summer months. Soils are typically Mollisolls and Entisols. The growing season averages 115 days, and ranges from 100 days on the Canadian border to 130 days on the Wyoming border. Climate is typical of mid-continental regions with long severe winters and hot summers. Typical land uses are grazing or dry farming. Wildlife such as mule deer, sage grouse, pheasants, and antelope are common on uncultivated grasslands.

Similar Systems

- Great Plains Sand Prairie

Vegetation

Dynamic vegetative communities make up this diverse prairie ecosystem. Vegetation is a mixture of mid and short grasses, generally having an average height of 30 centimeters (12 inches). Throughout the Montana portion of this system, rhizomatous western wheatgrass is the dominant component, especially on finer-textured soils and where the moisture balance is favorable. It decreases under prolonged or grazing regimes. Grasses were typically used by large herbivores such as bison, but since European settlement, herbivores such as cattle and sheep have been the primary users of the vegetation.

Near the Canadian border and at higher elevations with greater precipitation, this system grades into grasslands dominated by rough fescue and Idaho fescue. These two tussock grasses are indicative of more mesic sites and characterize the Rocky Mountain Lower Montane, Foothill and Valley Grassland system. In areas of southeastern Montana where the sagebrush steppe lands border the mixed grass prairie, common plant associations include silver sagebrush /western wheatgrass. In these border regions, shrub-loving wildlife such as antelope, mule deer, and sage grouse are common. Previously cultivated acres may have been re-vegetated by non-native plants creating associations such as Kentucky bluegrass/western wheatgrassand pure stands of crested wheatgrass. Sites with a strong component of green needlegrass indicate a more favorable moisture balance, although this is one of the most palatable of the mid-grasses. Needle and thread is also an important component; it increases with coarser soil textures, or under heavy grazing at the expense of western wheatgrass. Extreme overgrazing can result in the loss of western wheatgrass from the system, followed by drastic reductions in needle and thread and ultimately, the dominance of blue grama, Sandberg's bluegrass *(Poa secunda*), and prairie junegrass (*Koeleria macrantha*). Common forbs within this system include yarrow (*Achillea millefolium*), scarlet globemallow (*Sphaeralcea coccinea*), western sagewort, (*Artemisia ludoviciana*), boreal sagewort (*Artemisia frigida*), silver lupine (*Lupinus argenteus*), fuzzy beardtongue (*Penstemon eriantherus*), shining penstemon (*Penstemon nitidus*), prairie cinquefoil *(Potentilla gracilis*), Missouri goldenrod (*Solidago missouriensis*) anddalea (*Dalea* species). Shrub species may include western snowberry (*Symphoricarpos occidentalis),* serviceberry (*Amelanchier alnifolia*), shrubby cinquefoil (*Dasiphora fruticosa*), creeping juniper (*Juniperus horizontalis*), silver sage and Wyoming big sagebrush (*Artemisia tridentata* var. *wyomingensis*).

Dynamic Processes

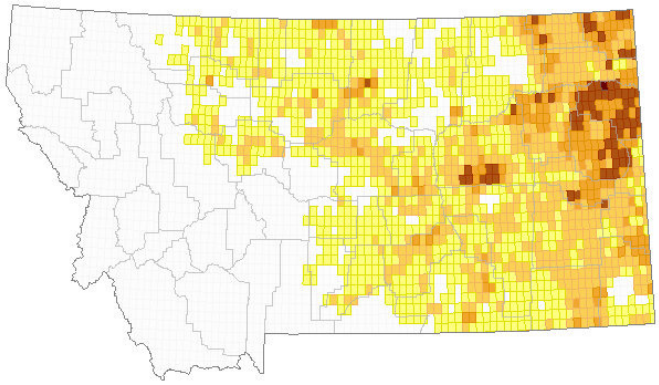
Historically, frequent indigenous anthropogenic fires and large numbers of migrating bison and other herbivores contributed to plant species and plant community diversity within this system. In the Northern Great Plains, pre-settlement fire frequency occurred at intervals ranging from 3 to 20 years (Umbanhowar, 1996). The elimination of bison and frequent fire intervals disrupted plant community dynamics, leading to a decrease in plant community diversity.

Communities associated with this ecological system are adapted to soils that may be dry throughout the growing season. They may also occur on shallow soils, particularly Entisols, with parent material and/or bedrock formation close to the surface. Plant communities occurring on Entisols may be drought tolerant, grazing resistant, and winter hardy. Deep-rooted communities are more generally associated with Mollisols. Typically, these communities are tolerant of managed grazing practices, moderate-intensity fires, and fallowed wheat-cropping practices. Prolonged, extreme drought is a major threat to this system, reducing the density and cover of short grasses by as much as 80 percent and the bunchgrasses and native forbs to almost zero (Albertson, 1937). During prolonged drought, native forbs are rapidly replaced by non-native invasive forbs. During the severe droughts of the 1930's and 1950's, basal area cover of grasses decreased from 80 to less than 10 percent under moderate grazing regimes in 3 to 5 years (Barbour and Billings, 2000). In short, the dynamics of species changes in this system is a function of climate, but the magnitude of these changes is greatly influenced by the intensity of grazing and fire frequency.

Grassland Systems
Lowland/Prairie Grassland

Great Plains Sand Prairie

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=7121



Approximately 10,516 square kilometers are classified as Great Plains Sand Prairie in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* The land cover classification may overstate the range of true sand prairie, as silver sagebrush communities, which are widespread, are currently included in this system. If they were to be classified separately, the area of occupancy would decrease dramatically

Environment

The distribution, species richness and productivity of plant species within the sand prairie ecological system are controlled primarily by environmental conditions, in particular the temporal and spatial distribution of soil moisture and topography. Soils in the sand prairies can be relatively undeveloped and are highly permeable. Soil texture and drainage, along with a species' rooting morphology, photosynthetic physiology, and mechanisms to avoid transpiration loss, determine the composition and distribution of communities/associations within the sand prairies. Soils are also susceptible to wind erosion. Blowouts and sand draws are some of the unique wind-driven disturbances in the sand prairies, which can profoundly impact vegetation composition and succession within this system. In most of eastern Montana, substrates supporting this system have weathered in place from sandstone caprock; thus the solum is relatively thin, and the wind-sculpted features that are present further east, particularly in Nebraska, do not develop. Graminoid species dominate the sand prairies, although relative dominance can change due to impacts of wind disturbance.

This system is found primarily on sandy and sandy loam soils, generally in areas with a rolling topography, although it can occur on ridges, midslopes and/or lowland areas within a region. In Montana, occurrences are associated with the Great Plains Mixed Grass Prairie, usually occupying higher positions in local landscapes, because sandy members of predominantly marine shale formations constitute the highest and most weathering-resistant points in the landscape.

Similar Systems

- Great Plains Mixedgrass Prairie

Vegetation

Needle and thread is the dominant graminoid within this system, regardless of disturbance, and is found on sands and, to a lesser extent. on sandy loams. This species increases in cover with disturbance relative to other graminoids. Prairie sandreed is the only other robust graminoid occurring in abundance and is usually associated with the coarse-textured substrates, becoming nearly a monospecific dominant on sands. Other graminoids such as sun sedge, threadleaf sedge, sand bluestem, little bluestem and big bluestem may be present. Big bluestem and sand bluestem are found only as small patch occurrences in easternmost Montana. Little bluestem occurs preferentially on sites derived from sandstone or porcellanite.

Many of the warm-season graminoids such as western wheatgrass (*Pascopyrum smithii*), blue grama (*Bouteloua gracilis*), Sandberg's bluegrass *(Poa secunda*), prairie junegrass (*Koeleria macrantha*) and threadleaf sedge extend to the Rocky Mountain Front occurrences as dominant components on appropriate sites or as a response to disturbance (Kudray and Cooper 2006).

Characteristic forbs differ by region, but species of scurf pea and Indian breadroot are common. Narrowleaf purple coneflower (*Echinacea angustifolia*) can occur on sandy sites. Very diffuse patches of skunkbush sumac andhorizontal juniper (*Juniperus horizontalis*) are found on shallow sandy soils, often associated with breaklands. Other shrubs occasionally found within this system include silver sage. Soapweed yucca (*Yucca glauca*) occurs on sandy upland sites and bottomlands, but usually with less than 15 % cover. In some cases, Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) occurs within or adjacent to this system.

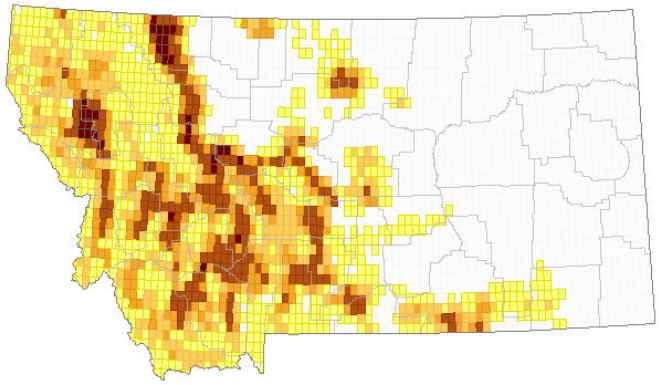
Dynamic Processes

The distribution, species richness and productivity of plant species within the sand prairie ecological system are controlled primarily by environmental conditions, in particular the temporal and spatial distribution of soil moisture and topography. Another important aspect of this system is its susceptibility to wind erosion. Blowouts and sand draws can impact vegetation composition and succession within this system; fire and grazing constitute the other major disturbances. Overgrazing, fire and trampling that leads to the removal of vegetation in areas susceptible to blowouts can either instigate a blowout or perpetuate blowouts occurring within the system. Overgrazing can also lead to significant erosion.

Grassland Systems
Montane Grassland

Rocky Mountain Lower Montane, Foothill, and Valley Grassland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=7112



Approximately 20,096 square kilometers are classified as Rocky Mountain Lower Montane, Foothill, and Valley Grassland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

Environment

This fescue-dominated grassland is transitional between the mixed grass prairie and montane/subalpine grasslands occurring adjacent to or within forested habitats. In northern Montana, it is often associated with aspen parkland. Rough fescue (*Festuca campestris*) and Idaho fescue (*Festuca idahoensis*) are the dominants in northwestern Montana. To the west, this system grades into Palouse prairie in northern Idaho and contains many of the same species. Average precipitation ranges from 292-406 millimeters (11.5 to 16.5 inches). Mean temperatures increase on the eastern edge of this system. Where it occurs within glaciated landscapes, numerous pothole wetlands and other wetland systems are found, often characterized by a perimeter of willow (*Salix* species).

In northwestern and west-central Montana, this ecosystem forms in openings in Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) forests, and in intermountain and mountain valleys and big sagebrush (*Artemisia tridentata*) shrublands. East of the Continental Divide, this system is found along valley bottoms and steep canyon slopes at montane elevations along the Rocky Mountain Front to west-central Montana. Rolling uplands and undulating plains are typical topography east of the Continental Divide, from the Alberta border south along the Rocky Mountain Front and east where this system merges with mixed prairie grassland. Much of this area is cultivated. Black Chernozems are the dominant soils, reflecting moister, cooler conditions and the incorporation of relatively high amounts of organic matter.

Similar Systems

- Big Sagebrush Steppe
- Rocky Mountain Subalpine-Upper Montane Grassland

Vegetation

In Montana, two plant communities dominate this system: 1) Rough Fescue - Idaho Fescue, found on moister sites such as the north- and east-facing slopes in foothills and swales in the northwestern edge of the Great Plains and valley bottoms with deeper soils; and 2) Bluebunch Wheatgrass - Idaho Fescue, found on drier sites such as ridges, hilltops, and south- and west-facing slopes in the foothills and on level sites with sharply drained glacial-till soils.

On pristine, moist sites, rough fescue can form a nearly continuous cover, interspersed with Idaho fescue and the rhizomatous ecotype of bluebunch wheatgrass. Other graminoids include western needlegrass (*Achnatherum occidentale*), Richardson's needlegrass (*Achnatherum richardsonii*), oatgrass (*Danthonia* species), prairie junegrass (*Koeleria macrantha*), Sandberg's bluegrass (*Poa secunda*), western wheatgrass (*Pascopyrum smithii*), thickspike wheatgrass (*Elymus lanceolatus*), basin wildrye (*Leymus cinereus*), and Liddon sedge (*Carex petasata*). These moister sites support a forb- rich community that includes species such as arrowleaf balsamroot (*Balsamorhiza sagittata*), yarrow (*Achillea millefolium*), silky lupine (*Lupinus sericeus*), sticky geranium (*Geranium viscossisimum*), nine-leaf biscuitroot (*Lomatium triternatum*), sticky cinquefoil (*Potentilla glandulosa*), prairie cinquefoil (*Potentilla gracilis*), sulphur penstemon (*Penstemon confertus*), little larkspur (*Delphinium bicolor*), crazyweed (*Oxytropis* species), prairie gentian (*Gentiana affinis*), wild strawberry (*Fragaria virginiana*), and Indian paintbrush (*Castilleja* species).

Shrub cover is usually less than 10 percent and includes species such as shrubby cinquefoil (*Dasiphora fruticosa*), Woods' rose (*Rosa woodsii*), snowberry (*Symphoricarpos* species), and common juniper (*Juniperus communis*). Serviceberry (*Amelanchier alnifolia*), Douglas hawthorn (*Crataegus douglasii*), and common chokecherry (*Prunus virginiana*) often occur as patches on north-facing slopes of foothills where snow persists longer into the growing season.

On drier sites dominated by Idaho fescue and the bunchgrass ecotype of bluebunch wheatgrass, common forbs include yarrow, Indian blanketflower (*Gaillardia aristata)*, boreal bedstraw (*Galium boreale*), prairie smoke (*Geum triflorum*), prairie arnica (*Arnica sororia*), rosy pussytoes (*Antennaria microphylla*), prairie cinquefoil*,* silver lupine (*Lupinus argenteus*)*,* silky lupine,early biscuitroot (*Lomatium macrocarpum*)*,* alyssum leaf phlox (*Phlox alyssifolia*), Hood's phlox (*Phlox hoodii*), gayfeather (*Liatris punctata*), stoneseed (*Lithospermum ruderale*), buckwheat (*Eriogonum species*), fuzzytongue penstemon (*Penstemon eriantherus*), Missouri goldenrod (*Solidago missouriensis*)*,* crazyweed (*Oxytropis species*), alumroot (*Huechera species*), prairie crocus (*Pulsatilla patens*), brittle prickly pear (*Opuntia fragilis*), western sagewort (*Artemisia ludoviciana*), boreal sagewort (*Artemisia frigida*), and daisy (*Erigeron* species). Endemic species are common in drier, rocky sites along the northwestern edge of the Great Plains, e.g., Rocky Mountain douglasia (*Douglasia montana*), shining penstemon (*Penstemon nitidus*), and Alberta penstemon (*Penstemon albertinus*). Other graminoids present within this drier community includetimber oatgrass (*Danthonia intermedia*), prairie junegrass (*Koeleria macrantha*), Sandberg's bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), Geyer's sedge (*Carex geyeri*), andthreadleaf sedge (*Carex filifolia*). Lesser spikemoss (*Selaginella densa*) may be present in high cover on some sites. Lichen cover can be high on ungrazed occurrences (Antos et al,1983) or where fire has been suppressed. Moss can be variable, depending on level of disturbance.

Dynamic Processes

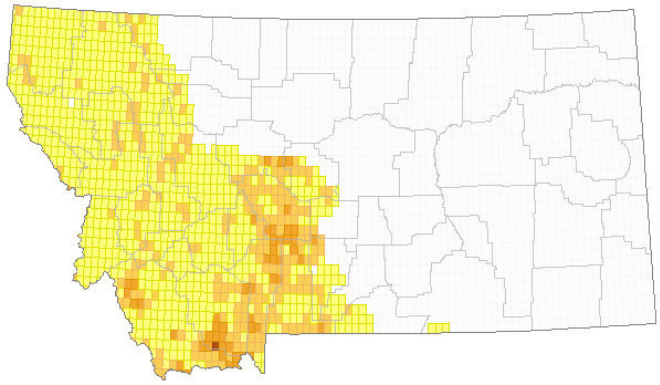
Shrubs may increase following heavy grazing and/or with fire suppression. Rough fescue is highly palatable throughout the grazing season. Summer overgrazing for 2 to 3 years can result in rough fescue loss. In one study, although a light stocking rate for 32 years did not affect range condition, a modest increase in stocking rate led to a marked decline in range condition (Willms and Rhode, 1998). Oatgrass tends to replace rough fescue under moderate or heavy grazing pressure. Long-term heavy grazing on moister sites can result in a shift to a Kentucky bluegrass (*Poa pratensis*)/timothy(*Phleum pratense*)/ smooth brome (*Bromus inermis*) type.

In Montana, many exotic species invaded these grasslands, and in some cases have completely replaced native species. On disturbed, drier sites, Japanese brome (*Bromus japonicus),* sulfur cinquefoil (*Potentilla recta*), leafy spurge (*Euphorbia esula*), spotted knapweed (*Centaurea biebersteinii*), Saint John's wort (*Hypericum perforatum*), and whitetop (*Cardaria draba*) are common. Mesic sites are threatened by meadow hawkweed complex (*Hieracium pratense*, *H. floribundum*, *H. piloselliodes*), orange hawkweed (*Hieracium aurantiacum*), ox-eye daisy (*Leucanthemum vulgare*), tall buttercup (*Ranunculus acris*) and Canada thistle (*Cirsium arvense*).

Grassland Systems
Montane Grassland

Rocky Mountain Subalpine-Montane Mesic Meadow

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=7118



Approximately 3,020 square kilometers are classified as Rocky Mountain Subalpine-Montane Mesic Meadow in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S5

* This system may experience a decline if climate change results in a decrease in snowpack; currently grazing and hydrologic modification are threats

Environment

This system is restricted to sites from lower montane to subalpine elevations where finely textured soils, snow deposition, or windswept conditions limit tree establishment. Many occurrences are small patches, often found in mosaics within woodlands, dense shrublands, or just below alpine communities. Elevations range from 600 to 2,011 meters (2,000-6,600 feet) in the northern Rocky Mountains and from 2,286 to 2,682 meters (7,500-8,800 feet) in the mountains of southwestern Montana. This system occurs on gentle to moderate-gradient slopes and in relatively moist habitats. Soils are typically seasonally moist to saturated in the spring, but dry out later in the growing season. At montane elevations, soils are usually clays or silt loams with an A horizon greater than 10 centimeters (4 inches), and some occurrences may have inclusions of hydric soils in low, depressional areas. At subalpine elevations, soils are derived a variety of parent materials, and are usually rocky or gravelly with good aeration and drainage, but with a well developed organic layer.

Similar Systems

- Alpine-Montane Wet Meadow

Vegetation

Some occurrences are more heavily dominated by grasses, while others are more dominated by forbs, Tall forb dominated mesic meadows are typically comprised of a wide diversity of genera and contribute more to overall herbaceous cover than graminoids. At montane elevations, important flowering forbs include Siberian chives (*Allium schoenoprasum*), meadow arnica (*Arnica chamissonis*), common camas (*Camassia quamash*), aspen daisy (*Erigeron speciosus*), aster (*Eucephalus* and *Symphyotrichum* species), bluebells (*Mertensia* species), fireweed (*Chamerion angustifolium*), stickseed (*Hackelia* species), small flowered penstemon (*Penstemon procerus*), large leaved avens (*Geum macrophyllum*), harebells (*Campanula rotundifolia*), Canadian goldenrod (*Solidago canadensis*), elegant death camas (*Zigadenus elegans*), western meadowrue (*Thalictrum occidentale*), tall groundsel (*Senecio hydrophiloides*) and tall ragwort (*Senecio serra*). Common camas (*Camassia quamash*) dominates some mesic meadows in western Montana and east of the Continental Divide in northwestern Montana. These meadows were important food gathering sites for indigenous people and were intensively managed for food production.

At subalpine elevations, arrowleaf groundsel (*Senecio triangularis*), subalpine wandering daisy *(Erigeron peregrinus*), glacier lily (*Erythronium grandiflorum*), lovage (*Ligusticum* species), green false hellebore (*Veratrum viride*) and valerian (*Valeriana* species) become a more significant component of the forb layer. Burrowing mammals can increase the forb diversity. Broad leaf deciduous shrubs such as shrubby cinquefoil and snowberry are occasional but not abundant.

Under natural disturbance regimes at montane elevations, early successional stages may be dominated by fireweed, horsemint (*Agastache urticifolia*), Virginia strawberry (*Fragaria virginiana*), stinging nettle (*Urtica dioica*), yarrow (*Achillea millefolium*), and other forbs, and small amounts of mesic grasses such as mountain brome (*Bromus carinatus*) and tufted hairgrass (*Deschamspia cespitosa*).

Graminoid-dominated meadows usually feature taxa with relatively broad and soft blades such as tufted hairgrass, mountain brome, showy oniongrass, blue wildrye, awned sedge, slender beaked sedge (*Carex athrostachya*), small wing sedge, Hood's sedge (*Carex hoodii*), Raynold's sedge (*Carex raynoldsonii*), and chamisso sedge (*Carex pachystachya*). Bluejoint reedgrass (*Calamagrostis canadensis*) may be present in some occurrences. At subalpine elevations, tufted hairgrass, alpine timothy (*Phleum alpinum*), poverty oatgrass (*Danthonia intermedia*) and purple mountain hairgrass (*Vahlodea atropurpurea*) become more common components of the graminoid layer. In the Beaverhead Mountains, some occurrences contain Idaho fescue (*Festuca idahoensis*) (Cooper et al, 1997).

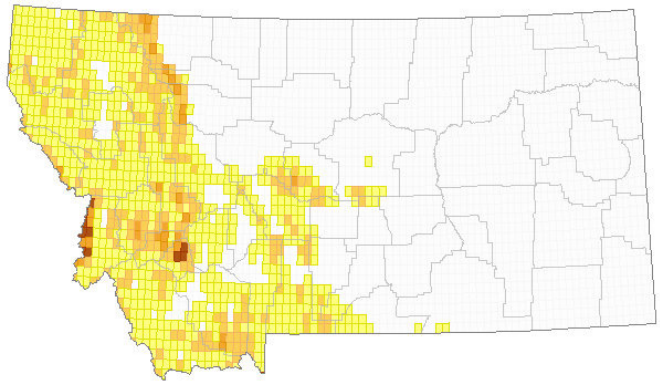
Dynamic Processes

Communities associated with this ecological system are adapted to soils that may be flooded or saturated in the early growing season. Typically these associations are tolerant of moderate-intensity ground fires and late-season livestock grazing (Kovalchik 1987). Most appear to be relatively stable types, although in some areas these may be impacted by intensive livestock grazing.

Grassland Systems
Montane Grassland

Rocky Mountain Subalpine-Upper Montane Grassland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=7113



Approximately 2,758 square kilometers are classified as Rocky Mountain Subalpine-Upper Montane Grassland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S5
* This system faces fewer threats than the lower montane, foothill and valley systems.

Environment

This ecological system grades into the Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland ecological system at its lower elevational limit, and into Rocky Mountain Alpine Fellfield and Alpine Turf systems at its upper limit. In northwestern and west-central Montana it forms within upper elevation Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), spruce-fir (*Picea engelmannii-Abies lasiocarpa*) and whitebark pine (*Pinus albicaulis*) forests. Immediately east of the Continental Divide, it occurs on high ridges (5200 feet or higher) bordering the northwestern Great Plains and on steep mountain slopes and benches above 5200 feet along the Rocky Mountain Front to west-central Montana. Elevations represented by the northernmost extent of this system are approximately 2075-2200 meters (6,800-7, 200 feet). In southern Montana, this system is regularly found at elevations up to 2930 meters (9600 feet) with extremes at 3050 meters (10,000 feet). Sites range from small meadows to large open grasslands surrounded by high elevation forest types. Young soils are derived from recent glacial and alluvial material, but tend to be deeper than soils in adjacent forest communities or in alpine plant communities.

Similar Systems

- Rocky Mountain Lower Montane Foothill and Valley Grassland

Vegetation

Rough fescue (*Festuca campestris*) and Idaho fescue (*Festuca idahoensis*) are the dominants of this system. In Montana, this system generally occurs as two plant community associations: 1) Rough Fescue-Idaho Fescue, found on moister sites such as the north- and east-facing slopes and benches in the mountains; and 2) Idaho Fescue-Bluebunch Wheatgrass, found on drier sites such as ridges, hilltops, and south and west facing slopes and benches. At elevations greater than 2,280 m (7500 feet), Idaho fescue becomes solely dominant or is associated with slender wheatgrass (*Elymus trachycaulus*); in some areas, it may associated with tufted hairgrass (*Deschampsia cespitosa*) (Cooper et al. 1999).

On relatively pristine, moist sites, rough fescue (*Festuca campestris*) canopy cover can approach 70% and form a nearly continuous cover. Rough fescue is most common in northwestern Montana, although it occurs as far south and east as the Anaconda-Pinlar Ranges. Other grasses are typically interspersed with the rough fescue, especially Idaho fescue (*Festuca idahoensis*) and other mesic site graminoids such as western needlegrass (*Achnatherum occidentale*), Richardson's needlegrass (*Achnatherum richardsonii*), basin wildrye (*Leymus cinereus*), Raynolds' sedge (*Carex reynoldsii*), Hood's sedge (*Carex hoodii*), and Liddon sedge (*C. petasata*). The rhizomatous ecotype of bluebunch wheatgrass (*Pseudogeneria spicata*) also occurs sporadically on mesic sites, whereas the purely tussock form is consistently represented only at the xeric extremes. Other graminoids include oatgrass (*Danthonia* species), prairie junegrass (*Koeleria macrantha*), Sandberg's bluegrass (*Poa secunda*), slender wheatgrass (*Elymus trachycaulus*), andneedle and thread (*Hesperostipa comata*). At higher subalpine elevations, alpine timothy (*Phleum alpinum*), tufted hairgrass (*Deschampsia cespitosa*), spike trisetum (*Trisetum spicatum*), obtuse sedge (*Carex obtusata*), and single spike sedge (*Carex scirpoidea)* become common.

These grasslands also supports a rich forb flora, including..subalpine taxa, that are absent from Rocky Mountain Montane grasslands. Species found in this system at upper montane elevations include arrowleaf balsamroot (*Balsamorhiza sagittata*), yarrow (*Achillea millefolium*), silky lupine (*Lupinus sericeus*), sticky geranium (*Geranium viscossisimum*), nine-leaf biscuitroot (*Lomatium triternatum*), prairie cinquefoil (*Potentilla gracilis*), sulphur penstemon (*Penstemon confertus*), little larkspur (*Delphinium bicolor*), wild strawberry (*Fragaria virginiana*), Indian paintbrush (*Castilleja* species), boreal bedstraw (*Galium boreale*), prairie smoke (*Geum triflorum*), prairie arnica (*Arnica sororia*), boreal sagewort (*Artemisia frigida*), western sagewort (*Artemisia ludoviciana*), prairie alumroot (*Huechera parviflora*), prairie crocus (*Pulsatilla patens*), rosy pussytoes (*Antennaria microphylla*), silver lupine (*Lupinus argenteus*), early biscuitroot (*Lomatium macrocarpum*), woolly groundsel (*Packera cana*), alyssum leaf phlox(*Phlox alyssifolia*),Hood's phlox (*Phlox hoodii*), buckwheat (*Eriogonum species*), fireweed(*Chamerion angustifolium),* and cut-leaf daisy (*Erigeron compositus*). Subalpine taxa include diverse leaf cinquefoil (*Potentilla diversifolia*), alpine goldenrod (*Solidago multiradiata),* boreal crazyweed (*Oxytropis borealis*), yellow sweetvetch (*Hedysarum sulphurescens*), smelowskia (*Smelowskia calycina*), subalpine buckwheat (*Eriogonum ovalifolium*), yellow buckwheat (*Eriogonum flavum*), yellow draba (*Draba aurea*), Rydberg's penstemon (*Penstemon rydbergii*), twinflower sandwort (*Minuartia obtusiloba*), and rock jasmine (*Androsace chamaejasme*). Species endemic to the northern Rocky Mountain subalpine and northwestern Great Plains are common in the drier, rocky sites, including Rocky Mountain douglasia (*Douglasia montana*), shining penstemon (*Penstemon nitidus*), Alberta penstemon (*Penstemon albertinus*), Parry's townsendia (*Townsendia parryi*) and alpine buckwheat (*Eriogonum androsaceum*).

Shrub species may be scattered among these grasslands, especially shrubby cinquefoil (*Dasiphora fruticosa*), Woods' rose (*Rosa woodsii*), snowberry (*Symphoricarpos species*), bearberry (*Arctostaphylos uva-ursi*), Canada buffaloberry (*Shepherdia canadensis*), and common juniper (*Juniperus communis*). Serviceberry (*Amelanchier alnifolia*), and common chokecherry (*Prunus virginiana*) often occur as patches on north-facing slopes where snow persists longer into the growing season.

Dynamic Processes

Fire return intervals in grassland- Douglas-fir ecotones in southwestern Montana are estimated at 35 to 40 years, although they may be shorter in the grasslands proper (Arno and Gruell, 1983). With fire suppression, shrubs may increase, and trees may encroach on grasslands. Conversely, when fires eliminate shrublands, especially stands of Mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) common in southwestern Montana, these grassland systems may develop.

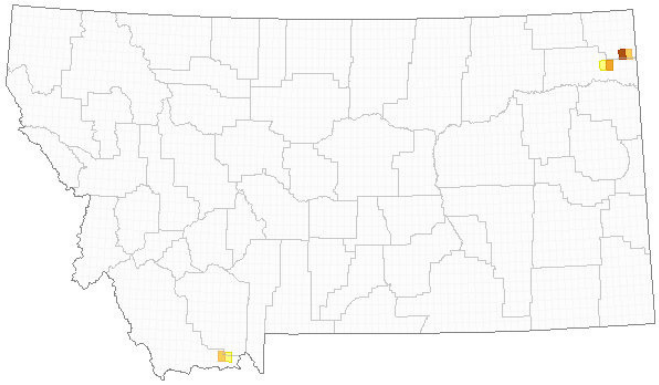
Rough fescue is highly palatable throughout the grazing season, and so tends to attract livestock use. Summer overgrazing for a two to three year period can result in rough fescue loss (Willms and Rhode 1998). Even at moderate stocking rates, livestock grazing decreases cover of rough fescue, especially during summer months. Oatgrass tends to replace rough fescue under moderate or heavy grazing pressure (Willms and Rhode, 1998).

In Montana, noxious exotic species threaten this grassland system through invasion and potential complete replacement of native species. On drier sites,, sulfur cinquefoil (*Potentilla recta*), leafy spurge (*Euphorbia esula*), knapweed species (*Centaurea spp.*), Saint John's wort (*Hypericum perforatum*), and whitetop (*Cardaria draba*) are problematic. Mesic sites within this system are threatened by meadow hawkweed complex (*Hieracium pratense*, *H. floribundum*, *H. piloselliodes*), orange hawkweed (*Hieracium aurantiacum*), ox-eye daisy (*Leucanthemum vulgare*), tall buttercup (*Ranunculus acris*), and Canada thistle (*Cirsium arvense*). Introduced grasses like Kentucky bluegrass (*Poa pratensis*), common timothy (*Phleum pratense*), and smooth brome (*Bromus inermis*) occur on almost all sites within this system, and can pose significant threats.

Sparse and Barren Systems
Bluff, Badland and Dune

Active and Stabilized Dune

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=3160



Approximately 75 square kilometers are classified as Active and Stabilized Dune in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

Environment

This is a minor system in Montana, primarily found in the Centennial Valley of southwestern Montana. It occurs as a mosaic, with land cover ranging from shifting, bare dunes with little to no vegetation (usually immediately post-disturbance) to anchored and stabilized dunes with sparse to moderate shrub cover in later successional stages. Throughout its North American range, the system develops in areas with sand substrates and high winds. The Centennial occurrence formed following the drying of post-Pleistocene lakes, when sediments were blown out of the lake basins and the remaining sands were distributed to the northeast of these sources.

Similar Systems

- Big Sagebrush Steppe
- Montane Sagebrush Steppe

Vegetation

Across the system's U.S. range, the typical primary successional sere on sands appears to be as follows: bare sand or sparse herbaceous vegetation on migrating sand; denser herbaceous vegetation or stands of rubber rabbitbrush (*Ericameria nauseosa*) on anchored or recently stabilized sand; and shrub vegetation of sagebrush (*Artemisia species*) on longer-stabilized sands. In the Centennial Valley of southwestern Montana, early- and mid-seral shrub communities in dunes are dominated by greenrabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush, horse brush (*Tetradymia cancescens*) and needle and thread (*Hesperostipa comata)*. Several plant species of concern occur in the Centennial Valley dunes and are associated with early-successional stages. In areas where the dunes are stabilized, basin big sagebrush (*Artemisia tridentata ssp. tridentata*) and three-tip sagebrush (*Artemisia tripartita ssp. tripartita*) contribute a moderate amount of cover and are associated with needle and thread (*Hesperostipa comata)* or, in more mesic conditions, mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and Idaho fescue (*Festuca idahoensis*). These dunes bear a resemblance to the St. Anthony dunes in Idaho (Chadwick and Dalke 1965) but are distinct in many respects.

Dynamic Processes

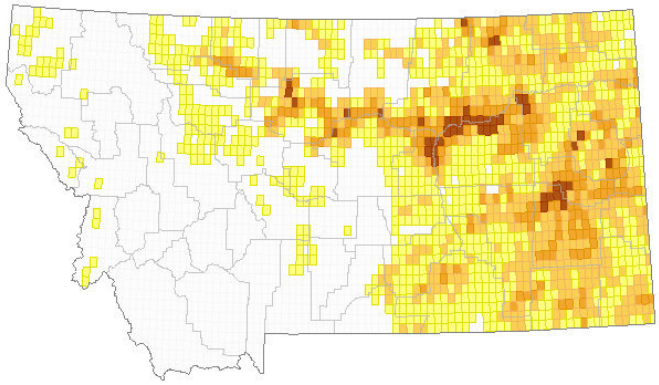
Periodic drought influences dune migration rates by reducing anchoring vegetation cover (Marin, 2005; Jones 2006; Forman et al., 2006). Disturbances by fire, grazing, and burrowing are important processes influencing successional dynamics (Lesica and Cooper 1997). Fire removes dominant shrubs in stabilized areas and maintains pocket gopher habitat, creating bare areas capable of supporting early successional species.

Sparse and Barren Systems
Bluff, Badland and Dune

Great Plains Badlands

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=3114

Provisional State Rank: S5



Approximately 9,534 square kilometers are classified as Great Plains Badlands in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Environment

These systems are primarily found on eroded uplands, slopes, and creek bottoms throughout the northwestern Great Plains region of Montana. Soils are extremely dry and easily erodible consolidated clayey soils with bands of sandstone or isolated consolidates. In these arid to semi-arid climates, infrequent but torrential rains cause rapid erosion, leaving a highly dissected landscape with a complex dendritic drainage pattern.

Similar Systems

- Great Plains Cliff and Outcrop
- Shale Badland

Vegetation

Vegetation within the Badlands region is sparse. Typically less than 20% of the total land cover will be occupied by vegetation in this ecological system. In northeastern Montana, vegetation cover is at the higher end, but in southeastern Montana, portions of this system may have little to no vegetation. Vegetation is typically a mixture of shrub and herbaceous species. Common plant associations include greasewood (*Sarcobatus vermiculatus*) - Gardner's saltbush (*Atriplex gardneri*) or few-flowered buckwheat (*Eriogonum pauciflorum)* - threadleaf snakweed (*Gutierrezia sarothrae*). Graminoid cover is very sparse, but may include western wheatgrass (*Pascopyrum smithii*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and Indian ricegrass (*Achnatherum hymenoides*). Common forbs include few-flowered buckwheat (*Eriogonum pauciflorum*), threadleaf snakweed (*Gutierrezia sarothrae*), Hooker's sandwort (*Arenaria hookeri*), bud sagebrush (*Picrothamnus desertorum),* curlycup gumweed (*Grindelia squarrosa*), longleaf wormwood (*Artemisia longfolia*), and Nutall's povertyweed (*Monolepis nuttalliana*). Other shrubs that may be present include Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*), silver sagebrush (*Artemisia cana*), rabbitbrush (*Chrysothamnus viscidiflorus* and *Ericameria nauseosa*), and saltbush (*Atriplex* species).

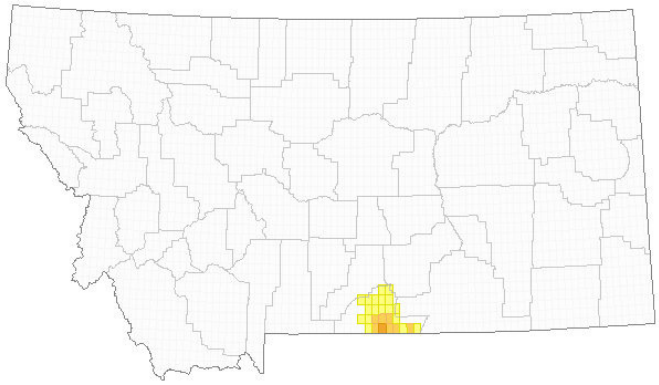
Dynamic Processes

Vegetation communities associated with this ecological system are adapted to soils that are dry throughout the growing season. Typically soils of the badlands ecosystem are easily erodible consolidated clay or sandstone outcrops. They may also occur on shallow Entisols, with parent material and/or bedrock formation close to the surface. These highly erodible soils can also be strongly influenced by infrequent but often torrential rains.

Sparse and Barren Systems
Bluff, Badland and Dune

Shale Badland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=3139



Approximately 80 square kilometers are classified as Shale Badland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* There are numerous large patches of this system well-distributed across southwestern Montana, and although oil/gas exploration poses a threat, it has not yet been extensively realized. Grazing has the potential to cause significant damage to these systems, but the steep terrain and sparse vegetation generally deters livestock, except in areas where surrounding grasslands and steppe is in poor condition.

Environment

This system is primarily found on eroded rounded hills and plains that form a rolling topography with moderately steep slopes. It is found within an arid to semi-arid climate where infrequent but torrential rains cause erosion. A combination of factors such as elevation, rainfall, the carving action of water and wind, and parent material contributes to the development of this system. Soils are extremely dry and easily erodible, usually consolidated silty to clayey soils with bands of shale, siltstones. Mudstones, or isolated consolidates. Most commonly, the soils are alkaline silts or bentonite clays (water-weathered volcanic ash), typically derived from marine shales. Harsh soil properties and high rates of erosion and deposition are driving environmental variables supporting sparse vegetation cover.

Similar Systems

- Great Plains Badlands

Vegetation

This system is typically sparsely vegetated (less than 10 percent cover) with a mixture of shrub and herbaceous species. In southwestern Montana, common shrubs include big sagebrush (*Artemisia tridentata ssp. tridentata*), fourwing saltbush (*Atriplex canescens*), green rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush (*Ericameria nauseosa*), greasewood (*Sarcobatus vermiculatus*), Gardner's saltbush (*Atriplex gardneri*), and horsebrush (*Tetradymia* species). Shrubs are commonly dominant on mid- to late-seral stands, and rubber rabbitbrush (*Ericameria nauseosa*) can be found at any stage. In Montana, graminoid cover is very sparse. Indian ricegrass (*Achnatherum hymenoides)* is characteristic of early-seral vegetation through much of this system's range. Other species include needle and thread (*Hesperostipa comata),* alkali sacaton (*Sporobolus airoides*), saline wildrye (*Leymus salinus)*, bluebunch wheatgrass (*Pseudoroegneria spicata*), western wheatgrass (*Pascopyrum smithii*) and dry, upland muhly species (*Muhlenbergia spp.*). Common forbs include buckwheat (*Eriogonum* species), western sagewort(*Artemisia ludoviciana*), knotweed (*Polygonum species*), threadleaf snakeweed(*Gutierrezia sarothrae*), bladder twinpod (*Physaria* species), sandwort (*Arenaria* species), stemless four nerve daisy (*Tetraneuris acaulis*), rock evening primrose (*Oenothera cespitosa*), and penstemon (*Penstemon* species).

Dynamic Processes

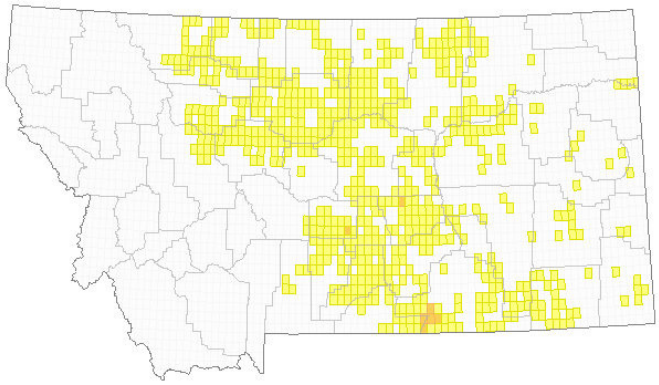
Communities associated with this ecological system are adapted to highly erodible soils that may be dry throughout the growing season. They may also occur on shallow soils, with parent material and/or shale bedrock formation close to the surface. Generally, the plant communities will be drought tolerant, grazing resistant, and winter hardy, and will be tolerant of managed grazing practices or light-intensity fires. Because of the erodible soils, the shale badlands system is not tolerant of heavy use.

Sparse and Barren Systems
Cliff, Canyon and Talus

Great Plains Cliff and Outcrop

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=3142

Provisional State Rank: S5



Approximately 109 square kilometers are classified as Great Plains Cliff and Outcrop in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Environment

These systems are primarily found on cliffs and outcrops throughout the western Great Plains region of Montana. Landforms such as buttes, mesas, and eroded cliff bands constitute the major landforms. A combination of factors such as elevation, rainfall, wind erosion and parent material can contribute to the development of this system. It contains pockets of soil development below the cliff faces, usually derived from limestone and sandstone parent materials. Soils are dry and easily erodible. The system is found within an arid to semi-arid climate with infrequent, but torrential, rains that cause erosion. Climate is typical of mid continental regions with long severe winters and warm summers. Precipitation ranges from 300 to 650 millimeters (12 to 26 inches) with two-thirds coming during the summer and most of the other third in the spring. The growing season is on average 115 days, although the growing season ranges from 100 days on the Canadian border to 130 days on the Wyoming border. This system can occur where the land lies well above its local base level or below and is created by several factors, including elevation, wind, rainfall, carving action of streams, erosion and parent material.

Similar Systems

- Great Plains Badlands

Vegetation

Vegetation is restricted to shelves, cracks and crevices in the rock. Vegetation is typically a mixture of shrub and herbaceous species. Common shrubs include three leaf sumac, greasewood (*Sarcobatus vermiculatus*), Gardner's saltbush (*Atriplex gardneri*), big sagebrush (*Artemisia tridentata*), silver sagebrush (*Artemisia cana*), rabbitbrush (*Chrysothamnus* species) and saltbush (*Atriplex* species). In the northwestern Great Plains region of Montana, it can include horizontal juniper (*Juniperus horizontalis*), common juniper (*Juniperus communis*), bearberry (*Arctostaphylos uva-ursi*), and shrubby cinquefoil (*Dasiphora fruticosa*).

Forbs adapted to sandy soils and sandstone and limestone substrates inhabit this system. Common species include buckwheat (*Eriogonum*species), threadleaf snakeweed (*Gutierrezia sarothrae*), Hooker's sandwort (*Arenaria hookeri*), bud sagebrush (*Picrothamnus desertorum),* curlycup gumweed (*Grindelia squarrosa*), bladderpod (*Lesquerella* species), twinpod (*Physaria*species), douglasia (*Douglasia montana*), rock evening primrose (*Oenothera cespitosa*), four-nerve daisy (*Tetraneuris acaulis*) and penstemon (*Penstemon* species). In Montana, graminoid cover is typically sparse. Species include sideoats grama, blue grama, prairie sandreed, western wheatgrass (*Pascopyrum smithii*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and Indian ricegrass (*Achnatherum hymenoides*).

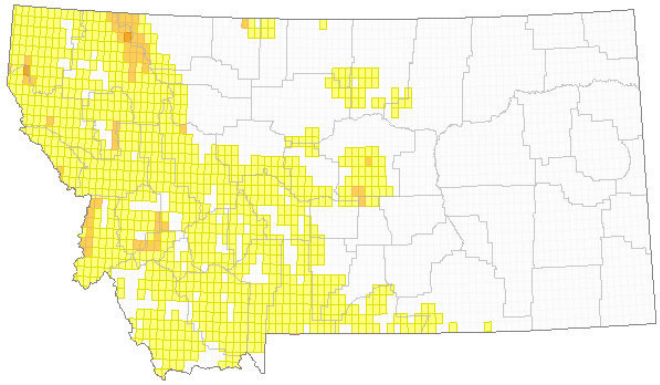
Dynamic Processes

Communities associated with this ecological system are adapted to soils that may be dry throughout the growing season. Typically, soils are more developed than in similar badlands systems and are derived from sandstone or limestone. Communities can be tolerant of managed grazing practices or light-intensity fires, but are not tolerant of heavy use on the landscape due to easily erodible conditions. Soils can also be strongly influenced by infrequent, but often torrential, rains. Invasive species can become established where there is frequent disturbance.

Sparse and Barren Systems
Cliff, Canyon and Talus

Rocky Mountain Cliff, Canyon and Massive Bedrock

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=3129



Approximately 693 square kilometers are classified as Rocky Mountain Cliff, Canyon and Massive Bedrock in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* Because these systems tend to occur in inaccessible locations, they have not been widely disturbed. However, warming and/or drying climatic patterns and loss of tree species to fire or insects may limit the range and distribution over the short term.

Environment

The Rocky Mountain Cliff, Canyon and Massive Bedrock ecological system occurs on steep cliff faces, in narrow canyons, and on smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types, and includes the unstable scree and talus slopes that typically occur below cliff faces. Soils are typically thin and/or poorly developed, and moisture for plant growth is primarily retained in crevices in the rock substrate.

Similar Systems

- Great Plains Cliff and Outcrop
- Wyoming Basin Cliff and Canyon

Vegetation

This system is characteristically dry and sparsely vegetated, typically having less than 10% plant cover. Species composition includes individuals present in adjacent systems (unless exposed parent material is radically different) and herbaceous species specifically adapted to cliff faces and unstable talus slides. Soil development is limited, as is herbaceous cover. Although there may be small patches of dense vegetation, the system usually consists of scattered trees and/or shrubs such as Douglas-fir (*Pseudotsuga menziesii*), Ponderosa pine (*Pinus ponderosa*), limber pine (*Pinus flexilis*), aspen (*Populus tremuloides*), or subalpine fir (*Abies lasiocarpa*). Juniper (*Juniperus* spp.) is common at lower elevations. Shrubs adapted to xeric growing conditions and rocky soils are typically present, e.g. oceanspray (*Holodiscus discolor*), currant (*Ribes species*), common ninebark (*Physocarpus malvaceus*), wild rose *(Rosa* species), common juniper *(Juniperus communis*), Lewis mock orange (*Philadelphus lewisii*), creeping Oregon grape (*Mahonia repens*), three leaf sumac (*Rhus trilobata*), American wild raspberry (*Rubus idaeus*) or serviceberry (*Amelanchier alnifolia)*. Woody colonizing vegetation is usually limited to the toeslopes of talus and scree slides or in protected pockets beneath cliff faces. Herbaceous plants inhabit both the talus and scree slides and fractures in the cliff faces. Forbs may include penstemon (*Penstemon* species), buckwheat (*Eriogonum* species), western sagewort (*Artemisia ludovicana*), Michaux's sagewort (*Artemisia michauxiana*), and spotted saxifrage (*Saxifraga bronchialis*). Graminoids may include slender wheatgrass (*Elymus trachycaulus*) and bluebunch wheatgrass (*Pseudoroegneria spicata*). Mosses and xeric-adapted ferns such as cliff fern (*Woodsia* species), holly fern (*Polystichium lonchitis*), and fragile fern (*Cystopteris fragilis*) occur in fractures of the bedrock, cliff faces or in toeslopes of unstable talus slides. Lichen cover can be high on larger size talus.

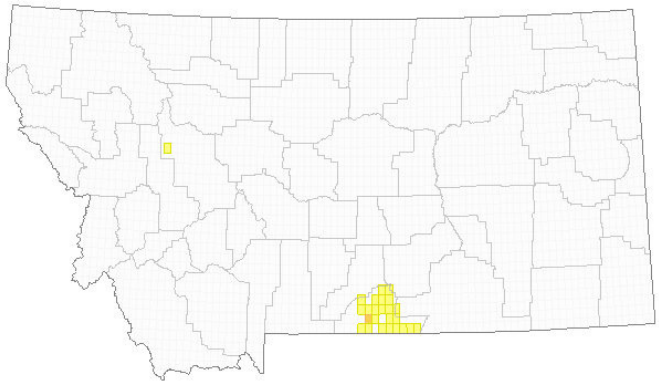
Dynamic Processes

Historically, stand-replacing fires occur frequently in adjacent forests, woodlands and shrublands. Lightning strikes can cause fire within these cliff and canyon systems, although severity and spread is usually variable. Warming or drying climatic patterns will impact this system and the distribution of the peripheral species, northern Rocky Mountain endemics and rare species that occur within it.

Sparse and Barren Systems
Cliff, Canyon and Talus

Wyoming Basin Cliff and Canyon

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=3173



Approximately 7 square kilometers are classified as Wyoming Basin Cliff and Canyon in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3?

* If the areas mapped as Inter-Mountain Basin Cliff and Canyon within Montana are indeed different in their abiotic and biotic components from the Rocky Mountain Cliff, Canyon and Massive Bedrock system, then the Montana occurrences will be the northern extent of the system's range. Because it is not mapped as widespread, it can be considered to be uncommon, and has therefore been tentatively ranked as an S3.

Environment

Environmental attributes of this system need to be defined. Refer to the Rocky Mountain Cliff, Canyon and Massive Bedrock system for more information.

Similar Systems

- Rocky Mountain Cliff Canyon and Massive Bedrock

Vegetation

Vegetation has not been described in Montana.

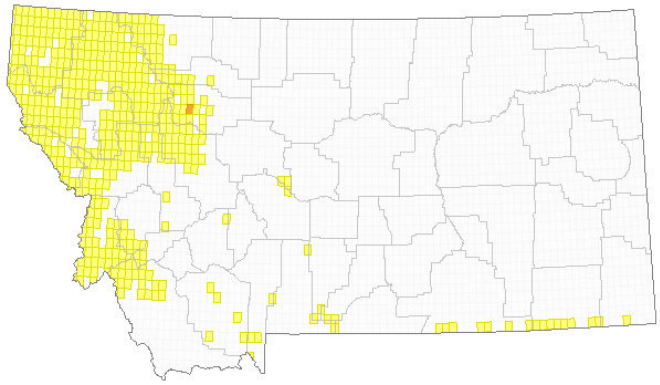
Dynamic Processes

Information incomplete

Wetland and Riparian Systems
Bog or Fen

Rocky Mountain Subalpine-Montane Fen

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9234



Approximately 44 square kilometers are classified as Rocky Mountain Subalpine-Montane Fen in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* Although fens are relatively uncommon, they are well distributed across Montana in small patches, and many occur within managed and protected areas. Climate change and loss of forest ecosystems to fire, insects and disease may alter the hydrology of fen systems in coming decades.

Environment

The montane-subalpine fen ecological system is a small-patch system composed of mountain wetlands that support a unique community of plants not found in other types of wetlands. Fens are confined to specific environments defined by groundwater discharge, soil chemistry, and peat accumulation of at least 40 centimeters (15 inches), although peat accumulations in areas overlain by gravel, cobble or bedrock may be less. Soils are typically organic histosols with 40 centimeters or more of organic material if overlying a mineral soil, or less if overlying bedrock, cobbles or gravels. Histosols range in texture from clayey-skeletal to loamy-skeletal and fine-loams. Fens form at low points in the landscape or near slopes where groundwater intercepts the soil surface. Groundwater inflows maintain a fairly constant water level year-round, with water at or near the surface most of the time. Constant high water levels lead to accumulations of organic material. Rich and extremely rich fens are found in areas underlain by limestone. Water chemistry ranges from only slightly acidic to alkaline and is usually distinctly calcareous. Marl deposits (precipitated calcium carbonates) are common in these systems. Tufa deposits or terraces can be seen in some rich fens and are composed of virtually pure calcium carbonate at the soil surface, formed by continuous discharge and evaporation of calcite saturated groundwater. In northwestern Montana, pH values usually range from 5.9 to 8.4 (Chadde et al., 1998). Poor fens are more common in the northern Rocky Mountains and occur in areas overlain by non-calcareous bedrock, e.g., argillites and granite. These are usually flat, acidic, and saturated to the surface, sometimes with standing water. Iron rich fens are more rare in occurrence, and can be strongly acidic (as low as pH 2.98) and associated with geothermal features and bedrock of weathering pyrite, as found in some occurrences in the Yellowstone Plateau (Lemly, 2007). Iron rich fens support a diverse bryophyte community, typically have less vascular plant diversity, and are composed of species dependant on more acidic conditions.

Fens develop successionally through lake-filling, flow-through successional processes or by paludification (Chadde et al., 1998). Lake filling occurs in depressions and is often characterized by the presence of floating mats and a ring of carr vegetation on the outer margin of the peatland. Flow-through fens are the most common in the northern Rocky Mountains. They occur along springs, streams, slopes and benches with a constant inflow and outflow of calcium-rich water. They are characterized by a series of linear hummocks oriented perpendicular to the slope. Carr shrubland is well developed in flow-through fens due to well-aerated, nutrient-rich water near the inflow and outflow zones. Usually there is an open, nutrient- poor community in the central portion of the fen. Paludification occurs when fens expand due to a rise in the water table caused by peat accumulation. This process is most often observed near seeps and springs or adjacent to closed basin peatlands where peat accumulation causes wetter conditions along the outer edges. Higher water tables kill existing trees. In the northern Rocky Mountains, this successional process is limited due to prolonged summer droughts; however it may be seen in some fen systems at higher elevations.

In northwestern Montana, fens occur at montane to subalpine elevations, generally ranging from 985-2,165 meters (2,500-5,500 feet). In southwestern Montana, subalpine and alpine fens occur at higher elevations (Heidel and Rodemaker, 2008). These communities typically occur in seeps and wet sub-irrigated meadows in narrow to broad valley bottoms. Surface topography is typically smooth to concave with lake-fill peatlands or with slopes ranging from 0 to 10 percent in flow-through fens.

Similar Systems

- Alpine-Montane Wet Meadow

Vegetation

Floristically, rich and extremely rich fens support the greatest vascular plant species diversity of all peatland types in the Rocky Mountains. Extremely rich fens are characterized by high species diversity and a mosaic of herbaceous and woody plant communities. In contrast, poor fens have scattered vascular plant cover and lower species diversity but are characterized by a nearly continuous and diverse cover of mosses and other bryophytes.

Several vascular plants have been identified as extremely rich or rich fen indicators in Montana, and some of these species are uncommon or rare. Indicators include: sage-leaf willow (*Salix candida*), simple bog sedge (*Kobresia simpliciuscula*), Bellardii bog sedge (*Kobresia myosuroides*), Rolland's small clubrush (*Trichophorum pumilum*), little green sedge (*Carex viridula*), northern single spike sedge (*Carex scirpoidea*), pale sedge (*Carex livida*), bulblet-bearing water hemlock (*Cicuta bulbifera*), slender cottongrass (*Eriophorum gracile*), green keeled cottongrass (*Eriophorum viridicarinatum*), beaked spikerush (*Eleocharis rostellata*), northern bog violet (*Viola nephrophylla*), pale bog laurel (*Kalmia polifolia*), Kalm's lobelia (*Lobelia kalmii*), and yellow widelip orchid (*Liparis loeselii*). Other orchids such as giant helleborine orchid (*Epipactis gigantea*) are found in open sedge-dominated portions of the fen system, while one-leaf orchid (*Ameorchis rotundifolia*), sparrow's egg ladyslipper (*Cypripedium passerinum*) and small yellow ladyslipper (*Cypripedium parviflorum*) occur on raised sphagnum hummocks around trees and shrubs near the perimeter of the fen. These species are found almost exclusively in fens or wet forest habitats bordering fens. Poor fens often include species found in more acidic conditions such as pale bog laurel (*Kalmia polifolia*), rannoch rush (*Scheuchzeria palustris*) and sundews (*Drosera* species).

In extremely rich and rich fens, the herbaceous community is often dominated by beaked sedges (*Carex utriculata* or *Carex rostrata*), water sedge (*Carex aquatilis*), mud sedge (*Carex limosa*), woolyfruit sedge (*Carex lasiocarpa*), spikerush (*Eleocharis species*), cottongrass (*Eriophorum species*), rushes (*Scirpus* species and *Trichophorum* species) and bulrushes (*Shoenoplectus* species). Other frequent species include Buxbaum's sedge (*Carex buxbaumii*), analogue sedge (*Carex simulata*), northern bog sedge (*Carex gynocrates*), bristly-stalked sedge (*Carex leptalea*), poor sedge (*Carex paupercula*), yellow sedge (*Carex flava*), hair sedge (*Carex capillaris*), silvery sedge (*Carex canescens*), lens sedge (*Carex lenticularis*), Baltic rush (*Juncus balticus*), northern rush (*Juncus alpino-articulatus*), dagger leaf rush (*Juncus ensifolius*), threadleaf rush (*Juncus filiformis*), common spike rush (*Eleocharis palustris*), and few-flowered spike rush (*Eleocharis quinqueflora*). Common grasses include bluejoint reedgrass (*Calamagrostis canadensis*), tufted hairgrass (*Deschampsia cespitosa*), and fringed brome (*Bromus ciliatus*).

Rich and extremely rich fens also support high forb diversity. Common species include showy pussytoes (*Antenarria pulcherrima*), bog orchid (*Plantanthera* species), buckbean (*Menyanthes trifoliata*), elegant death camas (*Zigadenus elegans*), grass-of-parnassus (*Parnassia* species), beautiful shooting-star (*Dodecatheon pulcherrinum*), pink elephant's head (*Pedicularis groenlandica*), arrow-grass (*Triglochin palustris*), and Siberian chives (*Allium schoenoprasum*). At subalpine elevations, common butterwort (*Pinguicula vulgaris*) often occurs near seeps or springs, in areas where there is marl accumulation or on tufa deposits or terraces.

In Montana, wet, floating *Sphagnum*-dominated mats are associated with open water edges or depressional areas of fen systems. Bryophyte floating mats often consist of Meesia moss (*Meesia triquetra*), Scorpidium moss (*Scorpidium* species), Magellan's peatmoss (*Sphagnum magellanicum*) and brown peatmoss (*Sphagnum fuscum*). The bryophyte floating mat supports a very minor component of sedges such as mud sedge (*Carex limosa*) and smaller sedges such as grape sedge (*Carex aurea*), softleaf sedge (*Carex disperma*) and inland sedge (*Carex interior*), as well as cottongrass species (*Eriophorum* species). Fen indicators such as pale laurel (*Kalmia polifolia*), rannoch rush (*Scheuchzeria palustris*) and sundews (*Drosera* species) occur on these floating mats. Buckbean (*Menyanthes trifoliata*) is a late seral species from the sedge mat phase and is often present on floating mats.

Fens are frequently bordered by willow-bog birch (*Salix* species-*Betula nana glandulosa*) dominated carrs. Carr shrubland is well developed in flow-through fens due to highly-aerated nutrient-rich water near the inflow and outflow zones or the perimeter of basin fens. Sageleaf willow (*Salix candida*) is an indicator species, and sometimes the dominant willow species. Other willow species include autumn willow (*Salix serrissima*), Bebb's willow (*Salix bebbiana*), Drummond's willow (*Salix drummondiana*), plane-leaf willow (*Salix planifolia*), wolf willow (*Salix wolfii*), and undergreen willow (*Salix commutata*). Other common carr shrubs include alder (*Alnus* species), bog birch (*Betula nana*), alder buckthorn (*Rhamnus alnifolia*), shrubby cinquefoil (*Dasiphora fruticosa*), and western Labrador tea (*Ledum glandulosum*). Engelmann spruce (*Picea engelmannii*) is the most frequent conifer species associated with fens and forested fen margins of these systems (Hansen and others, 1996).

Dynamic Processes

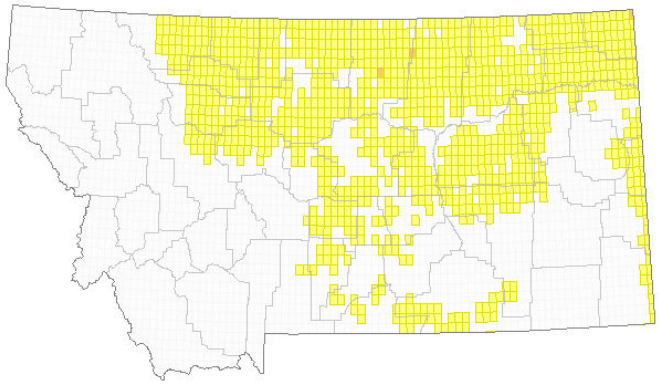
Mountain fens act as natural filters, cleaning ground and surface water. Fens also act as sponges by absorbing heavy

precipitation, then slowly releasing it downstream, minimizing erosion and recharging groundwater systems. Persistent groundwater and cold temperatures allow organic matter to accumulate, forming peat, which allows classification of wetlands within this system as fens. Peat accumulates at the rate of 8 to 11 inches per 1000 years, making peatlands a repository of 10,000 years of post-glacial history.

Wetland and Riparian Systems
Depressional Wetland

Great Plains Closed Depressional Wetland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9252



Approximately 172 square kilometers are classified as Great Plains Closed Depressional Wetland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3

Environment

This system is typified by depressional basins found in flat enclosed upland areas and level shallow lake basins, with an impermeable layer such as dense clay isolating the wetland from the regional groundwater system. It differs from Western Great Plains Open Depression Wetlands and Great Plains Prairie Potholes by being completely isolated from both the regional groundwater system and inter-wetland surface drainage systems. These wetlands occur in depressional basins found in flat enclosed upland areas or on level shallow lake basins. The major sources of input water are precipitation and snow melt; water loss occurs through evapotranspiration. The basins are typified by the presence of an impermeable layer, such as dense clay formed in alluvium that is poorly drained. Subsurface soil layers are restrictive to water movement and root penetration (Cook and Hauer, 2007). Ponds and lakes associated with this system can experience periodic drawdowns during dry years, but are replenished by spring rains. Closed depressions experience irregular hydroperiods, filling water only occasionally and drying quickly, which influences the plant communities that are present.

Similar Systems

- Emergent Marsh
- Great Plains Prairie Pothole
- Great Plains Saline Depression Wetland

Vegetation

Vegetation within this system is highly influenced by hydrology, salinity, fire and adjacent land uses. The drawdown zone is typically dominated by western wheatgrass (*Pascopyrum smithii*) and foxtail barley (*Hordeum jubatum*), the most common wet meadow component of this landscape. Needle spikerush (*Eleocharis acicularis*) and the small annual forbs slender plantain (*Plantago elongata*) and purslane speedwell (*Veronica peregrina*) are common in most stands. Povertyweed (*Iva axillaris*) and willow dock (*Rumex salicifolius*) occupy the broad, low gradient basins which are shallowly inundated in the spring and draw down every year to reveal bottoms of gray bentonite. The common spikerush (*Eleocharis palustris*) association is also within the drawdown zone but occurs at sites where there is more organic matter in the substrate. Foxtail barley (*Hordeum jubatum*) and needle spikerush (*Eleocharis acicularis*) are typically well represented in drier stands, while water knotweed (*Polygonum amphibium*) stands are found at wetter sites. Marsh vegetation, dominated by hardstem bulrush (*Schoenoplectus acutus*), typifies depressions sufficiently deep to remain permanently inundated during most years. Forbs commonly associated with these marsh communities include water knotweed *(Polygonum amphibium*), common spikerush (*Eleocharis palustris*) and two headed water-starwort (*Callitriche heterophylla*).

Dynamic Processes

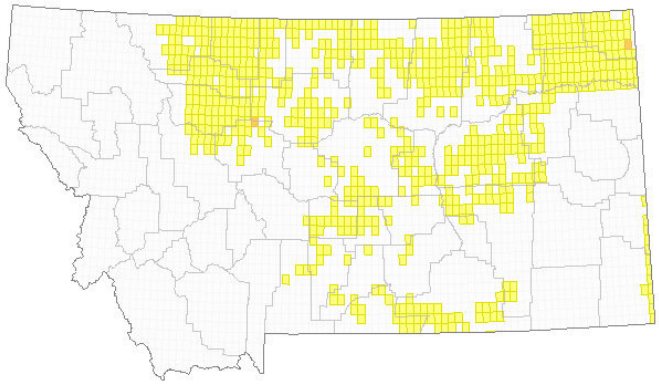
These systems developed under Northern Great Plains climatic conditions, which included natural disturbances by large herbivores, periodic flooding events and occasional fire. Wet-drought year climatic cycles in Montana, often in 10 to 20 year intervals, influence the ecological communities in these systems (Hansen et al., 1995). Each year seeds from annuals and perennials germinate and cover exposed mud flats, but when precipitation floods the depressions, the annuals drown and the perennials survive. Over a series of years the perennials dominate. The drawdown to mudflats is necessary so that emergent vegetation can become reestablished. This flooding, drawdown and the eventual exposure of mud flats drive the water-level vegetation cycle.

Wetland and Riparian Systems
Depressional Wetland

Great Plains Open Freshwater Depression Wetland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9218

Provisional State Rank: S3



Approximately 84 square kilometers are classified as Great Plains Open Freshwater Depression Wetland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Environment

Open depression wetlands are found throughout the Northwestern Glaciated Great Plains region of Montana. They form in lowlands, and along lake borders and stream margins. They generally have more open basins, a large watershed, and a permanent water source throughout most of the year, except during exceptional drought years. This system differs from closed depressional wetlands by having a larger watershed and/or significant connection to the groundwater table (Cook and Hauer 2007). In Montana, most sites within this system are found at elevations of 664-2,027 meters (2,180-6,650 feet). Soils are typically Mollisols, Entisols or occasionally Histosols. Soil pH varies from neutral to slightly alkaline.

Similar Systems

- Emergent Marsh
- Great Plains Closed Depressional Wetland
- Great Plains Saline Depression Wetland

Vegetation

Open depression wetlands often have submerged aquatic plants in the open water zone including common hornwort (*Ceratophyllum demersum*), short spikewater milfoil *(Myriophyllum sibiricum*), and horned pondweed (*Zannichellia palustris*) as well as floating-leaved plants including pondweeds (*Stuckenia* and *Potamogeton* species), white water crowfoot (*Ranunculus aquatilis*) and arrowheads (*Sagittaria*species). The central marsh zone is typically dominated by hardstem bulrush (*Schoenoplectus acutus*), but softstem bulrush (*Schoenoplectus tabernaemontani*), common threesquare (*Schoenoplectus pungens*) and alkali bulrush (*Schoenoplectus maritimus*), often co-dominate. Also found in the marsh zone are cattails (*Typha* species), water knotweed (*Polygonum amphibium*), and hemlock water parsnip (*Sium suave*). The seasonally flooded zones are typically dominated by graminoids including common spikerush *(Eleocharis palustris*), needle spikerush (*Eleocharis acicularis*), American sloughgrass (*Beckmannia syzigachne*), wheat sedge (*Carex atherodes*), foxtail barley (*Hordeum jubatum*), shortawn foxtail (*Alopecurus aequalis*), and water foxtail (*Alopecurus geniculatus*). Open depressional systems are often bordered by wet prairie zones characterized by species such as slimstem reedgrass (*Calamagrostis stricta*), clustered field sedge (*Carex praegracilis*), bluejoint (*Calamagrostis canadensis*) and fowl bluegrass (*Poa palustris*). Open depressions with more alkaline or saline water and soil chemistry will typically be bordered by species such as saltgrass (*Distichlis spicata)*, western wheatgrass (*Pascopyrum smithii)*, and freshwater cordgrass (*Spartina pectinata)*. Sites that have been moderately grazed often have an increase in Baltic rush (*Juncus balticus*), knotted rush (*Juncus nodosus*), foxtail barley (Hordeum jubatum), American sloughgrass (*Beckmannia syzigachne*), and western wheatgrass (*Pascopyrum smithii*).

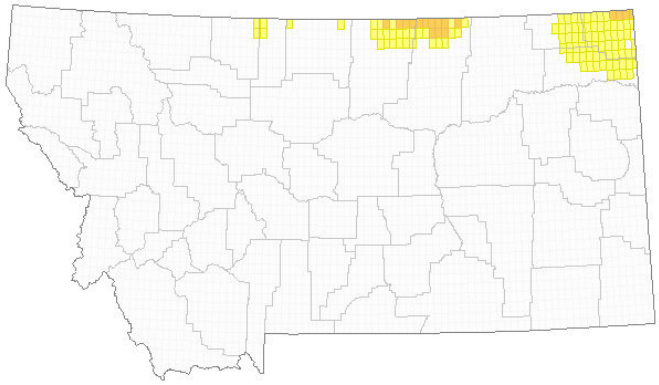
Dynamic Processes

These systems developed under Northern Great Plains climatic conditions, and experienced the natural influence of large herbivores, periodic flooding events and occasional fire. Wet-drought year climatic cycles in Montana, often in 10 to 20 year intervals, influence the ecological communities (Hansen et al., 1996). Seeds from annuals and perennials germinate and cover exposed mud flats, but when precipitation floods the depressions, the annuals drown and the perennials survive. Over a series of years the perennials dominate. The drawdown to mudflats is necessary so that emergent vegetation can become reestablished. Flooding, drawdown and the eventual exposure of mud flats drive the water-level vegetation cycle. Species richness can vary considerably among individual examples and is especially influenced by adjacent land use. Agriculture may provide nutrient and herbicide runoff. In saline soil wetlands, the increase in precipitation during exceptionally wet years can dilute the salt concentration in the soils, which may allow for less salt-tolerant species to occur.

Wetland and Riparian Systems
Depressional Wetland

Great Plains Prairie Pothole

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9203



Approximately 145 square kilometers are classified as Great Plains Prairie Pothole in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3

Environment

The prairie pothole ecological system is dominated by closed basins that receive irregular inputs of water from the surroundings and export water as groundwater. The climate is characterized by mid-continental temperature and precipitation extremes. The region is distinguished by a thin mantle of glacial drift with overlying stratified sedimentary rocks of the Mesozoic and Cenozoic ages; these form a glacial landscape of end moraines, stagnation moraines, outwash plains and lake plains. The glacial drift is from 30 meters to 120 meters thick and forms steep to slight local relief with fine-grained, silty to clayey soils. Limestone, sandstone, and shales are predominant, and highly mineralized water can discharge from these rocks. Precipitation and runoff from snowmelt are often the principal water sources, with groundwater inflow as a secondary source. Evapotranspiration is the primary source of water loss, with seepage loss secondary. The hydrology of this system is complex, and the concentration of dissolved solids results in water that ranges from fresh to extremely saline, with chemical characteristics varying seasonally and annually. Most prairie potholes and associated lakes contain water that is alkaline (pH >7.4). Surrounding uplands are generally in cropland (small grains), hay, or range.

Prairie potholes are considered to be the most important breeding habitat for waterfowl in North America, with production estimates ranging from 50% to 80% of the continent's main species. However, the extreme variability in climate and pothole water levels also results in extreme fluctuations in waterfowl populations from year to year. Prairie wetlands also support a diverse assemblage of water-dependent birds including Montana species of concern such as the black-crowned night heron (*Nycticorax nycticorax*), white-faced ibis (*Plegadis chihi*), Franklin's gull (*Larus pipixcan*), common tern (*Sterna hirundo*), Forster's tern (*Sterna forsteri*), and black tern (*Chlidonias niger*). American white pelicans (*Pelecanus erythrorhynchos*) feed extensively on tiger salamanders (*Ambystoma tigrinum*) found in prairie potholes. Sparsely-vegetated alkali potholes, especially in Sheridan County, are attractive to piping plovers *(Charadrius melodus*).

Similar Systems

- Great Plains Closed Depressional Wetland
- Great Plains Saline Depression Wetland

Vegetation

Vegetation within this system is highly influenced by hydrology, salinity and dynamics. This system includes elements of emergent marshes and wet, sedge meadows that develop into a pattern of concentric rings. Potholes can vary in depth and duration, which determines the local gradient of species. Similarly, plant species found within individual potholes will be strongly influenced by periodic drought and wet periods. The wettest sites, where water stands into or through summer, are characterized by hardstem bulrush (*Schoenoplectus acutus*), often occurring as a near monoculture, or with a fringe of softstem bulrush (*Schoenoplectus tabernaemontani*) or common threesquare (*Schoenoplectus pungens)* along slightly drier margins. Cattails (*Typha spp*) are also seen in these wetter systems, although they are typically a minor component. During spring or in permanently flooded sites, aquatic buttercups (*Ranunculus* species), aquatic smartweeds (*Polygonum* species), pondweeds (*Potamogeton* species) or duckweeds (*Lemna* species) may be abundant. At the drier extremes, pothole vegetation generally occurs in a concentric pattern from a wetter middle dominated by spikerush (*Eleocharis*species) through a drier ring of foxtail barley (*Hordeum jubatum*) and an outer margin of western wheatgrass (*Pascopyrum smithii*) or thickspike wheatgrass (*Elymus lanceolatus*) (Hansen et al, 1996; Lesica 1989). Grazing, draining, and mowing of this system can influence vegetation distribution.

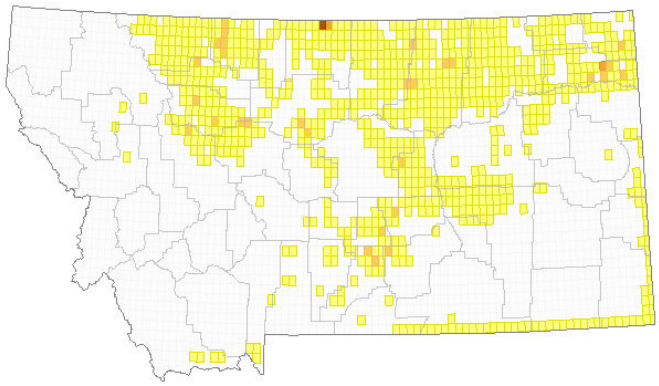
Dynamic Processes

Flooding is the primary natural dynamic influencing this system. Snowmelt in the spring often floods this system and can cause the prominent potholes within the system to overflow. Greater than normal precipitation can flood out emergent vegetation and/or increase herbivory by animal species such as muskrats. Periodic wet and droughty periods cause shifts in vegetation. Vegetation zones are evident, and each zone responds to changing environmental conditions. Draining and conversion to agriculture can also significantly impact this system. Much of the original extent of this system has been converted to cropland, and many remaining examples are under pressure to be drained.

Wetland and Riparian Systems
Depressional Wetland

Great Plains Saline Depression Wetland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9256



Approximately 493 square kilometers are classified as Great Plains Saline Depression Wetland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

Environment

This system is distinguished from the freshwater depression systems by brackish water caused by strongly saline and alkaline soils. This high salinity is attributed to excessive evaporation and the accumulation of minerals dissolved in groundwater discharge. Water is prevented from percolating out of the depression due to an impermeable dense clay soil. Salt encrustations can occur on the surface due to slow water movement (Hansen et al, 1995). On the Blackfeet Indian reservation, water samples collected from saline depressions had conductivity values that ranged from 1,550-40,000 uhmos/cm (Lesica and Shelley, 1988).

Similar Systems

- Emergent Marsh
- Great Plains Closed Depressional Wetland
- Great Plains Open Freshwater Depression Wetland

Vegetation

Vegetation within this system is highly influenced by soil salinity and soil moisture. Salt-tolerant and halophytic species that typify this system include alkali bulrush (*Schoenoplectus maritimus*), common three square (*Schoenoplectus pungens*), inland saltgrass (*Distichlis spicata*), Nuttall's alkali grass (*Puccinellia nuttalliana*), foxtail barley (*Hordeum jubatum)*, red swampfire (*Salicornia rubra)* and freshwater cordgrass (*Spartina pectinata*), and shrubs such as black greasewood (*Sarcobatus vermiculatus*). Other species include western wheatgrass (*Pascopyrum smithii)* and foxtail barley (*Hordeum jubatum*). Plant zonation related to soil salinity is often apparent in these systems. with distinct rings occurring around the fringe of the depression. In deeper, more depressed halophytic habitats, red swampfire or prairie cordgrass will dominate with Nuttall's alkali grass found directly upslope, followed by inland saltgrass. Shrubs such as greasewood and winterfat (*Krascheninnikovia lanata*) are common around the outer margins of this system. Pursh seepweed (*Suaeda calceoliformis*), annual goosefoot (*Chenopodium* species) and seaside arrowgrass (*Triglochin maritima*) are common forbs.

In northeastern Montana, the alkali bulrush association occurs as an emergent band around open water or as zonal vegetation around other plant associations. Water tables are often high, often remaining above the soil surface at least through late summer. Soils are poorly drained, alkaline Entisols. Alkali bulrush forms dense, monotypic stands with up to 91% cover. In some areas along the wetland edge, very minor amounts of common spikerush (*Eleocharis palustris*) may be present. Alkali bulrush can survive periods of total inundation up to 1 meter (3.3 feet) deep, as well as drought periods where the water table remains less than 1 meter below the soil surface. It is a vigorously rhizomatous species that colonizes and spreads when the water table is within 10 centimeters (4 inches) of the surface. Cover of alkali bulrush may be replaced by red swampfire and other associated species during drought years.

Red swampfire occurs in the drawdown zone that is flooded during the early part of the growing season but where the water table drops below soil surface by late spring or early summer. Soils in this zone usually have silty-clay to clay texture, and the soil surface is covered with salt crusts. Principle salts are sulfates and chlorides of sodium and magnesium. It is one of a very few species that can persist in these hyper-saline conditions when the water table drops below the soil surface (Dodd and Coupland,1966).

Dynamic Processes

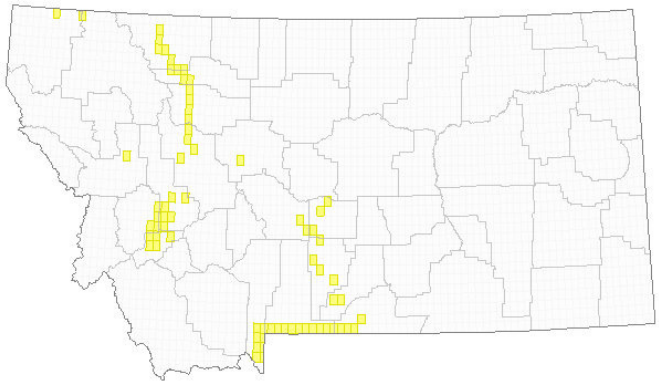
These systems developed under Northern Great Plains climatic conditions that include natural influence of periodic flooding events and occasional fire. Climate has an important effect on saline areas because precipitation and snowmelt transport salts to the depressions and can dilute the soil solution while temperature and wind influence the rate of evapotranspiration. Increased precipitation and/or runoff can dilute the salt concentration and allow for less salt-tolerant species to occur while increased evapotranspiration increases soil salinity leading to a more brackish habitat type.

Wetland and Riparian Systems
Depressional Wetland

Rocky Mountain Wooded Vernal Pool

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9162

Provisional State Rank: S4



Approximately 3 square kilometers are classified as Rocky Mountain Wooded Vernal Pool in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Environment

In northwestern Montana, these ponds and pools occur in forested environments. Occurrences are found from valley bottoms to montane elevations ranging from 866 to 1,585 m (2,840-5,200 feet) (Mincemoyer, 2005). This system is well represented in the Seeley-Swan valley in northwestern Montana. Pools are generally found on valley bottoms, lower benches, toeslopes, and flat sites, often in glaciated kettleholes that vary in size and depth.

Depending on annual patterns of temperature and precipitation, the drying of the pond may be complete or partial by the fall or during drought years. However, many of these ponds remain at fairly constant water levels throughout the growing season. These sites can be shallow and less than 1 meter (3.3 feet) in depth, but can be as much as 2 meters (6 feet) deep. The pool substrate is a poorly drained, often clayey layer with shallow organic sediments. Parent materials are typically clay alluvium or clay colluvium (Mincemoyer, 2005). These freshwater ponds have pH ranges from 6.2 to 7.8 with most measurements between 6.5 and 7.5. The size of the pools/ponds can range from .4 to 4 hectares (1-10 acres) in size.

Vegetation

The overstory surrounding vernal wooded pools is typically a mixed coniferous forest consisting of grand fir,, subalpine fir, western larch, Engelmannspruce,lodgepolepine, Douglas-fir, and deciduous trees like black cottonwood and, to a lesser extent, quaking aspen and paper birch. Western red cedar (*Thuja plicata*) often borders the ponds, especially in the northern Swan Valley. Common shrubs occurring in the forest edges surrounding the pools include thinleaf alder (*Alnus incana*), redoiser dogwood (*Cornus sericea*), buckthorn alder (*Rhamnus alnifolia*), and willows (*Salix spp.*).

The herbaceous component is dominated by graminoids such as shortawn foxtail (*Alopecurus aequalis*), water sedge(*Carex aquatilis*), beaked sedge (*Carex utriculata*), inflated sedge, common spikerush, and rushes (*Juncus spp.).* Other characteristic species include woolyfruit sedge (*Carex lasiocarpa*), awned sedge (*Carex atherodes*), and wooly sedge (*Carex pellita*). Reed canarygrass is invasive in this system.

Water starwort (*Callitriche* species), pondweeds (*Potamogeton spp.*), burr reed (*Sparganium spp.*), white water crowfoot (*Ranunculus aquatilis*), common mare's tail (*Hippuris vulgaris*), bladderworts (*Utricularia spp.*), field mint (*Mentha arvensis*), and yellowcress (*Rorippa spp.)* are common herbaceous plant associates. Horsetails (*Equisetum spp.)* are often present. In Lake and Missoula counties, wooded vernal pools are habitat for water howellia, a federally threatened species. This annual aquatic may undergo dramatic yearly fluctuations in population size.

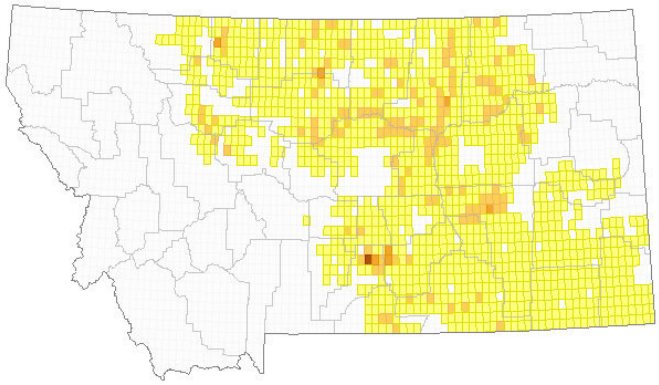
Dynamic Processes

Many of the pools in the Swan Valley remain at a fairly constant water level year round. In some cases, these pools can partially or completely dry down, depending on temperature, precipitation patterns and pool depth, by late fall. Prolonged drought caused by changing climatic patterns will impact the populations of species such as water howellia occurring within these pools.

Wetland and Riparian Systems
Floodplain and Riparian

Greasewood Flat

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9103



Approximately 1,386 square kilometers are classified as Greasewood Flat in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* The major threat to this system is drought, followed by grazing effects (trampling, pugging, hummocking)

Environment

In Montana, this ecological system represents one of the driest extremes of the riparian/wetland zone. It occurs on nearly level, older alluvial terraces on broad or narrow floodplains and coalescing alluvial fans in valleys. It may also occur on broad expanses along lake shores and playas. Sites typically have saline or alkaline soils and a shallow water table. They flood intermittently, but remain dry for most of the growing season. However, the underlying water table stays high enough to maintain vegetation, despite salt accumulations. The system occurs where overland flow or soils or a combination of both allow for a greater than normal moisture regime. High water tables are common, typically within 25 to 30 centimeters (10 to 12 inches) of the soil surface. Soils are fine textured, poorly drained and are alkaline or saline. Soil texture ranges from silt to clay. Sites range in elevation from 655 to 1,067 meters (2,150 to 3,500 feet) (Hansen et al., 1995).

Vegetation

Greasewood (*Sarcobatus vermiculatus*) is the dominant shrub, although overall canopy cover may be low. Other shrubs present in some occurrences include four-wing saltbush (*Atriplex canescens*), shadscale saltbush (*Atriplex confertifolia),* Gardner's saltbush (*Atriplex gardneri*), Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), big sagebrush (*Artemisia tridentata ssp. tridentata*), silver sage (*Artemisia cana ssp. cana*), green rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush (*Ericameria nauseosa*) or winterfat (*Krascheninnikovia lanata*).

Perennial grasses are the most common herbaceous cover, with western wheatgrass (*Pascopyrum smithii*) tending to dominate in undisturbed communities. Other graminoids commonly occurring in this system include slender wheatgrass (*Elymus trachycaulus*), prairie cordgrass (*Spartina pectinata*), Nutall's alkaligrass (*Puccinellia nuttalliana*), Sandberg's bluegrass (*Poa secunda*), inland saltgrass (*Distichlis spicata*), alkali sacaton (*Sporobolus airoides*), prairie sandgrass (*Calamovilfa longifolia*), basin wildrye (*Leymus cinereus*) and occasionally common spikerush (*Eleocharis palustris*). Common forb species include yarrow (*Achillea millefolium*), one-flowered groundsel (*Pyrrocoma uniflora),* boreal sagewort (*Artemisia frigida*), western sagewort (*Artemisia ludoviciana*)*,* goosefoot (*Chenopodium* species), scarlet globe mallow (*Sphaeralcea coccinea*), western saltwort (*Salicornia rubra*) and curlycup gumweed (*Grindelia squarrosa*).

Adjacent drier communities are dominated by upland shrub or grassland communities such as mixed salt desert scrub, big sagebrush (*Artemisia tridentata*) shrublands, or three tip sagebrush (*Artemisia tripartita*) shrublands. Wetter adjacent communities may be dominated by inland salt grass (*Distichlis spicata*) or willow-cottonwood (*Salix-Populus* species) dominated communities. In Montana, this system can occur near alkaline lakes or in overflow washes.

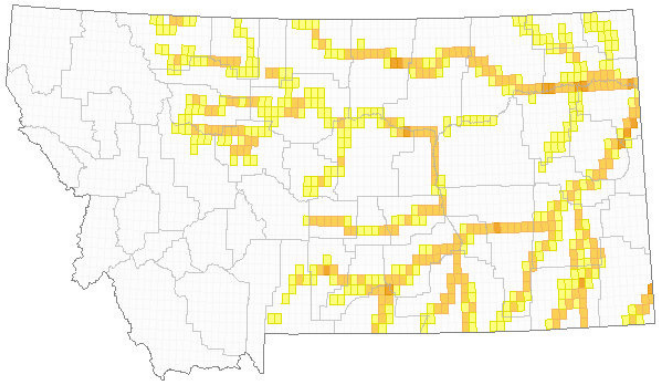
Dynamic Processes

Soil-water dynamics within this system support a restricted range of species. Communities in good condition typically have 30 to 40 % shrub cover. Under continued disturbance, greasewood and western wheatgrass decrease in cover, while species such as foxtail barley (*Hordeum jubatum*) and yarrow (*Achillea millefolium*), and exotics like cheatgrass (*Bromus tectorum*), Japanese brome (*Bromus japonicus*) and Kentucky bluegrass (*Poa pratensis*), increase in cover.

Wetland and Riparian Systems
Floodplain and Riparian

Great Plains Floodplain

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9159



Approximately 1,834 square kilometers are classified as Great Plains Floodplain in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3

Environment

This system may occur as relatively broad and extensive forests, as seen along the lower stretches of the Missouri and Yellowstone Rivers, or more narrow bands, as seen along the Milk, Little Missouri, Tongue and Powder Rivers. The elevational range of this system is from 579-1,310 meters (1,900-4,300 feet) (Hansen et al., 1996). These are the big perennial rivers of the region, with hydrologic dynamics largely driven by snowmelt and rainfall originating in their headwater watersheds, rather than by local precipitation events. In an undisturbed state, periodic flooding of the fluvial and alluvial soils and channel migration will create alluvial bars, depressions and backwaters supporting zones or mosaics of wetland and riparian vegetation, whose composition and structure is sustained, altered and redistributed by hydrology. Soils can be Entisols, Inceptisols and Mollisols on older stabilized sites. Often there is up to 1 meter of soil overlying river gravels and cobble. Water tables can drop to within 1 meter of the soil surface in summer months.

Similar Systems

- Great Plains Riparian

Vegetation

In the western part of the system's range in Montana, the overstory dominant species is black cottonwood, with narrowleaf cottonwood and Plains cottonwood occurring as co-dominants in the riparian/floodplain interface near the mountains. Further east, narrowleaf cottonwood and Plains cottonwood become dominant.

In less disturbed occurrences, willow species such as yellow willow (*Salix lutea*) planeleaf willow (*Salix planifolia*), and peachleaf willow (*Salix amygdaloides*) co-dominate the shrub layer with common chokecherry (*Prunus virginiana*), redosier dogwood (*Cornus sericea*), serviceberry (*Amelanchier alnifolia*) and currant (*Ribes* spps). Boxelder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), and American elm (*Ulmus americana*) are common in mid- to late-seral stands, and will generally succeed Plains cottonwood in the rivers of the Southeast. Sandbar willow (*Salix exigua*) and shrubby cinquefoil (*Dasiphora fruticosa*) frequently colonize recent alluvial bars in central and eastern Montana, while silverberry (*Elaeagnus commutata*), thinleaf alder (*Alnus incana*) and Drummond's willow (*Salix drummondiana*) are colonizers in black cottonwood-dominated floodplains near the mountains and riparian/floodplain interface. Common graminoids associated with these floodplain systems include big bluestem (*Andropogon gerardii*), wooly sedge (*Carex pellita*), streamside wild rye (*Elymus lanceolatus*), old switch panicgrass (*Panicum virgatum*), western wheatgrass (*Pascopyrum smithii*), little bluestem (*Schizachyrium scoparium*), and sand dropseed (*Sporobolus cryptandrus*). Forbs include Drummond's dryad (*Dryas drummondii*), yarrow (*Achillea millefolium*), starry solomon's seal (*Maianthemum stellatum*) and aster (*Symphyotrichum* species). Because of the disturbance regimes typical in these systems, they are highly susceptible to invasion by exotic species. Russian olive (*Elaeagnus angustifolia*) and cheatgrass (*Bromus tectorum*) have become established in many stands, and leafy spurge (*Euphorbia esula*) is a common invasive.

Dynamic Processes

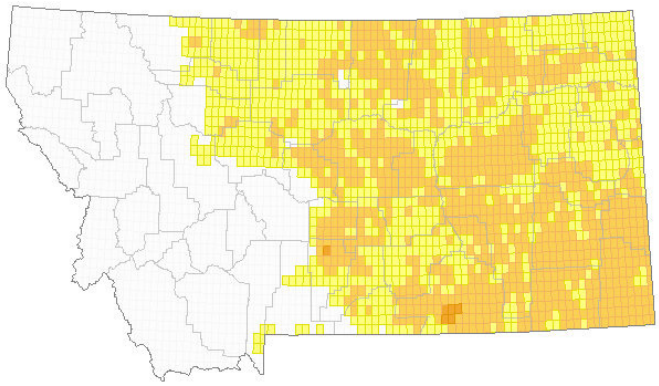
In Montana, many occurrences are now degraded to the point where the cottonwood overstory is the only remaining natural component. The hydrology of these floodplain systems has been affected by dams, highways, railroads and agricultural ditches. As a result, they have lost their characteristic wetland /riparian mosaic structure. This has resulted in a highly altered community consisting of relict cottonwood stands with little regeneration. In the system's disturbed/altered hydrological state and/or under heavy grazing pressure, there will be an increase in shrub species such as western snowberry and rose and a corresponding decrease in willow species, redosier dogwood, currant, serviceberry and common chokecherry.

Successional processes create a community resembling adjacent upland communities; western snowberry and rose may persist, but will be joined by other native shrubs from adjacent upland communities, such as silver sagebrush (*Artemisia cana*)and big sagebrush (*Artemisia tridentata*). In addition, exotic shrub species such as salt cedar (*Tamarix ramosissima*) can invade disturbed floodplain systems. Russian olive has become a dominant overstory tree in many areas, shading out native species. In these disturbed floodplains, the understory vegetation is dominated by a mixture of pasture grasses such as smooth brome (*Bromus inermis*), common timothy (*Phleum pratense*), redtop (*Agrostis stolonifera*) and Kentucky bluegrass (*Poa pratensis*), as well as non-native forbs such as sweetclover (*Melilotus* species), clovers (*Trifolium* species), Canadian thistle (*Cirsium canadensis*) and common dandelion (*Taraxacum officinale*). Once exotic grasses become dominant, especially in the absence of episodic flooding, these systems cannot return to their original state without substantial management intervention.

Wetland and Riparian Systems
Floodplain and Riparian

Great Plains Riparian

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9326



Approximately 5,888 square kilometers are classified as Great Plains Riparian in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S3

Environment

The primary inputs of water to these systems include groundwater discharge, overland flow, and subsurface interflow from the adjacent upland. Flooding is the key ecosystem process. It creates suitable sites for seed dispersal and seedling establishment, and controls vegetation succession. This system is associated with small rivers and perennial to intermittent or ephemeral streams that flow only during part of the year. In the Great Plains, the water source is primarily local precipitation and groundwater inflow (Decker, 2007); in systems receiving flow from central and southeastern mountain ranges, snowmelt and summer thunderstorms provide a significant portion of flows. The boundaries of these riparian areas extend beyond the limits of flooding into streamside vegetation (Gregory, 1991). They are important links between terrestrial and aquatic ecosystems, acting as ecotones between upland and wetland, and connecting ecological processes and plant communities.

Similar Systems

- Great Plains Floodplain
- Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
- Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

Vegetation

Like the Western Great Plains Riparian system of Wyoming, Colorado and New Mexico, Montana's Great Plains Riparian systems may include riparian forests or woodlands, as well as shrublands, tallgrass or mixedgrass wet meadows, herbaceous wetlands, and gravel/sand flats (Decker, 2007). Vegetation may be a mosaic of communities that are not always tree- or shrub-dominated. At lower elevations (e.g. along the Little Powder River and Mizpah Creek in southeastern Montana), forested communities may form galleries dominated by Plains cottonwood. Narrowleaf cottonwood occurs at intermediate elevations and black cottonwood tends to be prevalent at higher elevations (Hansen et al., 1996). Willows commonly associated with this system include sandbar willow (*Salix exigua*), yellow willow (*Salix lutea*), peachleaf willow (*Salix amygdaloides*), and diamondleaf willow (*Salix planifolia*). Other shrubs include redosier dogwood, western snowberry (*Symphoricarpos occidentalis*), chokecherry (*Prunus virginiana*), and woods rose (*Rosa woodsii*). In areas where the channel is incised, the understory may be dominated by big sagebrush or silver sagebrush. The herbaceous stratum is variable. Subirrigated areas may support tallgrass meadows dominated by big bluestem (*Andropogon gerardii*) or fresh water cordgrass *(Spartina pectinata*). Other graminoids include wooly sedge (*Carex pellita),* little bluestem (*Schizachyrium scoparium*)*,* western wheatgrass, porcupine needlegrass (*Hesperostipa spartea*)*,* northern dropseed (*Sporobolus heterolepis*), and panic grass (*Panicum virgatum*)*.* American licorice and Canada goldenrod (*Solidago canadensis*) are common understory forbs within all cottonwood riparian systems. These sites are prone to invasion by exotic grasses and forbs, the most widely established being creeping bentgrass (*Agrostis stolonifera*)*,* cheatgrass (*Bromus tectorum*)*,* quackgrass (*Agropyron repens*), Canada thistle (*Cirsium arvense*)*,* clovers *(Melilotus* species*)*, leafy spurge (*Euphorbia esula*) and common dandelion *(Taraxacum officinale*).

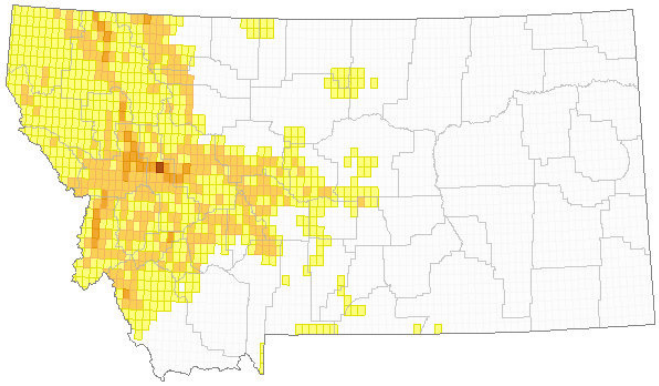
Dynamic Processes

Fluvial processes play a key role in the dynamics of Great Plains streams. The nature of these processes is often indicated by channel morphology. Meandering channels generally have a shallow gradient, low flow variability, and sediment loads dominated by silt and finer particles, while braided channels are characterized by a steep gradient, high flow variability, and a sediment load dominated by sand and coarser particles (Friedman, 2002). Flooding is the key ecosystem process whereby establishment sites for riparian vegetation are created, seeds are dispersed and vegetative succession is controlled. However, since Euro-American settlement, natural fluvial processes have been disrupted in many of these systems by dams and diversions. Fire has been suppressed, agricultural activities have increased siltation rates and introduced both non-native species and chemical changes, and native grazers have been largely replaced by domestic cattle. Consequently, there has been a direct loss of woody plant diversity. Furthermore, both channel incision and channel widening have altered flooding regimes, leading to establishment of flood-intolerant species in many areas.

Wetland and Riparian Systems
Floodplain and Riparian

Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9155



Approximately 2,683 square kilometers are classified as Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4
* This system faces multiple threats: residential and agricultural development, invasives, climate change, drought, etc. However, it is still widespread.

Environment

This riparian system is a seasonally flooded shrubland and woodland found throughout the northern Rocky Mountain region. It occurs at lower montane elevations in valleys and foothills on alluvial terraces, streambanks, and floodplains along moderate to high gradient streams and rivers. Soils are usually Entisols overlying river cobbles and gravel. Inceptisols and Mollisols can be found on older sites of relative stability that have had significant time for soil development. Soil texture varies from loam to coarse sand. Water tables may drop in late summer to 50 centimeters (20 inches) below the soil surface, but surface horizons remain moist due to capillary action. The coarse textured soils, stream gradients, and large amounts of coarse rock fragments create rapid movement of highly aerated water. Sites occur at elevations of 609-1,219 meters (2,000-4,000 feet) west of the Continental Divide. East of the Continental Divide, this system ranges up to 1,676 meters (5,500 feet) (Hansen et al., 1995).

Similar Systems

- Rocky Mountain Subalpine-Montane Riparian Woodland

Vegetation

Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) is the key indicator species. Several other tree species can be mixed in the canopy, including boxelder maple (*Acer negundo*), narrowleaf cottonwood (*Populus angustifolia*), eastern cottonwood (*Populus deltoides*), Douglas-fir (*Pseudotsuga menziesii*), peachleaf willow (*Salix amygdaloides*), or Mountain juniper (*Juniperus scopulorum*). Quaking aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), water birch (*Betula occidentalis*) and white spruce (*Picea glauca*) also occur. Grand fir (*Abies grandis*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*) are commonly co-dominant canopy species in western Montana occurrences, particularly in lower montane riparian zones. Shrub understory components include red-oiser dogwood (*Cornus sericea*), Rocky Mountain maple (*Acer glabrum*), thinleaf alder (*Alnus incana*), devil's club (*Oplopanax horridus*), and common snowberry (*Symphoricarpos albus*). Other shrubs may include currant (*Ribes* species), Douglas hawthorn (*Crataegus douglasii*), plane leaf willow (*Salix planifolia*) yellow willow (*Salix lutea*), Woods' rose (*Rosa woodsii*), alder buckthorn (*Rhamnus alnifolia*), and common chokecherry (*Prunus virginiana*). Shrubby cinquefoil (*Dasiphora fruticosa)*, Drummond's willow (*Salix drummondii*), and sandbar willow (*Salix exigua*) are often present on recent alluvial bars.

Dominant graminoid vegetation in the herbaceous stratum includes bluejoint reedgrass (*Calamagrostis canadensis*), and to a much lesser extent, blue wildrye (*Elymus glaucus*) and Bebb's sedge (*Carex bebbii*). Common forbs include yarrow (*Achillea millefolium*), fireweed (*Chamerion angustifolium*), swamp willow herb (*Epilobium palustre*), common cowparsnip (*Heracleum maximum*), aster (*Symphyotrichum* species), western meadow rue (*Thalictrum occidentale*), Canada goldenrod (*Solidago canadensis*), starry solomon's seal (*Maianthemum stellatum*), clasping-leaf twisted stalk (*Streptopus amplexicaulus*) and western sagewort (*Artemisia ludoviciana*). Fern and fern ally cover is often high and includes species such as American ladyfern (*Athyrium filix-femina*), oak fern (*Gymnocarpium dryopteris*), and horsetails (*Equisetum* species).

Flooding in these systems influences community composition by transporting sediments and creating establishment sites for colonization. Plants have acquired adaptive traits to survive in these high-energy flood-disturbance settings. Many plants have flexible, resilient stems and specialized cells to hold oxygen so that they can survive large flood events; some have reproductive adaptations like water-dispersed seeds and are able to sprout quickly from damaged stumps.

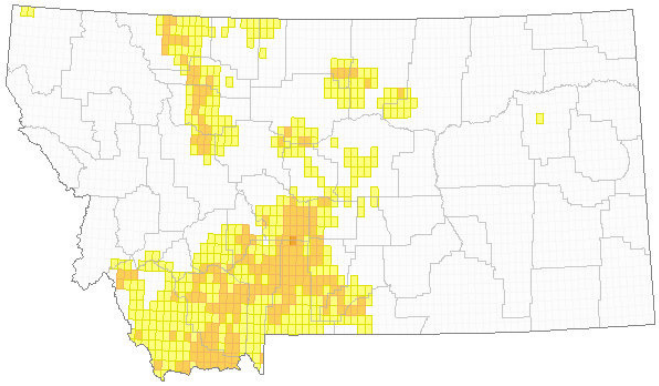
Dynamic Processes

Stochastic flood events and variable fluvial conditions are crucial to the development of establishment sites for riparian plants, and exert a primary control on plant succession. In areas with steep gradients, high-energy flows precipitated by snowmelt, rain-on-snow events or convective thunderstorms lead to floods, which in turn scour and transport coarse sediments. The scouring out and downstream accumulation constantly creates and destroys sites for the establishment of vegetation. Gravel bars are created at or near the surface of the river, where vegetation colonizes. As the gravel and point bars extend, mixed vegetation bands grow up, representing different stages of succession. The vegetation traps even more sediment, so that over time the size and height of the gravel bar increases. As gravel bar height increases, backwater channels can establish. These channels hold early runoff for an extended time, and are also fed by ground water seepage. Further from the channel, groundwater recharge from snowmelt may create shallow water tables or seeps that support vegetation when stream flow is low.

Wetland and Riparian Systems
Floodplain and Riparian

Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9156



Approximately 1,474 square kilometers are classified as Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* This system has an extensive distribution across Montana, although many occurrences have been impacted by hydrologic modification and adjacent land use, especially in valleys.

Environment

This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Occurrences are found within the flood zone of major rivers and the associated islands, sand or cobble bars, and along adjacent streambanks. It can occur as a large, wide patch on mid-channel islands in larger rivers or as narrow bands along small, rocky canyon tributaries and on well-drained benches. It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplains swales and irrigation ditches. Elevations generally range from 945 to 2,042 meters (3,100 to 6,700 feet) (Hansen et al., 1995). Soils are usually Entisols or, less commonly, Inceptisols with an organic A horizon of less than ten centimeters. Coarse textured substrates allow for rapid movement of highly aerated water. The water table can drop during late summer, but soils remain moist due to capillary action.

Similar Systems

- Rocky Mountain Subalpine-Montane Riparian Woodland

Vegetation

Because of the frequent disturbance regime, this system usually occurs as a mosaic of shrub and tree dominant communities. Dominant trees may include boxelder maple, narrowleaf cottonwood, Plains cottonwood, Douglas-fir, peachleaf willow, or Rocky Mountain juniper. In central and eastern Montana, narrowleaf cottonwood frequently dominates the overstory. Dominant shrubs include Rocky Mountain maple, thinleaf alder, river birch, redoiser dogwood, hawthorn, chokecherry, skunkbush, Drummond's willow, sandbar willow, Pacific willow, silver buffaloberry, rose or snowberry. Russian olive and saltcedar may invade some stands in southeastern and south-central Montana.

The herbaceous understory usually includes colonizing native forbs such as yarrow (*Achillea millefolium*), Canada goldenrod (*Solidago canadensis*), American licorice (*Glycyrrhiza lepidota*), Canada horseweed (*Conyza canadensis*) and exotics such as Canada thistle (*Cirsium arvense*) and common dandelion (*Taraxacum officinale*). Exotic grasses such as redtop (*Agrostis stolonifera*), Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*Poa pratensis*), common timothy (*Phleum pratense*) and reed canarygrass (*Phalaris arundinacea*) can dominate the graminoid layer if this system adjoins cultivated areas or disturbed upland communities. Generally, some stands may have a small component of native graminoid species like slimstem reedgrass (*Calamagrostis stricta*) or wheatgrasses (*Elymus* species) (Hansen et al., 1995). Wet meadow patches adjoining or asscociated with this system often contain woolly sedge (*Carex pellita*), clustered field sedge (*Carex praegracilis*), Baltic rush (*Juncus balticus*), and bluejoint reedgrass (*Calamagrostis canadensis*).

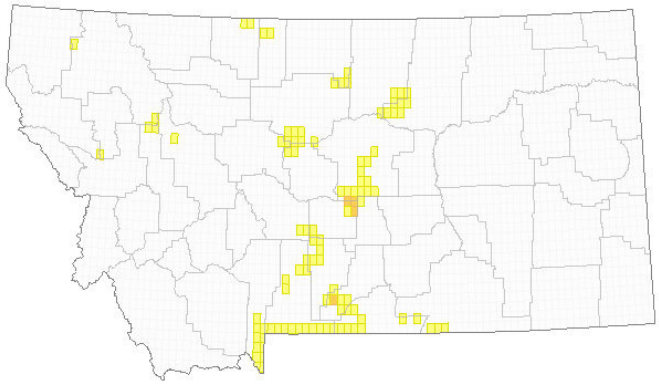
Dynamic Processes

Flooding is crucial to the development of establishment sites for cottonwood, and acts as primary control on plant succession. Steep gradients and high-energy flows driven by precipitation cause flooding events that transport coarse sediments. The scouring out and downstream accumulation of sediments constantly creates and destroys sites for the establishment of vegetation. Sediment accumulating in these systems often creates gravel bars at or near the surface of the river, creating bands of mixed vegetation occupying different stages of succession. Increasing vegetation traps even more sediment, so that over time the size and height of the gravel bar increases. Cottonwood and the associated shrub understory are adapted to these flooding events.

Wetland and Riparian Systems
Floodplain and Riparian

Rocky Mountain Subalpine-Montane Riparian Shrubland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9187



Approximately 46 square kilometers are classified as Rocky Mountain Subalpine-Montane Riparian Shrubland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S5

Environment

This riparian system is a seasonally flooded shrubland found at montane to subalpine elevations of the Rocky Mountains. In Montana, this system typically occurs at elevations between 1,750 and 2,693 meters (5,740-8,830 feet). This system consists of narrow bands of shrub vegetation lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels. This system is also typical around seeps, fens, and isolated springs on hillslopes away from valley bottoms. Sediment that accumulates in these systems may create gravel bars at or near the surface of the river where colonizing vegetation creates bands of mixed vegetation that occupy different stages of succession (Melanson and Butler, 1991). Ground water seepage from snowmelt may create shallow water tables or seeps that vegetation depends on for a portion of the growing season.

Similar Systems

- Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
- Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland
- Rocky Mountain Subalpine-Montane Riparian Woodland

Vegetation

Plant community composition and structure can vary depending on latitude, elevation and climate. For example, in southwest Montana Drummond's willow occupies higher elevations while Geyer's willow and booth willow are found at more intermediate elevations. In the northwest region of Montana, Geyer's and booth willow are barely present and Drummond's willow dominates most riparian areas (Hansen et al, 1995). Bebb's willow, planeleaf willow, undergreen willow and Idaho willow are frequent associates. Barclay's willow (*Salix barclayi*), shortfruit willow (*Salix brachycarpa*) and grayleaf willow (*Salix glauca*) become common at higher subalpine elevations. Sageleaf willow (*Salix candida*) is indicative of fens and occurs in association with other willow species to form the shrub-dominated carr layers within riparian areas feeding into or out of fens. Redoiser dogwood (*Cornus sericea*), shrubby cinquefoil (*Dasiphora fruticosa*), alder (*Alnus spp.*), currant (*Ribes spp.)* and Rocky Mountain maple (*Acer glabrum*) are common associates. Water birch (*Betula occidentalis*) or bog birch (*Betula nana, glandulosa*) may also be present.

Dominant graminoid vegetation in the herbaceous stratum of these shrubland riparian systems includes bluejoint reedgrass, northern reedgrass and Northwest Territory sedge. Common forbs include dwarf fireweed (*Chamerion latifolium*), field mint (*Mentha arvensis*), glaucous willowherb (*Epilobium glaberrimum*), western mountain aster (*Symphyotrichum spathulatum*), and tiny trumpets (*Collomia linearis*). Sharptooth angelica (*Angelica arguta*), starry solomon's seal (*Maianthemum stellatum*), sweet-cicely (*Osmorhiza* species), common cow parsnip (*Heracleum maximum*), clasp-leaf twisted stalk (*Streptopus amplexifolius*) and green false hellebore (*Veratrum viride*) are frequent at higher elevations. Within rich fen-carr shrublands, graminoid and forb species diversity is typically higher than other sites supporting these riparian shrublands.

Flooding in these systems influences vegetative communities by transporting sediments and creating establishment sites for colonization. Many plants in these high-energy systems that experience large disturbances from floods have acquired adaptive traits. Some have flexible, resilient stems and specialized cells to hold oxygen so that they can survive large flood events. These species also have reproductive adaptations such as water-dispersed seeds and are able to sprout quickly from flood damaged stumps. Ground water seepage from snowmelt may create shallow water tables or seeps that vegetation depends on for a portion of the growing season. Sites that are over-browsed will become dominated by Bebb willow, a shrub that is more resilient to heavy grazing. In sites where there is prolonged disturbance, willow coverage will decrease, resulting in a more open canopy. Herbaceous vegetation will transition to a grass-dominated system including fowl bluegrass (*Poa palustris*), Kentucky bluegrass (*Poa pratensis*) and field horsetail (*Equisetum arvense*) (Hansen et al, 1995).

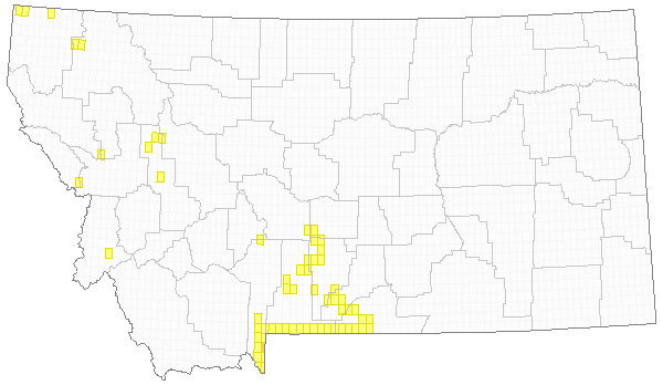
Dynamic Processes

Stochastic flood events and variable fluvial conditions are crucial to the development of establishment sites for riparian plants, and act as a primary control on plant succession. Steep gradients and high-energy flows controlled by precipitation cause flooding events that transport coarse sediments. Scouring out and accumulation of sediments constantly creates and destroys sites for the establishment of vegetation (Melanson and Butler, 1991). Accumulating sediments often create gravel bars at or near the surface of the water where colonizing vegetation creates bands of mixed vegetation occupying different stages of succession (Melanson and Butler, 1991). Ground water seepage from snowmelt may create shallow water tables or seeps that vegetation depends on for a portion of the growing season when stream flow is low.

Wetland and Riparian Systems
Floodplain and Riparian

Rocky Mountain Subalpine-Montane Riparian Woodland

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9171



Approximately 21 square kilometers are classified as Rocky Mountain Subalpine-Montane Riparian Woodland in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

Environment

This riparian woodland system includes seasonally flooded forests and woodlands found at montane to subalpine elevations of the Rocky Mountains. Stands typically occur at elevations between 4,600-8,800 feet. This system is common to the poorly-developed floodplains and terraces of V-shaped, narrow valleys and canyons, and less frequently, it occurs in moderate to wide valley bottoms on large floodplains along broad, meandering rivers such as the South Fork of the Flathead, and on pond or lake margins. In subalpine environments where there are steep gradients and high-energy flows controlled by precipitation and hydrological events, the transport and accumulation of sediments constantly creates and destroys sites for the establishment of vegetation (Melanson and Butler, 1991).

Similar Systems

- Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
- Rocky Mountain Subalpine-Montane Riparian Shrubland

Vegetation

Vegetation composition and structure can vary depending on latitude, elevation and climate. A woody riparian area in the subalpine zone of the Rocky Mountains in Montana is typically dominated by grand fir, subalpine fir and Engelmann spruce. Grand fir and Engelmann spruce are considered late seral species, while subalpine fir is predominantly found in climax communities at higher elevations or at lower elevations in frost pockets (Hansen et al., 1995). In the montane zone, dominant vegetation changes to a community dominated by ponderosa pine, western larch (*Larix occidentalis*) and Douglas fir (*Pseudotsuga menziesii*). Western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*) occur in moister sites west of the Continental Divide, and Some sites support Rocky Mountain juniper. The understory is typically sparse, but along the banks and on gravel bars, willow, alder and redosier dogwood can be present. Some sites support scattered black cottonwood (*Populus balsamnifera*) and/or small stands of quaking aspen (*Populus tremuloides*). The vegetation in these systems relies on a consistent shallow water table to meet individual plant requirements; however, periodic flooding is necessary for community maintenance. Flooding transports sediments and creates establishment sites for plant colonization. Many plants have acquired adaptive traits as a result of this disturbance regime. Mechanical adaptations such as stem flexibility and specialized oxygen-holding cells assist riparian plants to endure through the physical strains of flooding. Reproductive adaptations, including water-dispersible seeds, vegetative budding, and adventitious roots allow plants to colonize and regenerate by seed and asexual methods.

The understory shrub species often form in a narrow band in the gravel bars and embankments along the stream channel. In the montane zone, species such as thinleaf alder (*Alnus incana*), redoiser dogwood and willows such as Bebb's willow (*Salix bebbiana*), Booth's willow (*Salix boothii*), Drummond's willow (*Salix drummondiana*), dusky willow (*Salix melanopsis*), and Geyer's willow (*Salix geyeriana*) are common. In western Montana riparian forests dominated by spruce or subalpine fir, devil's club (*Oplopanax horridus*) may be a codominate in the understory, but this is an infrequent plant association. Other minor shrubs include thimbleberry (*Rubus parviflorus*), elderberry (*Sambucus species*), Douglas hawthorn (*Crataegus douglasii*), black twinberry (*Lonicera involucrata*), alder buckthorn (*Rhamnus alnifolia*), serviceberry (*Amelanchier alnifolia*), common snowberry (*Symphoricarpos albus*) and Woods' rose (*Rosa woodsii*).

In the subalpine elevations, sitka alder (*Alnus viridis*) and Drummond's willow are frequently dominant. Water birch (*Betula occidentalis*) or resin birch (*Betula glandulosa*) may also be present. Planeleaf willow (*Salix planifolia*), undergreen willow (*Salix commutata*), Barclay's willow (*Salix barclayi*), shortfruit willow (*Salix brachycarpa*) and grayleaf willow (*Salix glauca*) become common at higher elevations. Herbaceous vegetation forms a minor component of this system but may include small patches of bluejoint reedgrass (*Calamagrostis canadensis*), drooping woodreed (*Cinna latifolia*) and sedges such water sedge (*Carex aquatilis*). Common forbs include arrowleaf groundsel (*Senecio triangularis*), angelica (*Angelica spp.)* baneberry (*Actaea rubra*) western meadow rue (*Thalictrum occidentale*), starry solomon's seal (*Maianthemum stellatum*), fragrant bedstraw (*Galium triflorum*), Virginia strawberry (*Fragaria virginiana*), sweet-cicely (*Osmorhiza* species), common cow parsnip (*Heracleum maximum*), clasp-leaf twistedstalk (*Streptopus amplexifolius*) and green false hellebore (*Veratrum viride*). Common ferns and fern allies are often present, such as horsetail (*Equisetum* species), American ladyfern (*Athryium filix-femina*), and oak fern (*Gymnocarpium dryopteris*).

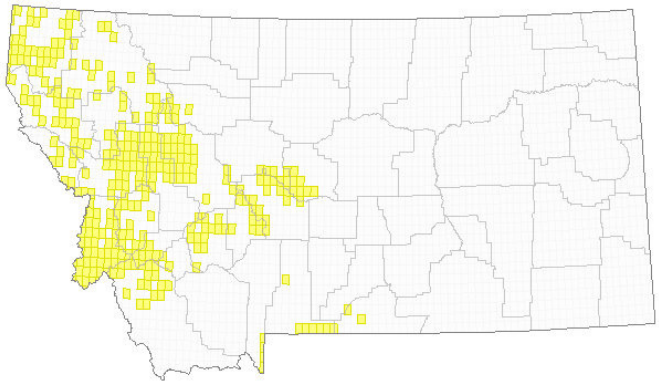
Dynamic Processes

Stochastic flood events and variable fluvial conditions are crucial to the development of establishment sites for riparian plants, and actl as a primary control on plant succession. Steep gradients and high-energy flows controlled by precipitation causes flooding events that transport sediments. The scouring out and accumulation of sediments creates and destroys sites for the establishment of vegetation (Melanson and Butler, 1991). Sediment accumulating in more meandering examples of these systems often creates gravel bars at or near the surface of the water where colonizing vegetation creates bands of mixed vegetation that occupies different stages of succession (Melanson and Butler, 1991). Ground water seepage from snowmelt may create shallow water tables or seeps that vegetation depends on for a portion of the growing season

Wetland and Riparian Systems
Forested Marsh

Rocky Mountain Conifer Swamp

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9111



Approximately 6 square kilometers are classified as Rocky Mountain Conifer Swamp in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S1

* This is a system with limited occurrence in Montana. Drought and climate change are the major stressors; increased fire frequency or intensity, or loss of overstory vegetation, may also alter dynamics.

Environment

This system is dominated by coniferous trees on poorly drained soils that are saturated year-round or are subjected to seasonal flooding during spring months. These forests are found on flat to gently sloping lowlands, but also occur up to the lower limits of continuous forest. In northwestern Montana, these uncommon wetland forests occur most frequently in depressions on valley bottoms. However, they can occur on steeper slopes where soils are shallow over unfractured bedrock. Soils in these systems are poorly drained and can be organic peat or muck, but are more commonly mineral soils with an A horizon of 10 centimeters (4 inches) or less. Surface horizons usually have high organic matter, and redox depletions are found in moist subsoil. Water tables are typically within 50 centimeters (20 inches) of the soil surface throughout the year, with standing water in surface depressions. Generally, there is both moving and stagnant water within these forests. The system is often seen as an ecotone gradient between fens, wet meadows or marshes and mesic, upland coniferous forests. Some occurrences develop in spring-fed areas adjacent to lakes and ponds, but the system is most often found on benches, toeslopes or valley bottoms along mountain streams. At higher elevations, subalpine fir-bluejoint reedgrass (*Abies lasiocarpa- Calamagrostis canadensis*) forests are found along sub-irrigated stream terraces, pond margins and wet meadows (Pfister et al 1977).

Vegetation

In conifer dominated swamps, the understory vegetation is characterized by high cover of ferns and fern allies such as American ladyfern (*Athyrium filix-femina*), woodfern *(Dryopteris* species), and horsetail (*Equisetum* species). Common graminoids include bluejoint reedgrass (*Calamagrostis canadensis*), beaked sedge (*Carex utriculata*) and softleaf sedge (*Carex disperma*).

In spruce- (*Picea* species) dominated swamps in the Flathead Valley, skunk cabbage (*Lysichiton americanus*) can form a nearly continuous cover in the understory. American ladyfern is often co-dominant on these sites. In other spruce-dominated occurrences, field horsetail (*Equisetum arvense*) or common horsetail (*Equisetum hyemale*) and American ladyfern are frequently the dominant species in the understory. Other forbs include arrowleaf groundsel (*Senecio triangularis),* Brewer's miterwort (*Mitella breweri*), five stamen miterwort (*Mitella pentandra*)*,* bunchberry dogwood (*Cornus canadensis*), dwarf red blackberry (*Rubus pubescens*), twisted stalk (*Streptopus amplexifolius*), and Canada violet (*Viola canadensis*) (Hansen et al., 1995). Orchids such as one leaf orchid (*Ameorchis rotundifolia*), sparrow's egg ladyslipper (*Cypripedium passerinum*) and small yellow ladyslipper (*Cypripedium parviflorum*) may occur on hummocks formed around base of trees and shrubs, especially in spruce swamps occurring adjacent to extremely rich fens. The shrub canopy may include thinleaf alder (*Alnus incana*), water birch (*Betula occidentalis*), dwarf birch (*Betula nana*) and redoiser dogwood (*Cornus sericea*).

In northwestern Montana, swamps of western redcedar (*Thuja plicata*) and western hemlock (*Tsuga occidentalis*) are largely confined to toeslopes and valley bottoms below 1,280 meters (4,200 feet). In these swamps, devil's club (*Oplopanax horridum*) is the dominant shrub. Pacific yew (*Taxus brevifolia*) is often present. The herbaceous understory includes American skunk cabbage, American ladyfern, oak fern (*Gymnocarpium dryopteris*), wild ginger (*Asarum caudatum*), foam flower (*Tiarella trifoliata*), starry solomon's seal (*Maianthemum stellatum*), and fragrant bedstraw (*Galium triflorum*).

Subalpine fir (*Abies lasiocarpa*) swamps are infrequently represented in Montana, but floristically, they are very similar to western red cedar swamps. This minor type occurs in colder areas between 1,188 to 1,324 meters (3,900 to 5,000 feet) in northwestern Montana (Pfister et al., 1977). However, subalpine fir-bluejoint reedgrass systems are common throughout Montana up to the subalpine elevations. Shrub cover is low and is usually represented by alder (*Alnus* species). Bluejoint reedgrass dominates the understory vegetation. Associated forbs include lanceleaf arnica (*Arnica latifolia*), Canadian horseweed (*Conyza canadensis*), Idaho licorice root (*Ligusticum tenuifolium*), and brook saxifrage (*Saxifraga arguta*).

Dynamic Processes

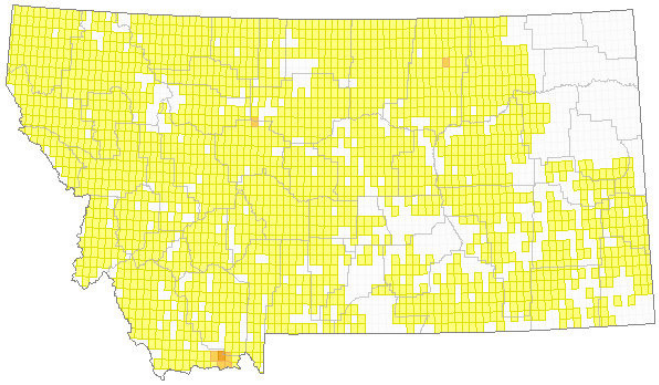
Due to the high water tables, trees are very susceptible to windthrow. Fire is very infrequent. Mortality from spruce budworm outbreaks in adjacent upland forests may affect this system.

Wetland and Riparian Systems
Herbaceous Marsh

Emergent Marsh

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9222

Provisional State Rank: S4



Approximately 247 square kilometers are classified as Emergent Marsh in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Environment

This system is found in environments where precipitation is approximately 25 to 50 centimeters (10 to 20 inches) per year. In Montana, this system is typically found in depressions surrounded by an upland matrix of mixed prairie, shrub steppe, steppe vegetation and forests near the mountains. Natural marshes occur in and adjacent to ponds and prairie potholes, as fringes around lakes or oxbows, and along slow-flowing streams and rivers as riparian marshes. Water chemistry may be alkaline or semi-alkaline, but is highly variable even within the same complex of wetlands. Marshes have distinctive soils that are typically mineral, but can also accumulate organic material. Soils characteristics reflect long periods of anaerobic conditions, with gleying, high organic content, and redoximorphic features. Wetland marshes are classified as either seasonal or semi-permanent based on the dominant vegetation found in the deepest portion of the wetland (Stewart and Kantrud, 1971 and LaBaugh et al., 1996). Vegetation communities occurring in these marsh systems is representative of their hydroperiod; some basins dry to bare soil after seasonal flooding, while others will have a variety of wetland types in a zoned pattern dependent on seasonal water table depths and salt concentrations (Kudray and Cooper, 2006).

Vegetation

Vegetation communities change according to wet-drought cycles. In seasonal ponds that dry out annually, and in semipermanent wetlands during drought years, buried seeds of both annuals and perennials germinate, covering exposed mud flats (Hansen et al., 1995). In semi-permanent marshes, the drawdown zone is typically dominated by western wheat grass (*Pascopyrum smithii)* near the upland edge, with Northwest Territory sedge (*Carex utriculata*) and Nebraska sedge (*Carex nebrascensis*) as the dominant sedges located down gradient, and broadleaf cattail (*Typha latifolia*) and hardstem bulrush (*Schoenoplectus acutus*) located in the deeper, central portion of the marsh. Water sedge (*Carex aquatilis*) is frequently co-dominant with Northwest Territory sedge. Less commonly, blister sedge (*Carex vesicaria*) and awned sedge (*Carex atherodes*) are intermixed with Northwest Territory sedge or occur as co-dominants on similar sites. Beyond the emergent vegetation, floating-leaved hydrophytes may be present in wetter sites with longer inundation periods, including water lilies (*Nymphaea* species), yellow pondlily (*Nuphar* species), buttercup (*Ranunculus* species) and pondweed (*Potamogeton* species). Other floating species may be present in shallow water, such as duckweed, (*Lemna* species), and submergents such as common hornwort (*Ceratophyllum demersum*), horned pondweed (*Zannichellia palustris*), mare's tail (*Hippuris vulgaris*) and water milfoil (*Myriophyllum* species).

Seasonal marshes are typically dominated by western wheat grass (*Pascopyrum smithii*), beaked sedge (*Carex utriculata*), inflated sedge (*Carex vesicaria*), Nebraska sedge (*Carex nebrascensis*), creeping spikerush (*Eleocharis palustris*), Baltic rush (*Juncus balticus*) and cattail (*Typha latifolia or angustifolia*). During wetter years, annuals disappear and marshes become dominated by emergent perennials. Common perennial forbs include common willow herb (*Epilobium ciliatum*), marsh cinquefoil (*Potentilla palustris*), Gmelin's buttercup (*Ranunculus gmelinii*), greater creeping spearwort (*Ranunculus flammula*), hemlock water parsnip (*Sium suave*), willow dock (*Rumex salicifolius*), field mint (*Mentha arvensis),* leafy aster (*Symphyotrichum foliaceum)* and broadleaf arrowhead (*Sagittaria latifolia*). Fern allies such as water horsetail (*Equisetum fluviatile*) and field horsetail (*Equisetum arvense*) often form significant cover within seasonal marshes. Grasses common to marshes include small floating mannagrass (*Glyceria borealis*), tufted hairgrass (*Deschampsia caespitosa*), and bluejoint reedgrass (*Calamagrostis canadensis*).

Seasonal and semi-permanent marshes with more alkaline water chemistry are commonly found throughout central and eastern Montana. Typical species include hardstem bulrush, cattail, common threesquare (*Schoenoplectus pungens*), alkali bulrush (*Schoenoplectus maritimus*) and inland saltgrass (*Distichlis spicata*), red swampfire (*Salicornia rubra*) and prairie cordgrass (*Spartina pectinata*) in adjacent drawdown zones. These marsh communities are brackish and support species adapted to saline and alkaline water and soil conditions, similar to Western Great Plains Saline Depression systems.

Typically, riverine marshes subjected to unaltered, seasonal water flow and annual flooding are characterized by zonal vegetation determined by water depth with stands of bulrush (*Schoenoplectus* species), softstem bulrush (*Schoenplectus tabernaemontani*), and cattail in deeper water, and manna grass (*Glyceria* species), water sedge, inflated sedge, water horsetail and common spikerush in shallower water zones. Riverine marshes can be influenced by beaver activity and human caused influences that can change the structure and species richness of these plant communities. Beaver activity can increase species richness and diversify community structure by altering water flow, depth, and organic sediment accumulation.

Dynamic Processes

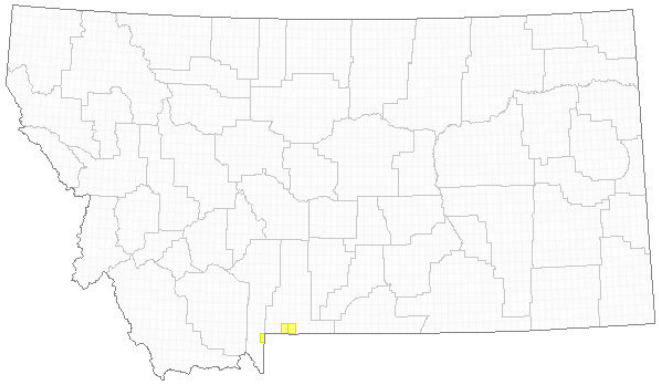
Wet-drought year climatic cycles in Montana, often in 10 to 20 year cycles, influence the ecological communities in these systems (Hansen et al., 1995). During this climatic cycle, wetlands go through a dry marsh, regenerating marsh, degenerating marsh and a lake phase that is regulated by periodic drought and deluge (Mitsch and Gosselink, 2000). During drought periods, seeds from annuals and perennials germinate and cover exposed mud flats, but when precipitation floods the depressions, the annuals drown and the perennials survive, regenerating the marsh. Over a series of years, perennials dominate and submersed and floating-leaved hydrophytes return. After a few years of the regenerating phase, emergent vegetation begins to decline and eventually the marsh reverts to an open water system. Muskrats may play an important role in the decline of emergent vegetation in some of these systems. During drought, the drawdown to mudflats is necessary so that emergent vegetation can become reestablished. Flooding, drawdown and the eventual exposure of mud flats drive the water-level vegetation cycle. In saline soil marshes, increase in precipitation during exceptionally wet years can dilute the salt concentration in the soils, allowing for less salt-tolerant species to occur.

Species richness can vary considerably among individual examples and is especially influenced by adjacent land use. Agriculture and forestry operations, when adjacent, may cause nutrient and herbicide runoff.

Wetland and Riparian Systems
Open Water

Geysers and Hot Springs

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=5000

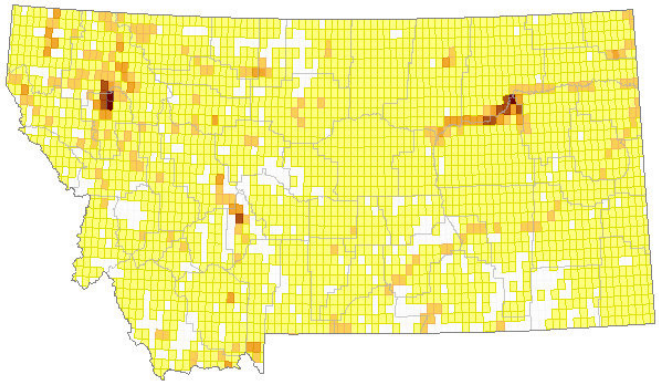


Less than 1 square kilometer is classified as <%=SNAME%> in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank:

Open Water

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=11



Approximately 3,470 square kilometers are classified as Open Water in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank:
* Open water state ranks vary by river, stream or water body type.

Environment

This system includes both natural and manmade water bodies. Although natural lakes and ponds are more common in headwater regions, manmade lakes, reservoirs and ponds are found throughout the state. The medium- to large rivers classified as open water are generally found in low-lying valley bottoms.

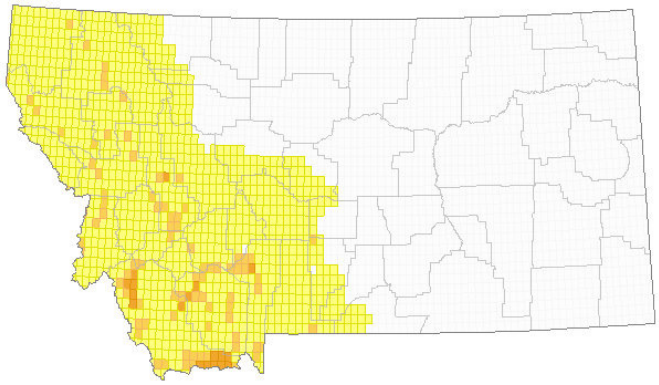
Vegetation

Emergent vegetation is not common in open water systems, except around the margins. Species associated with open water systems are those that tolerate permanent or semi-permanent flooding, such as sedges (*Carex spp.*), creeping spikerush (*Eleocharis palustris*), broadleaf cattail (*Typha latifolia*) and bulrush (*Schoenoplectus spp.*). Water sedge (*Carex aquatilis*) is frequently co-dominant with Northwest Territory sedge (*Carex utriculata*). Floating-leaved hydrophytes may be present in shallower areas of lakes, ponds and reservoirs, or in river backwaters. These include water lilies Nymphaea spp.), yellow pondlily (*Nuphar spp.*), buttercup (*Ranunculus spp.*), pondweed (*Potamogeton spp.*) and duckweed (*Lemna species*. Submergents such as common hornwort (*Ceratophyllum demersum*), horned pondweed (*Zannichellia palustris*), mare's tail (*Hippuris vulgaris*) and water milfoil (*Myriophyllum spp.*)are also found in warm, shallow areas of lakes, ponds and reservoirs.

Wetland and Riparian Systems
Wet meadow

Alpine-Montane Wet Meadow

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=9217



Approximately 1,273 square kilometers are classified as Alpine-Montane Wet Meadow in the 2013 Montana Land Cover layers. *Grid on map is based on USGS 7.5 minute quadrangle map boundaries.*

Provisional State Rank: S4

* This system is widespread from montane to subalpine elevations across Montana, and occurs frequently in protected areas. Climate change threatens the snowmelt-driven hydrology.

Environment

Moisture for these wet meadow community types comes from groundwater, stream discharge, overland flow, overbank flow, and precipitation. Salinity and alkalinity are generally low due to the frequent flushing of moisture through the meadow. Depending on the slope, topography, hydrology, soils and substrate, intermittent, ephemeral, or permanent pools may be present. Standing water may be present during some or all of the growing season, with water tables typically remaining at or near the soil surface. Fluctuations of the water table throughout the growing season are not uncommon, however. On drier sites supporting the less mesic types, the late-season water table may be one meter or more below the surface. Soils typically possess a high proportion of organic matter, but this may vary considerably depending on the frequency and magnitude of alluvial deposition. Organic composition of the soil may include a thin layer near the soil surface. Soils may exhibit gleying and/or mottling throughout the profile.

Similar Systems

- Rocky Mountain Subalpine-Montane Mesic Meadow

Vegetation

A variety of plant communities are found within this system in Montana. Composition and zonation of wet meadow plant communities represent the competitive abilities, moisture and nutrient requirements, and stress tolerance of anoxic conditions of individual plant species. Variability of water-table depth and reduced soil conditions, soil pH, and saturation duration, strongly influences the distribution and assemblage of species within a wet meadow. Obligate wetland species occur within a fairly restricted range of water-table depth, whereas many common species such as tufted hairgrass, Baltic rush (*Juncus balticus*) and Kentucky bluegrass (*Poa pratensis*) occur over wide ranges. Overlap in ranges of water-table depth for individual species suggests that small changes in hydrology could potentially result in shifts in dominance by different species, and ultimately replacement or loss of certain species.

Many alpine wet meadows throughout the state are dominated by tufted hairgrass, forming a dense stand of tussocks. The tufted hairgrass Temporarily Flooded Herbaceous Alliance has been found at elevations as high as 10,100 feet, but is much more common at lower elevations where it often occupies low gradient areas and slopes less than 15 percent, facing north to northeast (Cooper et al., 1997). This alliance is thought to be found in relatively undisturbed sites (Hansen et al., 1995), while more disturbed sites are dominated by Kentucky bluegrass (*Poa pratensis*), fowl bluegrass (*Poa palustris*), redtop (*Agrostis stolonifera*) and Baltic rush.

In southwestern Montana, wet meadow communities are dominated by species more characteristic of the Middle Rocky Mountains ecoregion, such as Holm's Rocky Mountain sedge (Cooper et al, 1999). Drier sites, especially those where soils and/or hydrology have been disturbed, may be characterized by Baltic rush and clustered field sedge (*Carex praegracilis*) communities. In the Northern Rocky Mountains, shortstalk sedge or Payson's sedge are dominant (Lesica, 2002), often found on slopes that range from zero to eight percent where the growing season lasts only for one to two months. In these northern occurrences, other common graminoids include small-head sedge, lens sedge (*Carex lenticularis*), smallwing sedge, black alpine sedge, beaked sedge (*Carex utriculata*), Drummond's rush, Merten's rush, arctic bluegrass, and alpine bluegrass. Common forbs include woolly pussytoes (*Antennaria lanata*), spreading globeflower, slender-sepal marsh marigold, arrow-leaf groundsel, elephant's head (*Pedicularis groenlandica*), small flowered anemone (*Anemone parviflora*), alpine bistort (*Polygonum viviparum*), Buek's groundsel (*Packera subnuda*), and Rocky Mountain goldenrod *(Solidago multiradiata*). Sibbaldia (*Sibbaldia procumbens*) often occurs in open areas within the turf or open peat. At more montane elevations, extensive shrubby cinquefoil (*Dasiphora fruticosa*) shrublands are frequently found adjacent to this system.

At montane elevations, zonation of wet meadow complexes is evident with sedges such as inflated sedges (*Carex utriculata* and *C. vescicaria*), wooly sedge (*Carex pellita*), Nebraska sedge (*Carex nebrascensis*) and water sedge (*Carex aquatilis*) occupying the wettest zone of the meadow complex. These sedge-dominated communities are typically surrounded by spikerushes (*Eleocharis spp.),* followed by a zone of grasses and forbs such as Baltic rush, bluejoint reedgrass (*Calamagrostis canadensis*), slimstem reedgrass (*Calamagrostis stricta*), pink elephant's head and water ragwort (*Senecio hydrophilus*).

Dynamic Processes

Communities associated with this ecological system are adapted to soils that may be flooded or saturated throughout the growing season. They may also occur on areas with soils that are only saturated early in the growing season, or intermittently during heavy convective storms in summer. Most appear to be relatively stable types, although in some areas these may be impacted by intensive livestock grazing.

Open Water
Large Valley River

Manmade Ditch or Canal

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1000

Provisional State Rank: SU

Open Water
Large Valley River

Northwestern Glaciated Plains Valley River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1110

Provisional State Rank: S3

* The stream river mile occurrence of this system in the state is fairly well known, and angler harvest is regulated for one member of the fish community group, the paddlefish. The Large Valley River type is an at risk system and supports one of the most endangered fish in the US, the pallid sturgeon (G1S1, USFWS federally endangered). Other fish in this community are Montana Species of Concern: sturgeon chub (S2), sicklefin chub (S1), and blue sucker (S2S3). It also contains the globally rare sand-dwelling mayfly group, which is currently ranked S1-S3 in Montana. The occurrence of numerous threatened, rare, and declining species, as well as consistent threats to the habitats required for spawning and rearing warrants a state rank of S3.

Environment

The Large Valley River type occurs in the Missouri River downstream from Great Falls, especially past the confluence with the Marias River, downstream below Fort Peck Reservoir to the North Dakota border and the Yellowstone River downstream from Billings to the Missouri River Confluence. The Yellowstone River transitional area to a characteristic Valley River begins below Billings to around Pompeys Pillar. Additionally, the Lower Powder, Tongue, and Big Horn Rivers have occurrences of the Large Valley River fish assemblage during spring run-off.

Vegetation

Riparian cottonwood stands as well as the floodplain dynamics that enhance recruitment of willows and cottonwood saplings must be maintained. Russian olive and salt cedar are widespread introduced species that have reached nuisance levels along some stretches of the Yellowstone, mostly from Laurel downstream.

Dynamic Processes

Fluvial processes play a key role in the dynamics of Great Plains rivers and streams. The nature of these processes is often indicated by channel morphology. Meandering channels generally have a shallow gradient, low flow variability, and sediment loads dominated by silt and finer particles, while braided channels are characterized by a moderately steep gradient, high flow variability, and sediment loads dominated by sand and coarser particles (Friedman, 2002). Flooding is the key ecosystem process whereby establishment sites for riparian vegetation are created, seeds are dispersed, and vegetative succession is controlled. However, since Euro-American settlement, natural fluvial processes have been disrupted in many of these systems by dams and diversions. Additional disruptions to the natural dynamics of this system include fire suppression, decreased flows and increased siltation rates due to agricultural activities, and the introduction of non-native fish species. Native grazers have been largely replaced by domestic cattle. Consequently, there has been a direct loss of woody plant diversity. Furthermore, both channel incision and channel widening have altered flooding regimes, leading to establishment of flood-intolerant species in many areas.

Open Water
Large Valley River

Northwestern Great Plains Valley River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1109

Provisional State Rank: S3

* The stream river mile occurrence of this system in the state is fairly well known, and angler harvest is regulated for one member of the fish community group, the paddlefish. The Large Valley River type is an at-risk system, containing one of the most endangered fish in the US, the pallid sturgeon (G1S1, USFWS federally endangered). Other fish in this community are Montana Species of Concern: sturgeon chub (S2), sicklefin chub (S1), and blue sucker (S2S3). It also contains the globally rare sand-dwelling mayfly group, which is currently ranked S1-S3 in Montana. The occurrence of numerous threatened, rare and declining species, and consistent threats to the habitats required for spawning and rearing warrants a state rank of S3.

Environment

The Large Valley River type occurs in the Missouri River downstream from Great Falls, especially past the confluence with the Marias River, downstream below Fort Peck Reservoir to the North Dakota border and the Yellowstone River downstream from Billings to the Missouri River Confluence. The Yellowstone River transitional area starts upstream of Billings to around Big Timber. Additionally, the Lower Powder, Tongue, and Big Horn Rivers have occurrences of the Large Valley River fish assemblage during spring run-off.

Vegetation

Riparian cottonwood stands as well as the flood plain dynamics that enhance recruitment of willows and cottonwood saplings must be maintained. Russian olive and salt cedar are widespread introduced species that have reached nuisance levels along some stretches of the Yellowstone, mostly from Laurel downstream.

Dynamic Processes

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Open Water

Large Intermountain Transitional River

Missouri Mainstem Intermountain Transitional River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1111

Provisional State Rank: S4

* A viable, fully functioning Mainstem Intermountain Transitional River is uncommon in the state. Diversion, flood control, and hydroelectric dams have significantly altered large portions of this Large River Ecosystem in Montana. Many of the native fish species that inhabited this river reach have been replaced by introduced salmonids (Rainbow and Brown Trout) and other predator fish (northern pike, walleye and smallmouth bass).

Environment

The environment within which this ecological system is found is typically the broad sage/grassland valleys with cottonwood riparian areas characteristic of the Central Broad Montana Valleys Ecoregion.

Vegetation

Riparian cottonwood stands as well as the flood plain dynamics that enhance recruitment of willows and cottonwood saplings must be maintained. Russian olive and salt cedar are widespread introduced species that have reached nuisance levels along some stretches of the Yellowstone, mostly from Laurel downstream.

Open Water

Large Intermountain Transitional River

Upper Yellowstone Intermountain Transitional River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1114

Provisional State Rank: S4

* A viable, fully functioning Mainstem Intermountain Transitional River is uncommon in the state. Diversion, flood control, and hydroelectric dams have significantly altered large portions of this Large River Ecosystem in Montana. Many of the native fish species that inhabited this river reach have been replaced by introduced salmonids (Rainbow and Brown Trout) and other predator fish (northern pike, walleye and smallmouth bass.

Vegetation

Riparian cottonwood stands as well as the flood plain dynamics that enhance recruitment of willows and cottonwood saplings must be maintained. Russian olive and salt cedar are widespread introduced species that have reached nuisance levels along some stretches of the Yellowstone, mostly from Laurel downstream.

Open Water

Large Intermountain Transitional River

Yellowstone Mainstem Intermountain Transitional River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1112

Provisional State Rank: S4

* A viable, fully functioning Mainstem Intermountain Transitional River is uncommon in the state. Diversion, flood control, and hydroelectric dams have significantly altered large portions of this Large River Ecosystem in Montana. Many of the native fish species that inhabited this river reach have been replaced by introduced salmonids (Rainbow and Brown Trout) and other predator fish (northern pike, walleye and smallmouth bass).

Vegetation

Riparian cottonwood stands as well as the flood plain dynamics that enhance recruitment of willows and cottonwood saplings must be maintained. Russian olive and salt cedar are widespread introduced species that have reached nuisance levels along some stretches of the Yellowstone River, largely from Laurel downstream.

Open Water
Large Prairie River

Northwestern Glaciated Large Prairie River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1131

Provisional State Rank: S3

* Diversion, flood control, and hydroelectric dams have significantly altered large portions of the Large Prairie River Ecological systems in Montana. The Powder River is the only undammed large prairie river remaining in the state. Many of the characteristic invertebrates of a properly functioning large prairie system are Globally Rare and only occur in a few river reaches in the state. At least one fish in this community is a Montana Species of Concern, the sturgeon chub (S2). It also contains the globally rare sand-dwelling mayfly group, whose members are currently ranked S1-S3 in Montana. The occurrence of numerous threatened, rare and declining species, and consistent ongoing threats of diversions and oil and gas production to the habitats required for spawning and rearing warrant a state rank of S3.

Vegetation

Riparian cottonwood stands as well as the flood plain dynamics that enhance recruitment of willows and cottonwood saplings must be maintained. Russian olive and salt cedar are widespread introduced species that have reached nuisance levels along some stretches of the Yellowstone, mostly from Laurel downstream.

Dynamic Processes

Fluvial processes play a key role in the dynamics of Great Plains rivers and streams. The nature of these processes is often indicated by channel morphology. Meandering channels generally have a shallow gradient, low flow variability, and sediment loads dominated by silt and finer particles, while braided channels are characterized by a moderately steep gradient, high flow variability, and sediment loads dominated by sand and coarser particles (Friedman, 2002). Flooding is the key ecosystem process whereby establishment sites for riparian vegetation are created, seeds are dispersed and vegetative succession is controlled. However, since Euro-American settlement, natural fluvial processes have been disrupted in many of these systems by dams and diversions. Modifications have included fire suppression, decreased flows and increased siltation rates due to agricultural activities, and the introduction of non-native fish species. Native grazers have been largely replaced by domestic cattle. Consequently, there has been a direct loss of woody plant diversity. Furthermore, both channel incision and channel widening have altered flooding regimes, leading to establishment of flood-intolerant species in many areas.

Open Water
Large Prairie River

Northwestern Great Plains Large Prairie River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1130

Provisional State Rank: S3

* Diversion, flood control, and hydroelectric dams have significantly altered large portions of the Large Prairie River Ecological systems in MT. The Powder River is the only undammed large prairie river left in the state. Many of the characteristic invertebrates of a properly functioning large prairie system are Globally Rare and only occur in a few river reaches in the state. At least one fish in this community is a Montana Species of Concern, the sturgeon chub (S2). It also contains the globally rare sand-dwelling mayfly group, whose members are currently ranked S1-S3 in Montana. The occurrence of numerous threatened, rare and declining species, and consistent ongoing threats of diversions and oil and gas production to the habitats required for spawning and rearing warrant a state rank of S3.

Vegetation

Riparian cottonwood stands as well as the flood plain dynamics that enhance recruitment of willows and cottonwood saplings must be maintained. Russian olive and salt cedar are widespread introduced species that have reached nuisance levels along some stretches of the Yellowstone, mostly from Laurel downstream.

Dynamic Processes

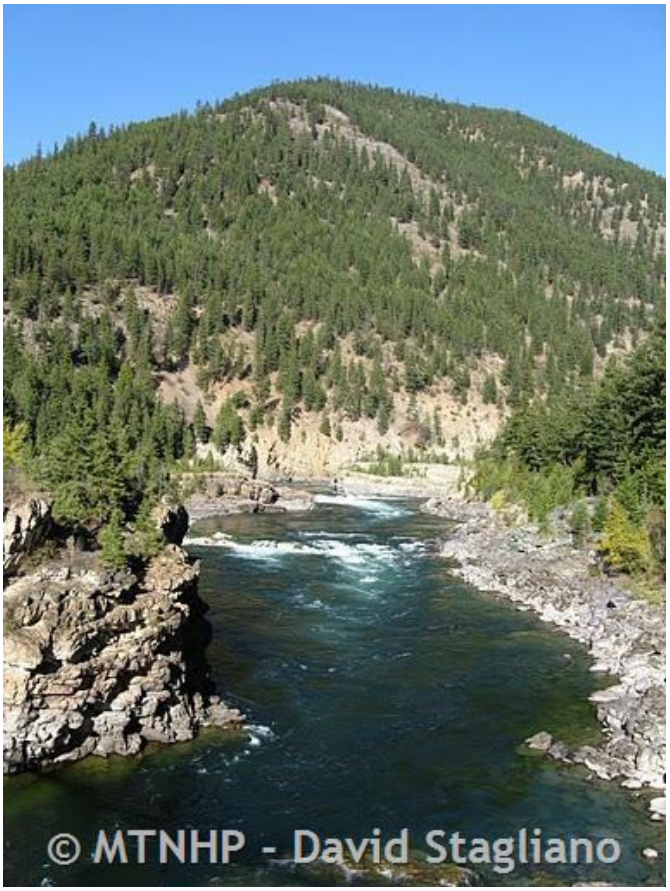
Fluvial processes play a key role in the dynamics of Great Plains rivers and streams. The nature of these processes is often indicated by channel morphology. Meandering channels generally have a shallow gradient, low flow variability, and sediment loads dominated by silt and finer particles, while braided channels are characterized by a moderately steep gradient, high flow variability, and sediment loads dominated by sand and coarser particles (Friedman, 2002). Flooding is the key ecosystem process whereby establishment sites for riparian vegetation are created, seeds are dispersed, and vegetative succession is controlled. However, since Euro-American settlement, natural fluvial processes have been disrupted in many of these systems by dams and diversions. Fire has been suppressed, agricultural activities have decreased flows and increased siltation rates, and introduction of non-native fish species have all had consequences. Native grazers have been largely replaced by domestic cattle. Consequently, there has been a direct loss of woody plant diversity. Furthermore, both channel incision and channel widening have altered flooding regimes, leading to establishment of flood-intolerant species in many areas.

Open Water

Large Valley Intermountain River

Large Glaciated Valley Intermountain River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1151



Provisional State Rank: S4

* Diversion, flood control, and hydroelectric dams have significantly altered large portions of this Large River Ecosystem in Montana. Threatened White Sturgeon and Bull Trout populations have been affected by Libby Dam operations for the last 40 years.

Open Water
Large Valley Intermountain River

Large Valley Intermountain River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1150

Provisional State Rank: S4

* Diversion, flood control and hydro dams have significantly altered large portions of this Large River Ecosystem in MT.

Open Water

Medium Intermountain Transitional River

Isolated Range Intermountain Transitional River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1212

Provisional State Rank: S5

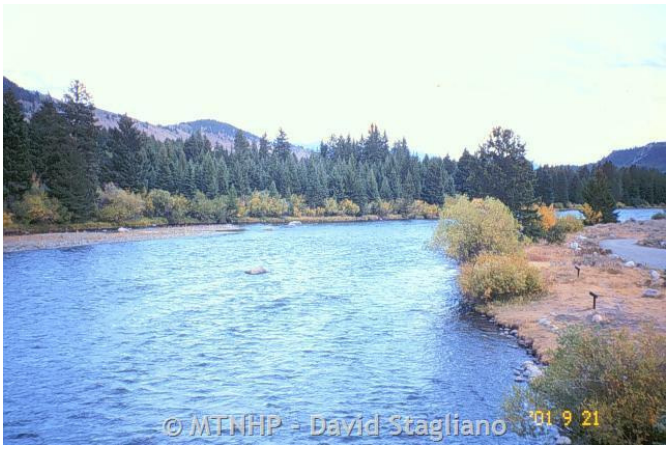
* Although widespread and with many representative river reaches in the state, this ecosystem is heavily affected by small dams, water diversions, stock ponds and introduced gamefish species that have had significant negative impacts on this community. Therefore, biologically intact river miles of this ecological system are rare.

Open Water

Medium Intermountain Transitional River

Medium Southwest Montana Basin Intermountain Transitional River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1210



Provisional State Rank: S5

* Although widespread and with many representative river reaches in the state, this ecosystem is heavily affected by small dams, water diversions, stock ponds, and introduced gamefish species that have had significant negative impacts on this community. Therefore, biologically intact river miles of this ecological system are rare.

Open Water

Medium Intermountain Transitional River

Medium Intermountain Transitional River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1211

Provisional State Rank: S5

* Although widespread and with many representative river reaches in the state, this ecosystem is heavily effected by small dams, water diversions, stock ponds and introduced gamefish species that have had significant negative impacts on this community. Therefore, it is fairly rare to find biologically intact river miles of this ecological system.

Open Water

Medium Intermountain Transitional River

Yellowstone Highland Intermountain Transitional River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1213

Provisional State Rank: S5

* Although widespread and with many representative river reaches in the state, this ecosystem is heavily affected by small dams, water diversions, stock ponds, and introduced gamefish species that have had significant negative impacts on this community. Therefore, examples of biologically intact river miles of this ecological system are rare.

Open Water
Medium Prairie River

Northwestern Glaciated Plains Medium Prairie River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1251

Provisional State Rank: S4

* Although this ecosystem is widespread and has many representative river reaches in the state, it is heavily affected by small dams, water diversions, stock ponds, and introduced gamefish species that have had significant negative impacts on this community. Therefore, examples of biologically intact river miles of this ecological system are rare.

Dynamic Processes

Fluvial processes play a key role in the dynamics of Great Plains rivers and streams. The nature of these processes is often indicated by channel morphology. Meandering channels generally have a shallow gradient, low flow variability, and sediment loads dominated by silt and finer particles, while braided channels are characterized by a moderately steep gradient, high flow variability, and sediment loads dominated by sand and coarser particles (Friedman, 2002). Flooding is the key ecosystem process whereby establishment sites for riparian vegetation are created, seeds are dispersed, and vegetative succession is controlled. However, since Euro-American settlement, natural fluvial processes have been disrupted in many of these systems by dams and diversions. Other disturbances include fire suppression, decreased flows and increased siltation rates due to agricultural activities, and the introduction of non-native fish species. Native grazers have been largely replaced by domestic cattle. Consequently, there has been a direct loss of woody plant diversity. Furthermore, both channel incision and channel widening have altered flooding regimes, leading to establishment of flood-intolerant species in many areas.

Open Water
Medium Prairie River

Northwestern Great Plains Medium Prairie River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1250

Provisional State Rank: S4

* Although widespread and with many representative river reaches in the state, this ecosystem is heavily affected by small dams, water diversions, stock ponds, and introduced gamefish species that have had significant negative impacts on this community. Therefore, examples of biologically intact river miles of this ecological system are rare.

Dynamic Processes

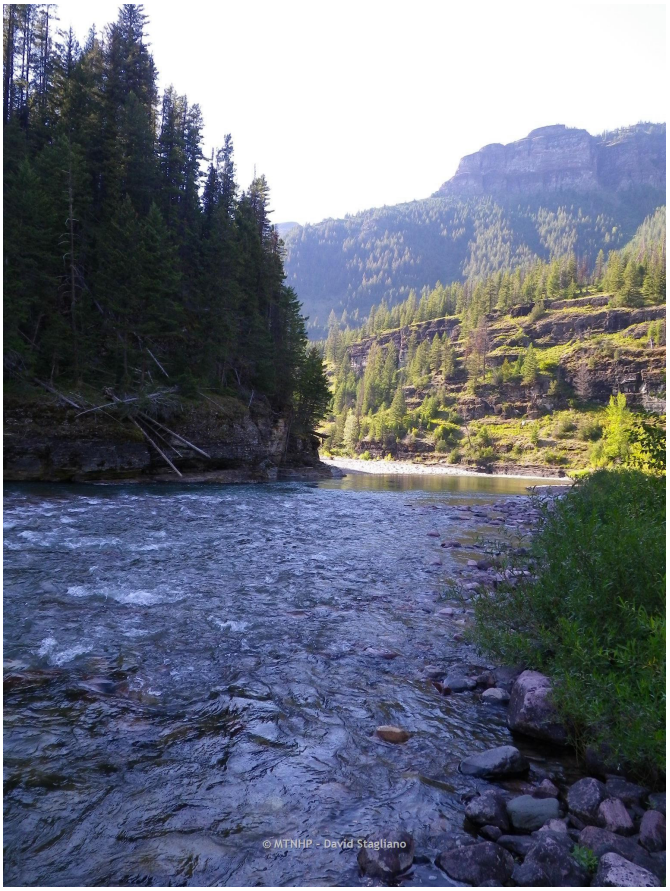
Fluvial processes play a key role in the dynamics of Great Plains rivers and streams. The nature of these processes is often indicated by channel morphology. Meandering channels generally have a shallow gradient, low flow variability, and sediment loads dominated by silt and finer particles, while braided channels are characterized by a moderately steep gradient, high flow variability, and sediment loads dominated by sand and coarser particles (Friedman, 2002). Flooding is the key ecosystem process whereby establishment sites for riparian vegetation are created, seeds are dispersed, and vegetative succession is controlled. However, since Euro-American settlement, natural fluvial processes have been disrupted in many of these systems by dams and diversions. Disruptions include fire suppression, decreased flows and increased siltation rates due to agricultural activities, and introduction of non-native fish species. Native grazers have been largely replaced by domestic cattle. Consequently, there has been a direct loss of woody plant diversity. Furthermore, both channel incision and channel widening have altered flooding regimes, leading to establishment of flood-intolerant species in many areas.

Open Water

Mainstem Intermountain Transitional River

Westslope Intermountain Transitional River

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1290



Provisional State Rank: S4

* Widespread and with many representative river reaches in the state, this ecosystem has been affected by small dams, water diversions, stock ponds and introduced gamefish species that have had significantly negative impacts on this community. Thus, outside of wilderness areas such as the Bob Marshall, it is fairly rare to find biologically intact river miles of this ecological system.

Open Water
Small Foothills and Valley Rivers

Rocky Mountain Front Foothill and Valley Rivers

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1314

Provisional State Rank: S4

* Although widespread and with many representative river reaches in the state, this ecosystem has been negatively affected by small dams, water diversions, stock ponds and introduced gamefish species. Therefore, it is fairly rare to find biologically intact river miles of this ecological system.

Dynamic Processes

Beaver played a large role in the ecological processes of this ecological system in the past and provided mediating flood control with their numerous beaver ponds in the watershed. Large riparian willow complexes were indicative of a proper functioning small mountain to foothill transitional stream.

Open Water
Small Foothills and Valley Rivers

Rocky Mountain Front Foothill and Valley Rivers

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1314

Provisional State Rank: S4

* Although widespread and with many representative river reaches in the state, this ecosystem has been negatively affected by small dams, water diversions, stock ponds and introduced gamefish species. Therefore, it is fairly rare to find biologically intact river miles of this ecological system.

Dynamic Processes

Beaver played a large role in the ecological processes of this ecological system in the past and provided mediating flood control with their numerous beaver ponds in the watershed. Large riparian willow complexes were indicative of a proper functioning small mountain to foothill transitional stream.

Open Water
Small Foothills and Valley Rivers

Small Foothills and Valley Rivers

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1311

Provisional State Rank: S4

* Although widespread and with many representative river reaches in the state, this ecosystem is negatively affected by small dams, water diversions, stock ponds and introduced gamefish species. Therefore, it is fairly rare to find biologically intact river miles of this ecological system.

Dynamic Processes

Beaver played a large ecological role in this system in the past, providing mediating flood control through numerous beaver ponds in the watershed. Large riparian willow complexes are indicative of a proper functioning Small Mountain to Foothill Transitional stream.

Open Water
Small Foothills and Valley Rivers

Transitional Foothills and Valley Rivers

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1310

Provisional State Rank: S4

* Although widespread and with many representative river reaches in the state, this ecosystem is negatively affected by small dams, water diversions, stock ponds and introduced gamefish species. Therefore, it is fairly rare to find biologically intact river miles of this ecological system.

Dynamic Processes

Beaver played a large role in the ecological processes of this ecological system in the past and provided mediating flood control with their numerous beaver ponds in the watershed. Large riparian willow complexes were indicative of a proper functioning small mountain to foothill transitional stream.

Open Water
Small Foothills and Valley Rivers

Upper Missouri Small Foothills and Valley Rivers

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1312

Provisional State Rank: S4

* Although widespread and with many representative river reaches in the state, this ecosystem is negatively affected by small dams, water diversions, stock ponds and introduced gamefish species. Therefore, it is fairly uncommon to find biologically intact river reaches of this ecological system.

Dynamic Processes

Beaver played a large role in the ecological processes of this ecological system in the past and provided mediating flood control with their numerous beaver ponds in the watershed. Large riparian willow complexes were indicative of a proper functioning small mountain to foothill transitional stream.

Open Water

Perennial Prairie Stream

Northern Glaciated Prairie Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1351

Provisional State Rank: S3

* The number of high-quality occurrences in the state is unknown, but it is likely that ~50% of the original stream numbers have suffered from game fish introductions, especially northern pike. The unimpaired stream community contains northern redbelly dace and the Montana Species of Concern northern redbelly/finescale hybrid dace (S3), pearl dace (S2), and the potential Species of Concern, Iowa darter, creek chub, plains minnow and brassy minnow. The occurrence of numerous rare, threatened or declining fish and macroinvertebrate species, and consistent (e.g. water diversions, northern pike populations) or future threats (natural gas wells) warrants a state rank of S3. This ecosystem is also negatively impacted by small dams, water diversions and stock ponds. The native fish community suffers from fish introductions and community homogenization (in the far eastern Montana drainages). Because it is fairly rare to find biologically intact river miles of this ecological system the S-rank denotes this as a potential Ecological System of Concern.

Open Water

Perennial Prairie Stream

Northwestern Great Plains Prairie Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1350

Provisional State Rank: S4

* Although widespread and with many representative river reaches in the state, this ecosystem is negatively impacted by small dams, water diversions, stock ponds and introduced gamefish species. The number of quality occurrences in the state is common, but the native community suffers from fish introductions and community homogenization (in the far eastern Montans drainages). Therefore, it is fairly rare to find biologically intact river miles of this ecological system. This community contains creek chub, plains minnow and Iowa darter, which are potential Species of Concern for Montana.

Open Water

Intermountian Foothill Stream

Western Foothills and Valley Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1370

Provisional State Rank: S5

* The number of viable stream mile occurrences is unknown, but these stream ecosystems are abundant across the mountain ranges of Western North America, often in protected lands managed by the BLM or US Forest Service.

Dynamic Processes

Beaver played a large role in the ecological processes of this ecological system in the past and provided mediating flood control with their numerous beaver ponds in the watershed. Large riparian willow complexes were indicative of a proper functioning small mountain to foothill transitional stream.

Open Water

Headwater Forested Source Streams

Headwater Forested Source Streams

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1401

Provisional State Rank: S5

* The number of viable stream mile occurrences is unknown, but these stream ecosystems are abundant across the mountain ranges of Western North America, often in protected lands managed by the BLM or US Forest Service.

Open Water

Headwater Foothills and Valley Stream

Headwater Foothills and Valley Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1410

Provisional State Rank: S5

* The number of viable stream mile occurrences is unknown, but these stream ecosystems are abundant across the mountain ranges of Western North America, often in protected lands managed by the BLM or US Forest Service.

Dynamic Processes

Beaver played a large role in the ecological processes of this ecological system in the past, providing mediating flood control with numerous beaver ponds in the watershed. Large riparian willow complexes are indicative of proper functioning condition.

Open Water

Small Foothills and Valley Dry Gulch

Small Foothills and Valley Dry Gulch

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1412

Provisional State Rank: S5

* These "stream" ecosystems are abundant across the dry mountain ranges of Western North America and are usually under private, BLM or National Forest Service land ownership.

Dynamic Processes

Heavy rainfall or summer thunderstorm events may cause these gulchs to temporarily contain and channel water downstream, but flow will not persist for long enough to allow an aquatic community to colonize and become established. Severe storms (i.e., "gully washers") may cause significant erosion of channel bed materials sending them downstream to perennial streams.

Open Water
Small Forested Mountain Streams

Small Forested Mountain Streams

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1420

Provisional State Rank: S5

* The number of viable stream mile occurrences is unknown, but these stream ecosystems are abundant across the mountain ranges of Western North America, often in protected lands managed by the National Park Service or US Forest Service.

Dynamic Processes

This diverse community of coldwater stenotherms consists of the Mountain Stream and Medium Mountain Stream Assemblages. The community indicator species are characterized by intolerant, main channel, fast current mayfly, stonefly and caddisfly species (Baetis bicaudatus, Caudetella spp., Drunella spp., Epeorus spp, Cinygmula, Zapada spp. Megarcys, Doroneuria, Sweltsa, Paraperla, Micrasema, Neothremma, Parapsyche, Neophylax spp., and numerous Rhyacophila spp. Groups) and the cold-water dipterans (Rhabdomastix, Bibiocephela, and Glutops). As mountain streams proceed downstream and begin to warm (>15 °C), a dominance shift occurs to the Medium Mountain Stream Assemblage. Populations of western pearlshell mussel have been reported from this stream type and this ecosystem may be their stronghold in the state east of the continental divide.

Open Water
Small Forested Mountain Streams

Small Westside Forested Mountain Streams

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1470

Provisional State Rank: S5

* The number of viable stream mile occurrences is unknown, but these stream ecosystems are abundant across the mountain ranges of Western North America, often in protected lands managed by the National Park Service or US Forest Service.

Open Water
Great Plains Intermittent Stream

Northwestern Glaciated Plains Intermittent Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1451

Provisional State Rank: S4

* The number of quality occurrences in the state is unknown, but probably fairly common. This is a difficult community type to quantify given the past years of drought in the state and the tenuous nature of this aquatic system. Intermittent pools containing the Ostracoda group should be inventoried for unique crustaceans, such as fairy or tadpole shrimp.

Dynamic Processes

Intermittent stream pool indicator species rely on seasonal pools as essential habitat. These species, sometimes also referred to as obligate species, are dependent upon these unique pools for their continued existence. One of the defining characteristics of the seasonal pool biotic community is a lack of permanent populations of predatory fish. Isolation and periodic drying keep predatory fish from colonizing and occupying the pool.

Open Water
Great Plains Intermittent Stream

Northwestern Great Plains Intermittent Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1450

Provisional State Rank: S5

* The number of quality occurrences in the state is unknown, but probably fairly common. This is a difficult community type to quantify given the past years of drought in the state and the tenuous nature of this aquatic system. Intermittent pools containing the Ostracoda group should be inventoried for unique crustaceans, such as fairy or tadpole shrimp.

Dynamic Processes

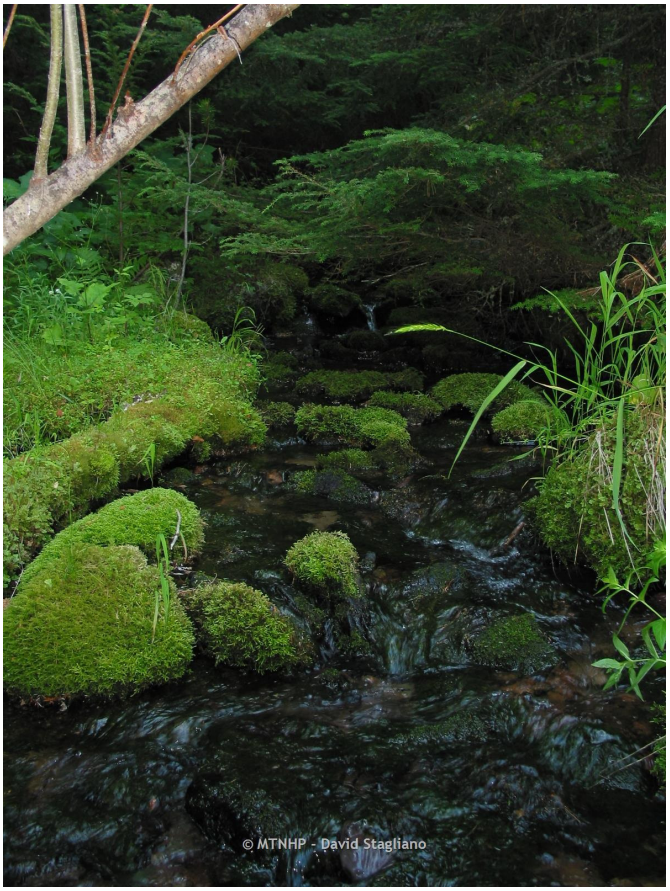
Intermittent stream pool indicator species rely on seasonal pools as essential habitat. These species, sometimes also referred to as obligate species, are dependent upon these unique pools for their continued existence. One of the defining characteristics of the seasonal (intermittent) pool biotic community is a lack of permanent populations of predatory fish. Isolation and periodic drying keep predatory fish from colonizing and occupying the pool.

Open Water

Northern Rocky Mountain Refugium Headwater Forested Streams

Northern Rocky Mountain Refugium Headwater Forested Streams

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1492



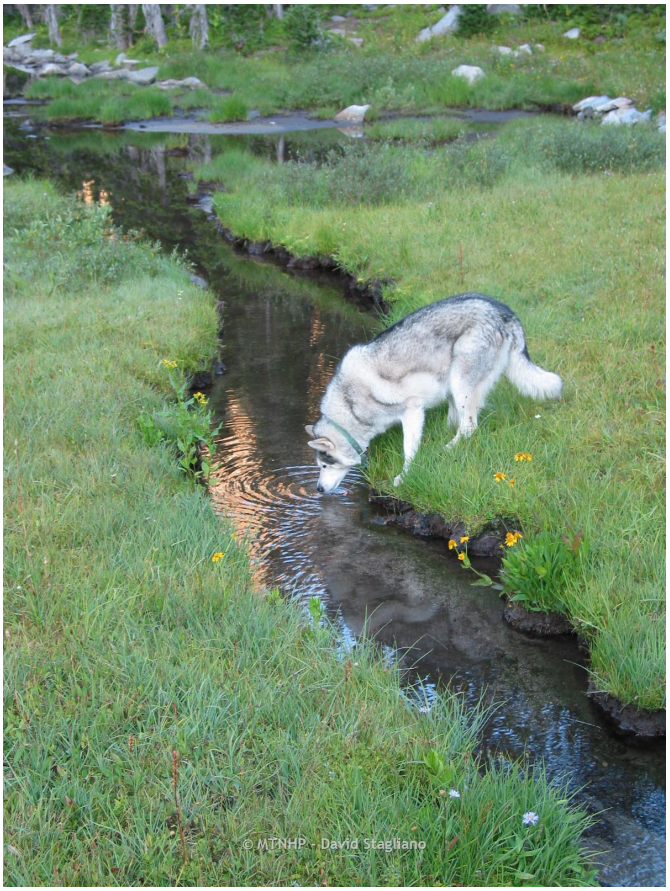
Provisional State Rank: S2

* This aquatic ecological system and the adjacent landscape contains more globally rare and endemic aquatic and terrestrial invertebrates than any other ecological system in the state.

Open Water
Alpine Stream

Low Alpine Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1511



Provisional State Rank: S5

* The number of viable occurrences is unknown, but abundant. These stream ecosystems are found across the mountain ranges of Western North America, often on lands managed by the National Park Service or United States Forest Service.

Dynamic Processes

Alpine ecosystems are tied to snowpack, climate, groundwater discharge, and water quality. Impacts to these parameters as well as their natural variability will have a corresponding effect on alpine biological ecological systems. Long-term drought, warming temperatures and heavy recreation in fragile alpine ecosystems are the common impacts on water quantity at alpine stream sites in the north western United States.

Open Water
Alpine Stream

Steep Alpine Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1510

Provisional State Rank: S5

* The number of viable occurrences is unknown, but abundant. These stream ecosystems are found across the mountain ranges of Western North America and are usually on protected lands managed by the National Park Service or the United States Forest Service. The state's concern over this ecosystem has increased recently because they may contain Species of Concern or candidate species for the Endangered Species Act, like the Lednian Meltwater stonefly (G1S1) and the western glacier stonefly (G2S1) from the glacier-fed streams of Glacier Park. Loss of glaciers may put this system at higher risk.

Dynamic Processes

Alpine ecosystems are tied to snowpack, climate, groundwater discharge, and water quality. Impacts to these parameters, as well as their natural variability, will have a corresponding effect on alpine biological and ecological systems. Long-term drought, warming temperatures and recreational disturbances in fragile alpine ecosystems are the common impacts on water quantity at alpine stream sites in the northwestern United States.

Open Water
Large Spring Stream

Large Volume Spring Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1620

Provisional State Rank: S4

* The number of occurrences is fairly well known and many spring creeks fall within private property. Very few spring creeks have had extensive biological inventories due to private land issues, but the potential of discovering new snail species is high (D. Gustafson, pers. comm.). Due to the constant temperatures, these streams can act as fish refuges during the summer and winter months with trout spawning areas on the gravel bottoms.

Environment

Surface topography usually has a moderate gradient but can be undulating or hummocky. Disturbance by cattle is widespread, as these springs often represent the only water source in the uplands.

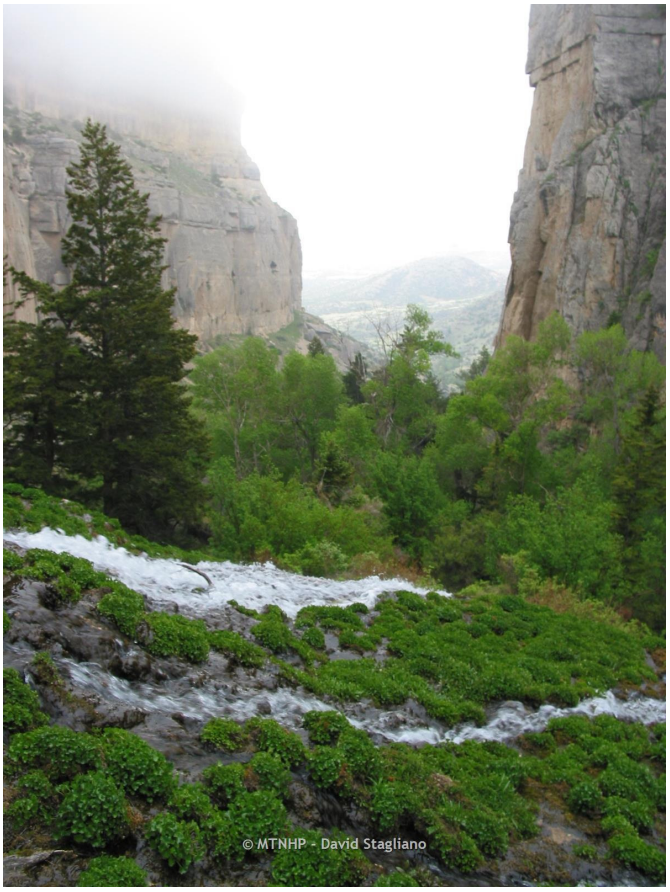
Dynamic Processes

Spring water ecosystems are tied to climate, groundwater discharge, and water quality. Impacts to these parameters, as well as their natural variability, will have a corresponding effect on spring biological and ecological systems. Long-term drought, groundwater withdrawal at local and regional levels, and local diversions at or near the orifice are common impacts on water quantity at spring sites throughout the Western United States.

Open Water
Medium Spring Stream

Medium Volume Spring Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1621



Provisional State Rank: S4

* The number of occurrences is fairly well known and many spring creeks fall within private property. Very few spring creeks have had extensive biological inventories due to private land issues, but the potential of discovering new snail species is high (D. Gustafson, pers. comm.). Due to the constant temperatures, these streams can act as fish refuges during the summer and winter months with trout spawning areas on the gravel bottoms.

Environment

Surface topography usually has a moderate gradient but can be undulating or hummocky. Disturbance by cattle is widespread, as these springs often represent the only water source in the uplands.

Dynamic Processes

Spring water ecosystems are tied to climate, groundwater discharge, and water quality. Impacts to these parameters, as well as their natural variability, will have a corresponding effect on spring biological ecological systems. Long-term drought, groundwater withdrawal at local and regional levels, and local diversions at or near the orifice are common impacts on water quantity at spring sites throughout the Western United States.

Open Water
Great Plains Perennial Spring

Northwestern Great Plains Perennial Spring

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1650

Provisional State Rank: S3

* The number of occurrences is unknown because of the potential occurrence on reservations or private lands. In an inital evaluation of USFS springs in Montana, this ecosystem was evaluated at 30 sites within the Custer National Forest Ashland District, but only five of these contained a high-quality, fully functional S005 community (Stagliano 2004). On subsequent surveys in the Custer Forest (Ashlands & Sioux Districts) numerous perennial spring sites were visited, but very few had intact aquatic communities present (Stagliano 2010, unpublished data 2011). In a similar ecological type, the caddisfly *Hesperophylax designatus* was also found to be an indicator species of perennial springs in the Glass Mountains of the Great Basin (UT) in a 1994 survey (Myers 1995). Therefore, this ecosystem may be widespread, but because of the limited occurrence of high integrity sites in Montana, long-term monitoring and restoration of degraded sites may be recommended.

Environment

Surface topography usually has a moderate gradient but can be undulating or hummocky. Disturbance by cattle is widespread, as these springs often represent the only water source in the uplands.

Dynamic Processes

Spring water ecosystems are tied to climate, groundwater discharge, and water quality. Impacts to these parameters, as well as their natural variability, will have a corresponding effect on spring biological ecological systems. Long-term drought, groundwater withdrawal at local and regional levels, and local diversions at or near the orifice are common impacts on water quantity at spring sites throughout the Western United States.

Open Water
Small Spring Streams and Seeps

Small Volume Spring Stream

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1640

Provisional State Rank: S4

* The number of occurrences of this system is fairly well known and many spring creeks fall within private property. Very few spring creeks have had extensive biological inventories due to private land issues, but the potential of discovering new snail species is high (D. Gustafson, pers. comm.). Due to the constant temperatures, these streams can act as fish refuges during the summer and winter months, with trout spawning areas on the gravel bottoms.

Environment

Surface topography usually has a moderate gradient but can be undulating or hummocky. Disturbance by cattle is widespread, as these springs often represent the only water source in the uplands.

Dynamic Processes

Spring water ecosystems are tied to climate, groundwater discharge, and water quality. Impacts to these parameters as well as their natural variability will have a corresponding effect on spring biological ecological systems. Long-term drought, groundwater withdrawal at local and regional levels, and local diversions at or near the orifice are common impacts on water quantity at spring sites throughout the Western United States.

Open Water
Small Perennial Wyoming Basin Springs

Small Perennial Wyoming Basin Springs

http://FieldGuide.mt.gov/displayES_detail.aspx?ES=1660

Provisional State Rank: S3
* This ecological system is a rare system in Montana, which contains only a small portion of the Wyoming Basin Ecoregion.

Environment

Surface topography usually has a moderate gradient, but topography can be undulating or hummocky. Disturbance by cattle is widespread, as these springs often represent the only water source in the uplands.

Dynamic Processes

Spring water ecosystems are tied to climate, groundwater discharge, and water quality. Impacts to these parameters, as well as their natural variability, will have a corresponding effect on spring biological ecological systems. Long-term drought, groundwater withdrawal at local and regional levels, and local diversions at or near the orifice are common impacts on water quantity at spring sites throughout the Western United States.