

**ECOLOGICAL SYSTEM VIABILITY SPECIFICATIONS FOR SOUTHERN
ROCKY MOUNTAIN ECOREGION**



Ecological System Viability Specifications for Southern Rocky Mountain Ecoregion

1st edition

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Front cover: Alpine tundra dry meadow, spruce-fir moist mesic forest, and alpine shrubland riparian ecological systems at the Bar NI ranch in Las Animas County, Colorado. Photo by Renée Rondeau.

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INTRODUCTION

Ecological systems are dynamic assemblages or complexes of plant and/or animal communities that 1) occur together on the landscape; 2) are tied together by similar ecological processes, underlying abiotic environmental factors or gradients; and 3) form a readily identifiable unit on the ground.

The principles and characteristics of Ecological Systems include the following:

1. They are unified by similar ecological conditions and processes (e.g., fire, riverine flooding), underlying abiotic environmental factors (e.g., shallow soils, limestone geology), and/or environmental gradient (elevation).
2. They form readily identified units on the ground. Matrix ecological systems will manifest themselves on the ground as a spatial aggregation at a broad scale. There are also large and small patch and linear Ecological Systems that are driven by smaller ecological processes across the landscape.
3. Their distributions are bounded by broad biogeographic provinces that encompass multiple TNC ecoregions. For example, low elevation riparian forests of the Southwestern United States, the Great Plains, the Southeastern Coastal Plain, and the Chaco are different Ecological Systems. While they share some commonalities of ecological process, their biodiversity values have little relationship to one another.

Plant associations are grouped into ecological systems. Usually plant associations are part of only one system but occasionally they can be found in two or more ecological systems, e.g., *Carex utriculata* / mesic forb plant association is found in both Montane wet meadows and Montane fens.

As part of The Nature Conservancy's Southern Rocky Mountains ecoregion plan (Neely et al. 2001¹) I developed descriptions and viability specifications for 38 ecological systems that were developed for the southern Rocky Mountains ecoregion. Table 1 lists all the ecological systems of the Southern Rocky Mountains ecoregion (39), of which all but the cave systems are described in this document.

These viability specifications are useful tools for ranking ecological systems and plant associations that are found in the Southern Rocky Mountains ecoregion. Each system has specifications for size, condition, and landscape context. Although, these specifications are written for the ecological system they can usually be applied at the plant association level. The one exception to this is with the size criteria. Often a plant association occurrence will occur at a much smaller size than at the ecological system size. When this happens the occurrence should be contained within the appropriate ecological system

¹ Neely, B., P. Comer, C. Moritz, M. Lammert, R. Rondeau, C. Pague, G. Bell, H. Copeland, J. Humke, S. Spackman, T. Schulz, D. Theobald, and L. Valutis. 2001 Southern Rocky Mountains ecoregion: an ecoregional assessment and conservation blueprint. The Nature Conservancy of Colorado, Boulder CO.

that meets minimum size criteria for the ecological system. For example, *Stipa comata* – *Bouteloua gracilis* plant association is part of the “Foothill grassland ecological system”. The minimum size for this ecological system in the Southern Rocky Mountain ecoregion is 1000 acres, yet this plant association may be viable at 500 acres as long as it is part of a larger grassland complex that is at least 1000 acres. In other words, plant association specifications, when written, will differ from the system level specifications at least in the size criteria. Therefore these system specifications are guidelines for plant association occurrences and can be used as such until further specifications are written.

Table 1. Southern Rocky Mountain Terrestrial Ecological Systems and the number of plant association and rare plant associations for each system.

Southern Rocky Mountain Ecoregion – Terrestrial Ecological Systems
ECOREGION ZONE (4)

Ecological System (39)	Patch Type	Number of Plant Associations	Rare Plant Associations (G1,G2 and some G3)
Alpine Zone			
Alpine Substrate/Ice Field	Small Patch	4	0
Alpine Tundra Dry Meadow	Matrix	21	2
Alpine Tundra Fell-Field	Small Patch	1+	0
Alpine Dwarf Shrubland	Large Patch	3	0
Subalpine Zone			
Alpine/Subalpine Wet Meadow	Small Patch	27	2
Bristlecone-Limber Pine Forest and Woodland	Large Patch	10	2
Spruce-Fir Dry-Mesic Forest	Matrix	13	0
Spruce-Fir Moist-Mesic Forest	Matrix	7	1
Upper Montane Zone			
Lodgepole Pine Forest	Matrix	6	0
Aspen Forest	Matrix	22	5
Montane Moist-Mesic Mixed Conifer Forest	Matrix	10	0
Montane Dry-Mesic Mixed Conifer Forest	Matrix	7	0
Montane Grassland	Large Patch	15	7
South Park Montane Grassland	Matrix		
Sagebrush Shrubland	Matrix	14	3
Montane Fen	Small Patch	4	3
Upper Montane Riparian Forest and Woodland	Linear	20	3
Montane / Subalpine Riparian Shrubland	Linear	53	0
Lower Montane-Foothills Zone			
Douglas Fir-Ponderosa Pine Forest	Large Patch	20	0
Montane / Foothill Cliff and Canyon	Large Patch	6	0
Ponderosa Pine Woodland	Matrix	15	5
Ponderosa Pine Savanna	Large Patch		
Pinyon – Juniper Woodland	Matrix	14	2
Juniper Savanna	Large Patch	10	3

Lower Montane-Foothills Shrubland	Large Patch	15	13
Gambell's Oak / Serviceberry Shrubland	Large Patch	10	1
Sagebrush Shrub Steppe	Large Patch	4	1
Winterfat Shrub Steppe	Large Patch	3	0
San Luis Valley Winterfat Shrub Steppe	Matrix		
Foothill Grassland	Large Patch	14	9
Active Sand Dune and Swale Complex	Large Patch	3	2
North Park Active Sand Dune	Large Patch		
Stabilized Sand Dune	Large Patch	3	1
Lower Montane Riparian Woodland	Linear	22	7
Foothills Riparian Woodland/Shrubland	Linear	16	5
Greasewood Flat and Ephemeral Meadow Complex	Large Patch	14	2
Cross-Zone Riparian and Wetland Systems			
Wet Meadow	Small Patch	14	0
Freshwater Marsh	Small Patch	17	0
Cross-Zone Cave System			
Caves	Small Patch		
Total		39	411

SOUTHERN ROCKY MOUNTAINS ECOREGION
ALPINE SUBSTRATE/ICE FIELD—SMALL PATCH

Sparse non-vascular vegetation (on rock and unconsolidated substrates)

Glacier

Snow Field

Aquilegia coerulea - *Cirsium scopulorum* Scree Herbaceous Vegetation

SCALE AND RANGE: LARGE PATCH AND WIDESPREAD

Alpine substrate/ice field ecological system is a small patch system that occurs at only the highest elevations (12,000-14,000 feet) within the Southern Rocky Mountains ecoregion. This system occupies less than 1% of the SRM ecoregion but is also found in other Rocky Mountain ecoregions from Canada to New Mexico.

The primary ecological processes include snow retention, wind dessication, and permafrost. The snow pack/ice field never melts or if so, then for only a few weeks. The alpine substrate/ice field ecological system is part of the alpine mosaic consisting of alpine tundra dry meadow, wet meadow, fell- fields, and dwarf shrubland.

Most likely the primary major threat to this system may be global warming as it occupies only the highest elevations of SRM.

Brown-capped rosy finch, a Southern Rocky Mountains endemic, nest in vertical cliffs and crags of the tundra and feed in the surrounding area. They often use snowfields for feeding, especially when strong winds cross snowfields the updrafts are cut off and insects fall stunned on the snow surface, where these finches forage on an abundant food source (Nelson 1998).

MINIMUM SIZE: 5 acres. (Connectivity is probably more important than size)

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including, major highways, urban development, mining, ski industry development, 2) natural community from a different ecological system wider than one mile wide.

Justification: This system is probably most susceptible to global warming and altered chemical composition, especially excess nitrogen from pollution. Higher than normal nitrogen contents have been detected for Rocky Mountain National Park (Jeff Connors pers. com). Connectivity is probably of utmost importance for the alpine communities.

RANK PROCEDURE: 1) condition, 2) landscape context, 3) size. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the current condition, landscape context, and historical continuity may contribute more to the diversity of an occurrence than does

occurrence size, although the species-area relationship still holds up for patch type communities.

CONDITION SPECIFICATIONS:

A –rated condition: Not fragmented or impacted by roads, trails, or mines. Pollution fallout is limited.

B- rated condition: Unnatural fragmentation is limited to < 3 % of the occurrence. Pollution fallout may show an excess of nitrogen.

C-rated condition: Unnatural fragmentation is limited to < 5% of the occurrence. Pollution fallout shows a significant excess of nitrogen.

D –rated condition: Unnatural fragmentation is > 10% of the occurrence. Pollution fallout of nitrogen may have a long lasting effect on the lichen communities.

Justification for A-rated criteria: Alpine substrate ice fields are mostly dependent on global climate. Potentially chemical imbalances due to excess nitrogen from pollution may be altering this system. Otherwise the only other significant factor of condition is fragmentation.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 50 acres)

B –rated size: Large (20 - 50 acres)

C –rated size: Moderate (5 - 20 ac)

D –rated size: Small (<5 ac)

Justification for A-rated criteria: A-ranked occurrences are large enough to support small impacts and be able to buffer small changes in chemical imbalances and climate fluctuations.

Justification for C/D threshold: C-ranked occurrences may still be able to contain some snow pack even with global warming. D-ranked occurrences are subject to loss with global warming.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Occurrence surrounded by unaltered, unfragmented landscape with very little to no human activities, e.g., trails, roads, mines, etc., (> 98% natural). No unnatural barriers present. Connectivity of adjacent systems allows natural migration to occur.

B-rated landscape context: Surrounding lands have been altered by human development but are > 90% natural. Examples of human development may include sheep grazing, mining, road building, etc. Connectivity to the surrounding alpine environment is very much intact.

C-rated landscape context: Surrounding landscape shows signs of fragmentation from either numerous trails, roads, mines, ski areas, or other human activities, but at least 75% natural. Significant disturbance but easily restorable.

D-rated landscape context: Major human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence are mined, heavily recreated (including skiing), or has numerous trails and roads. Connectivity is severely hampered.

Justification for A-rated criteria: These are occurrences with an intact alpine mosaic allowing for natural species migration and movement. Alpine substrate/ice fields are fully connected with natural intact alpine environment and fully buffered from human impact.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from human impact to the alpine environment. D-ranked occurrences have little or no buffering, and are subject to altered species composition including loss on native species.

AUTHORSHIP: Renée Rondeau

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- Anderson M. G. 1999. Viability and spatial assessment of ecological communities in the northern Appalachian ecoregion. Phd. Dissertation. University of New Hampshire.
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**SOUTHERN ROCKY MOUNTAINS ECOREGION
ALPINE TUNDRA DRY MEADOW — MATRIX**

Artemisia arctica ssp. *saxicola* Herbaceous Vegetation
Carex elynoides - *Oreoxis* spp. Herbaceous Vegetation
Carex foenea - *Geum rossii* Herbaceous Vegetation
Carex rupestris - *Geum rossii* Herbaceous Vegetation
Carex rupestris-*Trifolium dasyphyllum* Herbaceous Vegetation
Deschampsia cespitosa - *Geum rossii* Herbaceous Vegetation
Festuca brachyphylla - *Geum rossii* var. *turbinatum* Herbaceous Vegetation
Geum rossii - *Trifolium* spp. Herbaceous Vegetation
Kobresia myosuroides - *Geum rossii* Herbaceous Vegetation
Trifolium dasyphyllum Herbaceous Vegetation

SCALE AND RANGE: MATRIX AND WIDESPREAD

Alpine tundra dry meadow ecological system is the matrix system of the Southern Rocky Mountains ecoregion alpine zone and occupies approximately 3% of the ecoregion. These dry meadows occur between 10,000 and 14,000 feet in elevation on gentle to moderate slopes, flat ridges, valleys, and basins, where the soil has become relatively stabilized and the water supply is more or less constant. The system is commonly comprised of a mosaic of large patch plant communities that are dominated by sedges, grasses, and forbs. Dominant species include *Artemisia arctica*, *Carex elynoides*, *C. foenea*, *C. rupestris*, *Deschampsia cespitosa*, *Festuca brachyphylla*, *Geum rossii*, *Kobresia myosuroides*, and *Trifolium dasyphyllum*. Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost, and a short growing season. Although alpine tundra dry meadow is the matrix of the alpine it typically intermingles with alpine substrate ice field, tundra fell-field, alpine dwarf shrubland, and alpine/subalpine wet meadow ecological systems. The alpine tundra dry meadow ecological system is also found in other Rocky Mountain ecoregions as well.

Viable populations of American pipits and Brown-capped rosy finches may be an indicator of a healthy and adequately large occurrence. In addition, Ptarmigan may use this system at different times in their life cycle and have been chosen as an additional indicator of a healthy occurrence of alpine systems.

The major threats to this system are surface disturbances such as roads, mining, and degradation from current and historic sheep grazing.

MINIMUM SIZE: 3,000 acres

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including urban development greater than ½ mile wide, major highways, or 2) a different natural ecological system greater than 1 mile wide.

Justification: Primary criteria to be considered are the reaction of native species to fragmentation, seed dispersal by dominant forbs and graminoids and the connectivity for small mammals, e.g., pikas, marmots, pocket gophers, and shrews.

RANK PROCEDURE: 1) size, 2) condition, 3) landscape context. Size is the most important ranking factor for matrix communities. Condition is of secondary importance and while landscape context is still important, it is slightly less so than the overall size and condition of an occurrence.

CONDITION SPECIFICATIONS:

The following sources have good discussions about alpine condition: Schwan and Costello (1951) and Thilenius (1975).

A-rated conditions: A continuous mat of mulch in sheltered places. No sod breaks, scalped areas, trailing, hummocking, or gravel fans. Natural microrelief is undisturbed. Soil erosion is not accelerated by anthropogenic activities. No surficial disturbance is evident or if present than in only small, isolated areas and limited to <1% (e.g. mines or ranch activities and buildings; off-road vehicle use). Sheep grazing has not been present for the last ten years. There are few to no roads and trails found within the occurrence.

B-rated condition: Some limited exposed stony areas, are present. Minor sod breaks and snowbank trailing may be noticeable, but only where sheep tend to congregate. Scalped areas, pedestalling and gullying are absent. Native species that increase with sheep grazing have less than 10% cover. Ground cover is intact in at least 80% of the occurrence. Soil erosion may be slightly elevated due to anthropogenic activities. Surficial disturbance from mines, ranch activities, buildings, trails, and off-road vehicles if present is limited to less than 5% of the occurrence. There are only a few roads/trails found within the occurrence.

C-rated condition: Evidence of historic and current sheep grazing is distinctly noticeable but is capable of remedy in a reasonable length of time and with moderate management changes. Mulch may be in broken patches with as much as 30% bare ground showing. Sod breaks and scalped places may be locally present. Surficial disturbances occur on less than 20% of the area (e.g., mines, ranch activities, buildings, and off-road vehicle use). Roads and trails may be scattered throughout the occurrence.

D-rated condition: The severely depleted condition is seldom encountered over extensive areas in the alpine tundra. Destructive activities such as grazing or mining is usually confined to readily accessible areas. These disturbed areas present a ragged, broken, trailed-out appearance. Mulch is mostly depleted, although in less accessible places it may approach 30%. The ragged appearance of thinly vegetated summits and slopes, caused by sod-cutting, is a distinctive feature. Sod breaks and scalped places are usually common, and slopes are badly trailed. Numerous shallow to deep gullies are evident at the heads of drainages. Stream banks are cut, raw, and sharp. Often much snowbank trailing is evident. Surficial disturbances occur on more than 20% of the area

(e.g., mines, ranch activities, buildings or off-road vehicle use). Many roads or trails may be found within the occurrence.

Justification for A-rated criteria: characteristic ecological gradients and variation remain intact supporting interactions among component species. Natural disturbances can occur on a scale that permits maintenance of a diverse mosaic of alpine communities.

Justification for C/D threshold: C-ranked occurrences would naturally improve in condition with a change in management practices, with significant recovery expected within 100 years. D-ranked occurrences will not likely improve and are prone to irreversible changes in composition. Significant emphasis is placed on the relative loss of the topsoil, which may take as long as 500 years to be replaced. Emphasis is also placed in the degree of fragmentation from roads and the amount of accelerated soil erosion.

SIZE SPECIFICATIONS:

A-rated size: Very large (>20,000 acres)

B-rated size: Large (8,000-20,000 acres)

C-rated size: Moderate (3,000-8,000 acres)

D-rated size: Small (<3,000 acres)

Justification for A-rated criteria: A-ranked occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance, and would most likely survive accelerated erosion disturbance problems.

Justification for C/D threshold: stands smaller than C-ranked may be viable if they are surrounded by naturally occurring vegetation, or if it occupies all of the available habitat in an un-altered, unfragmented valley. As a rule, smaller stands lack variability, have largely disturbed or altered natural geomorphic disturbance processes and are surrounded by altered landscapes. The primary criteria considered are loss of diversity from livestock grazing and fragmentation by roads.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Highly connected to the surrounding intact landscape which has been little altered, captures the characteristic ecological gradients and geomorphic processes. The occurrence is completely surrounded by other high quality communities. The alpine landscape provides habitat for indicator species such as Ptarmigan, Rosy finches, Water pipit, and Black-chinned hummingbird.

B-rated landscape context: occurrence is surrounded by moderate-low quality natural communities, some of which may have been logged or disturbed in the past; an expansive semi-natural landscape that has been used extensively for livestock grazing.

C-rated landscape context: Moderately fragmented and isolated -- occurrences are surrounded by a mix of intensive mining, logging, or ski industry development, and adjacent semi-natural communities.

D-rated landscape context: Highly fragmented and isolated -- area around the occurrence is entirely, or almost entirely, surrounded by mining, logging, or ski industry development.

Justification for A-rated criteria: Characteristic ecological gradients remain intact supporting interactions among component species. Natural disturbances can occur on a scale that permits maintenance of patches of the matrix system in a variety of conditions.

Justification for C/D threshold: D-ranked occurrences have characteristic ecological gradients lacking or otherwise disrupted, with irretrievable impacts on habitat requirements for component species.

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SOUTHERN ROCKY MOUNTAINS ECOREGION
ALPINE TUNDRA FELL-FIELD—SMALL PATCH

Minuartia obtusiloba Herbaceous Vegetation
Paronychia pulvinata - *Silene acaulis* Cushion plant vegetation
Saxifraga chrysantha Herbaceous Vegetation
Sparse cushion plant vegetation

SCALE AND RANGE: SMALL PATCH AND WIDESPREAD

Alpine tundra fell-field ecological system is a small patch system scattered throughout the alpine zone of the Southern Rocky Mountains ecoregion, usually between 11,000 to 14,000 feet. This system is characterized by immature soils with nearly imperceptible horizon layers. Gravel and sand dominate the top horizons. This system may be found on gentle to steep slopes with varying aspects. The primary factor dictating the sparse character of a fell-field is wind. Wind scoures fell-fields free of snow in the winter, exposing the plants to the severest environmental stress on the tundra. During the summer, wind also blasts across the open surface and the fell-fields broil under the intense solar radiation of high altitudes. The soil drains so rapidly and retains so little moisture that fell-field plants must be specifically adapted for survival in low moisture, high dessication regions. Most fell-field plants are cushioned or matted, frequently succulent, flat to the ground in rosettes and often densely haired and thickly cutinized. Plants cover 15-50%, while exposed rocks make up the rest. Dominant species include *Minuartia obtusiloba*, *Paronychia pulvinata*, *Saxifraga chrysantha*, *Silene acaulis*, *Polemonium* spp, and *Eriogonum* spp. A true fell-field remains stable for hundreds, maybe thousands, of years until the soil builds up. Fell-fields are usually within or adjacent to alpine tundra dry meadows. This system is also found in the alpine zones of the other Rocky Mountain ecoregions.

Major threats to this system are fragmentation by roads and degradation through mining and ski development.

MINIMUM SIZE: 5 acres

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including, major highways, urban development, mining, and ski industry development, 2) natural community from a different ecological system wider than one mile wide.

Justification: Primary criteria to be considered are small mammal movement, e.g., marmots and pikas. The separation distance for intervening natural communities assumes different snow retention regime.

RANK PROCEDURE: 1) condition, 2) landscape context, 3) size. Condition and landscape context are the primary ranking factors, with size secondary.

CONDITION SPECIFICATIONS:

A –rated condition: Human disturbance from mining, road building, trails, ski development, or other human activity is non-existent.

B- rated condition: Human disturbance from mining, road building, trails, or ski development is limited to less than 3% of the occurrence.

C-rated condition: Human disturbance from mining, road building, trails, or ski development is limited to less than 5% of the occurrence.

D –rated condition: Human disturbance from mining, road building, trails, or ski development is greater than 10% of the occurrence.

Justification for A-rated criteria: Fell-fields in the Southern Rocky Mountains are generally undisturbed by livestock grazing and therefore physical disturbance is the primary alteration to condition. Disturbance to this fragile alpine environment may take over 500 years to recover. A-ranked occurrences are completely intact allowing for heavy winds to maintain little to no snow cover.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation such as from earth movement.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 50 acres)

B –rated size: Large (20 - 50 acres)

C –rated size: Moderate (5 - 20 ac)

D –rated size: Small (<5 ac)

Justification for A-rated criteria: Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic and hydrologic disturbance. They are buffered from edge effects and small surface disturbances.

Justification for C/D threshold: C-ranked occurrences are large enough to sustain some natural or human caused perturbations. While D-ranked occurrences are too small to remain viable from surface disturbances. They may also be too small to harbor viable populations of small mammals, e.g., pikas.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Surrounding lands are largely unaltered by human development (>98% natural). No unnatural barriers present. Connectivity of habitats allows natural processes and species migration to occur.

B-rated landscape context: Surrounding lands have been altered by human development but are > 90% natural. Examples of human development are sheep grazing, mining, road

building, and ski development. Connectivity to the surrounding alpine environment is very much intact.

C-rated landscape context: Surrounding lands have been altered by human development but are > 75% natural. Connectivity to the surrounding alpine environment is hindered which curtails natural migration/movement of fell-field species, e.g., pikas.

D-rated landscape context: Lands surrounding occurrence have been severely altered by human development (<75% natural). Connectivity and natural processes are almost nonexistent. Restoration is not feasible within a reasonable time frame.

Justification for A-rated criteria: These occurrences are within an intact alpine mosaic allowing for natural species migration and movement. Fell-fields are fully connected with natural alpine environment and buffered from human impact.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from human impact to the alpine environment and are within a mostly natural alpine mosaic. D-ranked occurrences have no buffering, and are subject to altered species composition which cannot be recolonized because of lack of connectivity with other patches.

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SOUTHERN ROCKY MOUNTAINS ECOREGION
ALPINE DWARF SHRUBLAND — LARGE PATCH

Salix arctica - *Salix reticulata* ssp. *nivalis* Dwarf-shrubland
Salix arctica / *Geum rossii* Dwarf-shrubland
Vaccinium (cespitosum, scoparium) Dwarf-shrubland

SCALE AND RANGE: LARGE PATCH AND WIDESPREAD

Alpine dwarf shrubland is a large patch ecological system that occurs in less than 1% of the Southern Rocky Mountains ecoregion. This system is found only at the highest elevations of the ecoregion, usually above 12,000 feet. The system is commonly comprised of a mosaic of “large patch” plant communities, especially *Salix arctica*, *S. reticulata*, and *Vaccinium* spp. It occurs primarily on gentle slopes and depressions where the snow lingers and the soil has become relatively stabilized and the water supply is more or less constant. Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost, and a short growing season. These large late-season snow fields are often found in the upper reaches of large bowls with coarser soils than the surrounding alpine tundra dry-meadow. Fell-fields often intermingle with the alpine dwarf shrubland.

The Uncompahgre fritillary (*Boloria improba* ssp. *acronema*) uses *Salix reticulata* ssp. *nivalis* as a host plant. Therefore viable populations of the fritillary is an indicator of a healthy and adequately large occurrence of an alpine Dwarf-shrubland. In addition, Ptarmigan, Rosy finches, and American pipit may use this system at different times in their life cycle and have been chosen as indicators of a healthy occurrence of alpine systems.

MINIMUM SIZE: 1000 acres

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including urban development greater than ½ mile wide, major highways, or 2) a different natural ecological system greater than 1 mile wide.

Justification: Primary criteria to be considered are the reaction of native species to fragmentation, seed dispersal by dominant forbs and graminoids and the connectivity for small mammals, e.g., pikas, marmots, pocket gophers, shrews, etc.

RANK PROCEDURE: 1) condition, 2) landscape context, 3) size. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does occurrence size, although the species-area relationship still holds up for patch type communities.

CONDITION SPECIFICATIONS:

The following sources have good discussions about alpine condition: Schwan and Costello (1951) and Thilenius (1975).

A-rated conditions: A continuous mat of mulch in sheltered places. No sod breaks, scalped areas, trailing, hummocking, or gravel fans. Natural microrelief is undisturbed. Soil erosion is not accelerated by anthropogenic activities. No surficial disturbance is evident or if present than in only small, isolated areas and limited to <1% (e.g. mines or ranch activities and buildings; off-road vehicle use). Sheep grazing has not been present for the last ten years. There are few or no roads or trails found within the occurrence.

B-rated condition: Some limited exposed stony areas, are present. Minor sod breaks and snowbank trailing may be noticeable, but only where sheep tend to congregate. Scalped areas, pedestalling and gullying are absent. Native species that increase with sheep grazing have less than 10% cover. Ground cover is intact in at least 80% of the occurrence. Soil erosion may be slightly elevated due to anthropogenic activities. Surficial disturbance, e.g. mines, ranch activities, buildings, off-road vehicles, etc., if present, limited to less than 5% of the occurrence. There are only a few roads/trails found within the occurrence.

C-rated condition: Evidence of sheep grazing is distinctly noticeable but is capable of remedy in a reasonable length of time and with moderate management changes. Mulch may be in broken patches with as much as 30% bare ground showing. Sod breaks and scalped places may be locally present. Surficial disturbances occur on less than 20% of the area (e.g., mines or ranch activities and buildings; off-road vehicle use). Roads may be scattered throughout the occurrence.

D-rated condition: The severely depleted condition is seldom encountered over extensive areas in the alpine tundra. Destructive grazing/mining etc., is usually confined to readily accessible areas. These present a ragged, broken, trailed-out appearance. Mulch is mostly depleted, although in less accessible places it may approach 30%. The ragged appearance of thinly vegetated summits and slopes, caused by sod-cutting, is a distinctive feature. Sod breaks and scalped places are usually common, and slopes are badly trailed. Numerous shallow to deep gullies are evident at the heads of drainages. Stream banks are cut, raw, and sharp. There is often much snowbank trailing. Surficial disturbances occur on more than 20% of the area (e.g., mines or ranch activities and buildings; off-road vehicle use). Many roads or trails may be found within the occurrence.

Justification for A-rated criteria: characteristic ecological gradients and variation remain intact supporting interactions among component species. Natural disturbances can occur on a scale that permits maintenance of a diverse mosaic of communities.

Justification for C/D threshold: C-ranked occurrences would naturally improve in condition with a change in management practices, with significant recovery expected within 100 years. D-ranked occurrences will not likely to improve and are prone to irreversible changes in composition. Significant emphasis is placed on the relative loss of

the topsoil, which may take as long as 500 years to be replaced. Emphasis is also placed in the degree of fragmentation from roads and the amount of accelerated soil erosion.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 3000 acres)

B –rated size: Large (2000 to 3000 acres)

C –rated size: Moderate (1000 - 2000 ac)

D –rated size: Small (<1000 ac)

Justification for A-rated criteria: A-ranked occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance, and would most likely survive accelerated erosion disturbance problems.

Justification for C/D threshold: stands smaller than C-ranked may be viable if they are surrounded by naturally occurring vegetation, or if it occupies all of the available habitat in an un-altered, unfragmented valley. As a rule, smaller stands lack variability, have largely disturbed or altered natural geomorphic disturbance processes and are surrounded by altered landscapes. The primary criteria considered are loss of diversity from livestock grazing and fragmentation by roads.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Highly connected – surrounding landscape has been little altered, captures the characteristic ecological gradients and geomorphic processes, and the occurrences are completely surrounded by other high quality communities.

B-rated landscape context: occurrence is surrounded by moderate-low quality natural communities, some of which may have been disturbed in the past; an expansive semi-natural landscape that has been used extensively for livestock grazing.

C-rated landscape context: Moderately fragmented and isolated -- occurrences are surrounded by a mix of intensive mining, logging, or ski industry development, and adjacent semi-natural communities.

D-rated landscape context: Highly fragmented and isolated -- area around the occurrence is entirely, or almost entirely, surrounded by mining, logging, or ski industry development.

Justification for A-rated criteria: Characteristic ecological gradients remain intact supporting interactions among component species. Natural disturbances can occur on a scale that permits maintenance of patches of the community in a variety of conditions.

Justification for C/D threshold: Characteristic ecological gradients lacking or otherwise disrupted, with irretrievable impacts on habitat requirements for component species.

AUTHORSHIP: Renée Rondeau

Date: July 14, 2000

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SOUTHERN ROCKY MOUNTAINS ECOREGION
ALPINE/SUBALPINE WET MEADOW—SMALL PATCH

Calamagrostis stricta Herbaceous Vegetation
Caltha leptosepala - *Deschampsia cespitosa* Herbaceous Vegetation
Caltha leptosepala - *Polygonum bistortoides* Herbaceous Vegetation
Caltha leptosepala - *Sedum rhodanthum* Herbaceous Vegetation
Caltha leptosepala Herbaceous Vegetation
Cardamine cordifolia - *Caltha leptosepala* Herbaceous Vegetation
Cardamine cordifolia - *Mertensia ciliata* Herbaceous Vegetation
Carex illota Herbaceous Vegetation
Carex microptera Herbaceous Vegetation
Carex scopulorum - *Caltha leptosepala* Herbaceous Vegetation
Carex vernacula Herbaceous Vegetation
Deschampsia cespitosa - *Carex nebrascensis* Herbaceous Vegetation
Deschampsia cespitosa - *Ligusticum tenuifolium* Herbaceous Vegetation
Deschampsia cespitosa - *Phleum alpinum* Herbaceous Vegetation
Deschampsia cespitosa Herbaceous Vegetation
Eleocharis quinqueflora Herbaceous Vegetation
Geum rossii - *Sibbaldia procumbens* Herbaceous Vegetation (often sign of disturbance)
Glyceria borealis Herbaceous Vegetation
Phippsia algida Herbaceous Vegetation
Rorippa alpina Herbaceous Vegetation
Saxifraga odontoloma Herbaceous Vegetation
Sibbaldia procumbens - *Polygonum bistortoides* Herbaceous Vegetation (often sign of disturbance)
Trifolium parryi Herbaceous Vegetation (often sign of disturbance)

SCALE AND RANGE: SMALL PATCH AND WIDESPREAD

Alpine/subalpine wet meadow ecological system is a small patch system confined to specific environments defined primarily by hydrology. Water levels are at or near the surface for much (or all) of the growing season, although some fluctuation may also occur as a function of precipitation and temperature patterns. Alpine/subalpine wet meadows may have surface water for part of the year, but depths rarely exceed a few centimeters. Soils of this system may be mineral or organic. In either case, soils show typical hydric soil characteristics, including high organic content and/or low chroma and redoximorphic features. This system often occurs as a mosaic of several plant associations with varying dominant herbaceous species that may include *Calamagrostis stricta*, *Caltha leptosepala*, *Cardamine cordifolia*, *Carex illota*, *C. microptera*, *C. scopulorum*, *C. vernacula*, *Deschampsia cespitosa*, *Eleocharis quinqueflora*, *Glyceria borealis*, *Phippsia algida*, *Rorippa alpina* and *Trifolium parryi*. Often alpine dwarf shrublands, especially those dominated by *Salix*, are immediately adjacent to the wet meadows. Wet meadows are tightly associated with snowmelt and typically not subjected to high disturbance events such as flooding.

Within the Southern Rocky Mountains ecoregion, this system is widely distributed, although usually limited to small areas. It is also found in the subalpine zones from Canada to southern New Mexico.

MINIMUM SIZE: 1 acre

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than ¼ mile wide, major highways, urban development, or large bodies of water. 2) natural community from a different ecological system greater than ½ mile wide, 3) major break in environmental factors such as topography, soils, geology, etc., especially one resulting in a hydrologic break.

Justification: Primary criteria to be considered are the hydrologic system and the surrounding landscape. The separation distance for intervening natural or semi-natural communities assumes a different hydrologic regime that would inhibit movement of wetland associated species. Alpine/subalpine wet meadows are often isolated hydrologically from other wetlands, and easily impacted by surrounding land use.

RANK PROCEDURE: 1) condition, 2) landscape context, 3) size. Condition and landscape context are the primary ranking factors, with size secondary because even small examples of this system can have high biological significance.

CONDITION SPECIFICATIONS:

A –rated condition: Natural hydrologic regime intact. No or little evidence of wetland alteration due to increased or decreased drainage, clearing, livestock grazing, anthropogenic nutrient inputs, etc. No or very few exotic species present with no or little potential for expansion. Native species that increase with disturbance or changes in hydrology/nutrients are absent or low in abundance.

B- rated condition: Natural hydrologic regime nearly intact. Alteration from local drainage, clearing, livestock grazing, or nutrient inputs is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. Native species that increase with disturbance or changes in hydrology/nutrients are absent, low in abundance, or restricted to disturbed or high-nutrient microsites that represent less than 5% of the total wetland area.

C-rated condition: Natural hydrologic regime altered by local drainage or other disturbances. Alteration from local drainage, clearing, livestock grazing, etc., is extensive, but potentially restorable over several decades. Exotic species may be widespread but potentially manageable. Native species that increase with disturbance or changes in hydrology/nutrients may be very prominent.

D –rated condition: Natural hydrologic regime or disturbance to site not restorable. System remains fundamentally compromised despite restoration of some processes. Exotic species may be dominant. Native species that increase with disturbance or changes in hydrology/nutrients are prominent to dominant.

Justification for A-rated criteria: Alpine tundra wet meadows in the Southern Rocky Mountains depend on perennial water regime, largely from snowpack and seasonally to permanently saturated soils. Alteration of the hydrologic regime invariably compromises the natural communities. Other anthropogenic influences (grazing, nutrient inputs) can significantly alter community composition by shifting competitive interactions. Non-native species (e.g., *Poa pratensis*), when in sufficient number, can displace native species. A-ranked occurrences have these hydrologic processes intact, thereby supporting the historic species composition, nutrient status, or other natural components of the wetland.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

Condition and landscape context are the primary ranking factors, with size secondary because even small examples of this system can have high biological significance.

A – rated size: Very large (> 75 acres)

B –rated size: Large (20 to 75 acres)

C –rated size: Moderate (1 to 20 ac)

D –rated size: Small (< 1 ac)

Justification for A-rated criteria: Alpine/subalpine wet meadow ecological system is usually composed of a mosaic of different plant associations. Very large occurrences would likely contain the maximum diversity of species and plant associations. Occurrences of this size would also likely contain sufficient internal variability to capture characteristic biophysical gradients, retain natural geomorphic features, and allow for natural disturbance regimes (e.g., annual flooding). The core of very large occurrences are buffered from edge effects and small hydrology alterations along their periphery.

Justification for C/D threshold: C-ranked occurrences are large enough to contain moderate diversity of species and plant associations, and to sustain some natural or human caused perturbations. While D-ranked occurrences are noticeably lacking in diversity, and are too small to remain viable with even small changes to the hydrologic regime. They are also extremely susceptible to invasions by non-natives making them subject to loss of wet meadow plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Uplands surrounding occurrence are largely unaltered (>95% natural) by urban or agricultural uses such as clearcuts, crop cultivation, land development, or heavy grazing. There are no unnatural barriers present to inhibit movement of organisms and materials across system boundaries. Connectivity of habitats allows natural processes and species migration to occur.

B-rated landscape context:

Uplands within ¼ mile of the occurrence with minimal urban or agricultural alteration (>90% natural), and with no major barriers to water or organism movement across the system boundaries. The landscape has high connectivity, because there are few unnatural barriers present between patches of native vegetation that would inhibit species movement. Some natural processes on the landscape such as flooding, grazing, and fire may have altered frequencies or intensities

C-rated landscape context: Uplands surrounding occurrence are fragmented by urban or agricultural alteration (>80% natural), with limited connectivity between the occurrence and important components of the surrounding landscape. Some barriers are present that inhibit movement of organisms and materials across the landscape. Natural processes (e.g., fire, flood) have either been eliminated or have greatly altered frequencies and intensities. Activities (development, clearcuts, heavy grazing, etc.) in surrounding uplands alter the hydrologic regime. Restoration of the hydrologic regime and species composition resembling the historic composition is feasible.

D-rated landscape context: Uplands surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity almost nonexistent and natural processes severely altered. Restoration is not feasible within reason.

Justification for A-rated criteria: These occurrences are within nearly intact watersheds with intact ecological processes resulting in natural system structure and function. Wetlands are fully connected with other occurrences of this system, and with natural intact uplands. The wetlands are fully buffered from upland influences.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from upland influences, they are connected (although minimally) with other natural systems in the surrounding landscape, and the hydrologic regime and nutrient status has not been completely altered by upland influences. With some effort, system function for C-ranked occurrences could be improved. D-ranked occurrences have little or no buffering, and are subject to altered hydrology and invasive species. Natural hydrologic processes are severely altered causing a shift in species composition and altering the entire complex. D-ranked occurrences are missing fundamental components that prohibit restoration.

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SOUTHERN ROCKY MOUNTAINS ECOREGION
**BRISTLECONE – LIMBER PINE FOREST AND WOODLAND ECOLOGICAL
SYSTEM—LARGE PATCH**

Pinus aristata / *Festuca arizonica* Woodland
Pinus aristata / *Festuca thurberi* Woodland
Pinus aristata / *Ribes montigenum* Woodland
Pinus aristata / *Juniperus communis* Woodland
Pinus aristata / *Trifolium dasyphyllum* Woodland
Pinus aristata / *Vaccinium myrtillus* Woodland
Pinus flexilis / *Arctostaphylos uva-ursi* Woodland
Pinus flexilis / *Calamagrostis purpurascens* Woodland
Pinus flexilis / *Festuca kingii* Woodland
Pinus flexilis / *Juniperus communis* Woodland

**SCALE AND RANGE: LARGE PATCH AND LIMITED WITHIN THE SRM
ECOREGION**

Bristlecone – limber pine forest and woodland ecological system is a large patch system that occurs in approximately 0.5% of the Southern Rocky Mountains (SRM) ecoregion. Bristlecone pine is a near endemic to the SRM and is found in the Front, Mosquito, Sawatch, San Juan, and Sangre de Cristo ranges (Ranne 1995). Outside of SRM, it is only found on the San Francisco Peaks in Arizona. Bristlecone pine is also the oldest living tree species in the Rocky Mountains (Ranne 1995). An ancient bristlecone pine forest in Park County was recently found to contain a tree over 2,400 years old (Brunstein and Yamaguchi 1992). Limber pine is more widely distributed and is found in many other ecoregions. It largely replaces bristlecone pine north of I-70.

The bristlecone – limber pine forest and woodland ecological system occupies dry, rocky, windswept ridges and slopes, primarily south-facing. While limber pine can be found at nearly all forested elevations within the ecoregion, bristlecone pine is found only above 9,000 feet.

Although limber and bristlecone pine may occur together, they appear to react very differently to fires. Baker (1992) states that the unimodal distribution of size classes in most mature stands and the near absence of seedlings in these stands, together with abundant seedlings in recently burned stands, suggest that bristlecone pine regenerates primarily following fires. Limber pine apparently does not withstand fires and primarily becomes established from Clark nutcracker caches. However these caches may be uncovered by fires (<http://www.fs.fed.us/database/feis/>).

J. Coles (pers. comm.) believes bristlecone/limber pine woodlands fall into one of two basic types 1) ancient woodlands on scree, talus, ashflow or other sparsely vegetated substrate, and 2) mixed forest with Douglas-fir, Engelmann spruce, aspen, lodgepole pine, etc. Fire is not a factor in the ancient stands, but nutcrackers (and possibly pine squirrels) are critical. The more closed mixed forest types differ ecologically, in

composition, structure, and process than do the ancient forests. The ancient stands often occupy a small area from 5-10 acres.

MINIMUM SIZE: 300 acres.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than one mile wide, major highways, or urban development. 2) natural community from a different ecological system wider than one mile wide, or 3) major break in topography, soils, geology, etc.

Justification: Primary criteria to be considered are fires, snow avalanches, and Clarks nutcrackers. Fire appears to be necessary for bristlecone pine regeneration. Snow avalanches have removed large patches of *P. aristata* forests, resulting in forests with alternating strips of forest and treeless patches (Ranne 1995). The separation distance for intervening natural or semi-natural communities assumes a distinct landscape difference that is not conducive to species migration.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Equal weighting is given to all ranking factors.

CONDITION SPECIFICATIONS:

A –rated condition: No or little evidence of alteration of the system due to excessive livestock grazing, fire suppression, past or current mining operation, recreation, fragmentation, etc. If the occurrence is fragmented it is due to natural breaks, e.g., avalanche chute or aspect. No or very few exotic species present with no potential for expansion. Multiple age classes of bristlecone or limber pine are present, although many ancient stands naturally have little regeneration (J. Coles, pers. com.).

B- rated condition: Some evidence of an altered system due to excessive livestock grazing, fire suppression, past or current mining operation, recreation, etc. Occurrence may be slightly fragmented due to roads but these fragments are small enough that fires could still proceed. Few to no exotic species with little potential for expansion if restoration occurs.

C-rated condition: Excessive livestock grazing, fire suppression, or past or current mining operation, recreation, etc. is impacting the species composition and altering the natural fire regime.

D –rated condition: The site is not restorable within the next 25 years. System remains fundamentally compromised despite restoration of some processes. Exotic species may be dominant. Soil compaction and continued disturbance is extensive throughout the occurrence. Bristlecone pine or limber pine does not have the opportunity to regenerate, often due to the lack of fires.

Justification for A-rated criteria: Bristlecone pine and limber pine systems may be dependent on fires to open up the serotinous cones or Clarks nutcracker caches.

Occurrences altered by livestock grazing, etc., may reduce chances of fire as well as alter the native species composition. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 2000 acres)

B –rated size: Large (1000 to 2000 acres)

C –rated size: Moderate (300 - 1000 ac)

D –rated size: Small (<300 ac)

Justification for A-rated criteria: Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance. They are buffered from edge effects. Occurrences of this size would most likely support a mosaic fire pattern.

Justification for C/D threshold: C-ranked occurrences maintain a size that will allow for a complex structure allowing for several plant associations to occur and natural ecological processes to occur. While D-ranked occurrences are too small to remain viable with natural or unnatural changes to the hydrology or surrounding landscape and are easily subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Adjacent systems are unaltered by urban, agricultural, or forestry uses (> 90% natural). No barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fires and avalanches to occur.

B-rated landscape context: Limited or minor human-caused alteration of adjacent systems. Adjacent systems surrounding occurrence have moderate urban, agricultural or forestry use (60-90% natural) but retaining much connectivity. Few non-natural barriers present.

C-rated landscape context: Local or moderate human-caused alteration of adjacent systems. Adjacent systems surrounding occurrence are fragmented by alteration (20 – 60% natural), with limited connectivity. Some non-natural barriers are present. Significant, but easily restorable.

D-rated landscape context: Major human-caused alteration of adjacent systems. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses or the surrounding forest has been clearcut. Connectivity is severely hampered.

Justification for A-rated criteria: The bristlecone – limber pine system exist in a natural fire regime that is necessary for seed germination. The system is fully connected with

natural intact vegetation allowing for species migration and is fully buffered by a natural landscape.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species and altered fire regime. While D-ranked occurrences have no buffering, and are subject to altered fire regime and invasive species.

AUTHORSHIP: Renée Rondeau

Date: July 6, 2000

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SOUTHERN ROCKY MOUNTAINS ECOREGION
SPRUCE-FIR DRY – MESIC FOREST ECOLOGICAL SYSTEM –MATRIX

Abies lasiocarpa - *Picea engelmannii* Ribbon Forest
Abies lasiocarpa / *Carex geyeri* Forest
Abies lasiocarpa / *Juniperus communis* Woodland
Abies lasiocarpa / *Mahonia repens* Forest
Abies lasiocarpa / Moss Forest
Abies lasiocarpa / *Vaccinium cespitosum* Forest
Abies lasiocarpa / *Vaccinium myrtillus* Forest
Abies lasiocarpa / *Vaccinium scoparium* Forest
Picea engelmannii / Moss Forest
Picea engelmannii / *Polemonium pulcherrimum* Forest
Picea engelmannii / *Vaccinium myrtillus* Forest
Populus tremuloides - *Abies lasiocarpa* / *Juniperus communis* Forest

SCALE AND RANGE: MATRIX AND WIDESPREAD

Spruce–fir dry-mesic forest and spruce-fir moist-mesic forest ecological systems form the primary matrix systems of the montane and subalpine zones of the Southern Rocky Mountains (SRM) ecoregion. Over 10% of SRM is within these two systems occupying nearly 1.3 million hectares (Alexander et al. 1984, Alexander 1987, Whipple and Dix 1979). In addition to being the primary montane/subalpine matrix forming forest of SRM it is common in the subalpine region from Canada to southern New Mexico.

Individual community types may be matrix or large patch in character, though most typically occur as a mosaic of large patches across the landscape. Spruce-fir dominated stands occur on all but the most xeric sites above 3100 m, and in cool, sheltered valleys at elevations as low as 2500 m. The relative dominance of the two canopy tree species and the understory composition vary substantially over a gradient from excessively moist to xeric sites (Peet 1981). The mesic spruce-fir type occurs on cool, sheltered, but well-drained sites above 2700 m and is one of the most widespread forest types in the subalpine zone. Open slopes above 3000 m are typically characterized by Peet's (1981) xeric spruce-fir type, with varying amounts of lodgepole and limber pine. Towards lower elevations, the spruce-fir types give way, often along abrupt fire-induced boundaries, to lodgepole pine or aspen-dominated forests.

Spruce-fir forest also exhibit changes with latitude including treeline elevation, species composition, and dominance. Tree line occurs at over 3800 m at the southern end of the Southern Rocky Mountain ecoregion, whereas it does not exceed 3400 m at the northern end (Peet 1978). Fir increases in importance with increasing latitude, and shares dominance with spruce at tree line over the northern half of the Southern Rocky Mountains ecoregion. Possible explanations for this geographic variation include a genetic differentiation in *Abies* at the southern end of the ecoregion and variation in moisture or exposure conditions experienced by these high-elevation forests. That the degree of dominance by *Abies* could, in part, reflect the degree of drought stress or

exposure of the site is suggested by the absence of *Abies* in the forests of Pikes Peak, a xeric mountain (Peet 1978).

Fire, spruce-beetle outbreaks, avalanches, and windthrow all play an important role in shaping the dynamics of spruce-fir forests. Fires in the subalpine forest are typically stand replacing, resulting in the extensive exposure of mineral soil and initiating the development of new forests. Fifty year return interval for high intensity surface fires and 100-400 years return interval for crown fires which cover 1000 to 10,000 acres are noted for this ecological system (Peet 1981, Mutch 1991 as cited in Rio Grande National Forest USDFA Forest Service –Vice Spero Final Environmental impact statement). Depending on site conditions, spruce and fir may share the post-fire site with shade-intolerant species such as lodgepole pine, limber pine, and quaking aspen. Many stands in the subalpine zone of the Colorado Front range are of post-fire origin from c. mid 1700's (Veblen 1986). In subalpine forests of Rocky Mountain National Park, Colorado, there was an estimated 1 fire /4ha per 8100 sq km per year, prior to 1870 (Clagg 1975).

Spruce beetle (*Dendroctonus rufipennis*) outbreaks may be as significant as fire in the development of spruce-fir forests. In addition to fires and beetle kill, wind disturbance in spruce-fir forests has been well documented (Schaupp et al. 1999). Blowdowns involving multiple treefalls add to the mosaic of spruce-fir stands.

Under a natural disturbance regime, subalpine forests were probably characterized by a mosaic of stands in various stages of recovery from disturbance, with old-growth just one part of the larger forest mosaic (Peet 1981). This mosaic was constantly changing and highly variable from place to place, so the extent of presettlement old-growth forest is uncertain. The current subalpine landscape is perhaps more homogeneous (in terms of stand age) than in the presettlement era, mainly due to the synchronizing effect of very extensive, regional disturbance (e.g., fires in the mid 1700s, beetle outbreak in the mid to late 1800's (Peet 1981)).

Pine martens (*Martes americana*) are mostly a spruce-fir obligate that require a healthy and sizeable occurrence of mature forest. Therefore a viable population of pine martens has been chosen as an indicator of a healthy and viable occurrence of the spruce-fir system.

MINIMUM SIZE: 30,000 acres (minimum size for pine martens). See text under “Size” for more information.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation (includes clearcuts/tree plantations) greater than one wide, major highways (e.g., I-70), or urban development; 2) a non spruce-fir ecological system wider than 1 mile wide.

Justification: Many of these communities occur naturally in a mosaic much of the time so minor breaks or small barriers are probably a very common part of the natural distribution and variability. If the breaks are larger, barriers may exist for some species.

RANK PROCEDURE: 1) size, 2) condition, 3) landscape context. Size is the most important ranking factor for matrix communities. Condition is of secondary importance and while landscape context is still important, it is slightly less so than the overall size and condition of an occurrence given the large extent of these systems.

CONDITION SPECIFICATIONS:

Spruce-fir forests are climax in the range that it occupies. No other tree species will replace spruce-fir, not withstanding disturbance. In younger stands subalpine fir may be the major component of the forest type. However, it is shorter lived than Engelmann spruce. Consequently, most of the overstory in a spruce-fir old-growth stand is Engelmann spruce. The understory may still have an abundance of subalpine fir due to its high tolerance to shade and vegetative layering. Engelmann spruce life span average 350 to 400 years with 500 year old or more trees common. Trees over 250 years are common for subalpine fir but most are 150 to 200 years old.

Romme (1982) established six postfire seral stages in a spruce-fir climax types:

<i>Stage</i>	Age Range, years
Herbaceous	0-20
Seedling-sapling	20-40
Immature spruce-fir forest	150-300
Transitional	300-400
Climax Forest	>400 to >450

Although the above seral stages were developed for Yellowstone National Park, it is thought to hold throughout the spruce-fir range. All of these types should be well represented in an ecoregional portfolio the later seral stages have a higher premium for pine martens (Fitzgerald et al. 1994).

The following condition specifications apply mostly to the late seral stages that pine martens prefer.

A -rated condition: A mature stand (transitional to climax stage) of spruce-fir forest characterized by large-diameter trees (mainly spruce), abundant large snags and logs, and multistoried vegetation. Multiple canopies exist with a wide range of canopy heights, with moderate class diversity. Approximately 10 trees per acre with a minimum DBH of 16 inches and the minimum age of approx. 150 years. Usually this is an uneven aged stand with approximately 2 dead standing trees per acre with a minimum DBH of 10 inches (Mehl 1992). This is a large, intact, unfragmented occurrence with few to no roads or trails. Although most of the occurrence is comprised of mature stands, some 10% is in early seral stages resulting from natural disturbances (e.g., fire, pine-beetle kill, windthrow). Logging, if present is limited to less than 10% of occurrence. The understory is dominated by native species with less than 1% non-natives. Invasive species are absent.

B -rated condition: Little to no evidence of past logging disturbance over a major proportion of the occurrence and majority of stand is > 150 years old, may show evidence of selective logging that has altered their structure. Although most of the occurrence is comprised of mature stands, some 20% or less is in early seral stages resulting from natural disturbances (e.g., fire, pine-beetle kill, windthrow). The understory is dominated by native species with less than 3% non-natives (no to little impact on ecological processes). Invasive species are absent. The occurrence is relatively unfragmented with few to no roads.

C -rated condition: Stands regenerated naturally after logging or young to mature stands with significant history of selective logging disturbance that altered composition or structure; non-native species may be uncommon to frequent but do not dominate or co-dominate understory (5-10% cover). Young (< 25 years old) even aged stand of spruce or fir with very low species diversity. Roads or trails may be scattered throughout the occurrence. *Note: These types of stands are seral to climax spruce-fir forest and must be represented within an ecoregional portfolio. Therefore, a site should be large enough to hold a mosaic that would have at least 10-20% of the mosaic in early seral stage).*

D -rated condition: Highly fragmented from roads, logging, ski development, mining, or other human activities. Soil loss/erosion is high and therefore negatively impacts the water quality within the immediate watershed.

Justification for A-rated criteria: Frequency of old-growth stands has been much reduced in this ecoregion, so old-growth carries a premium for condition. Pine martens were chosen as an indicator mammal for this system. They prefer undisturbed stands with hollow trees, logs, and diverse structure (Fitzgerald et al. 1994).

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATION:

A -rated size: Very large (>90,000 ac)

B -rated size: Large (50,000-90,000 ac)

C -rated size: Moderate (30,000-50,000 ac)

D -rated size: Small (<30,000 ac)

Justification for A-rated criteria: Occurrences should be large enough to support a mosaic of stand conditions, ages, and disturbance patterns. The home range size of a female lynx in Alberta and Alaska is 12 km² (Brand et al. 1976 cited in Fitzgerald et al. 1994). Assuming you need an area large enough to support 25 mature females the acreage needed is 75,000 acres. An A-ranked size would support more than a minimum viable population of both lynx and pine martens.

Justification for C/D threshold: Occurrences smaller than 30,000 acres is subject to edge effects and total destruction from a catastrophic event, e.g., a crown fire. In addition

there is little opportunity for a mosaic of disturbance patterns. Pine martens probably require a minimum of 30,000 acres of a mature (> 150 years old) contiguous patch of forest for a viable population (Major et al. 1981 as cited in Anderson 1999).

LANDSCAPE CONTEXT SPECIFICATIONS:

A -rated landscape context: Occurrence surrounded by a large area of natural vegetation. A few small roads may exist in the surrounding landscape. Fire suppression in surrounding ecological systems are minimal to moderate.

B -rated landscape context: Occurrence surrounded by at least 80% natural or semi-natural vegetation. Fire suppression in surrounding ecological systems may be moderate.

C -rated landscape context: Occurrence surrounded by a mosaic of agricultural or semi-developed areas and natural or semi-natural vegetation, the latter composing 25-80% of the landscape, or landscape is dominated by very young tree plantations (cut within last 20 years).

D -rated landscape context: Occurrence surrounded primarily by urban or agricultural landscape, with <25% landscape cover of natural or semi-natural vegetation.

Justification for A-rated criteria: Connectivity intact. Natural processes can function. Edge effect is a proportionally small area.

Justification for C/D threshold: Landscape connectivity seriously impacted below about 35% cover of natural/semi-natural vegetation.

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SOUTHERN ROCKY MOUNTAINS ECOREGION
SPRUCE-FIR MOIST- MESIC FOREST ECOLOGICAL SYSTEM --MATRIX

Abies lasiocarpa / *Actaea rubra* Forest

Abies lasiocarpa / *Erigeron eximius* Forest

Abies lasiocarpa / *Rubus parviflorus* Forest

Abies lasiocarpa / *Saxifraga bronchialis* Scree Woodland

Picea engelmannii / *Trifolium dasyphyllum* Forest

Populus tremuloides - *Abies lasiocarpa* / *Amelanchier alnifolia* Forest

Populus tremuloides - *Abies lasiocarpa* / *Carex geyeri* Forest

SCALE AND RANGE: MATRIX AND WIDESPREAD

Spruce–fir dry-mesic forest and spruce-fir moist-mesic forest ecological systems form the primary matrix systems of the montane and subalpine zones of the Southern Rocky Mountains (SRM) ecoregion. Over 10% of SRM is within these two systems occupying nearly 1.3 million hectares (Alexander et al. 1984, Alexander 1987, Whipple and Dix 1979). In addition to being the primary montane/subalpine matrix forming forest of SRM it is common in the subalpine region from Canada to southern New Mexico.

Individual community types may be matrix or large patch in character, though most typically occur as a mosaic of large patches across the landscape. Spruce-fir dominated stands occur on all but the most xeric sites above 3100 m, and in cool, sheltered valleys at elevations as low as 2500 m. The relative dominance of the two canopy tree species and the understory composition vary substantially over a gradient from excessively moist to xeric sites (Peet 1981). The mesic spruce-fir type occurs on cool, sheltered, but well-drained sites above 2700 m and is one of the most widespread forest types in the subalpine zone. Open slopes above 3000 m are typically characterized by Peet's (1981) xeric spruce-fir type, with varying amounts of lodgepole and limber pine. Towards lower elevations, the spruce-fir types give way, often along abrupt fire-induced boundaries, to lodgepole pine or aspen-dominated forests.

Spruce-fir forest also exhibit changes with latitude including treeline elevation, species composition, and dominance. Tree line occurs at over 3800 m at the southern end of the Southern Rocky Mountain ecoregion, whereas it does not exceed 3400 m at the northern end (Peet 1978). Fir increases in importance with increasing latitude, and shares dominance with spruce at tree line over the northern half of the Southern Rocky Mountains ecoregion. Possible explanations for this geographic variation include a genetic differentiation in *Abies* at the southern end of the ecoregion and variation in moisture or exposure conditions experienced by these high-elevation forests. That the degree of dominance by *Abies* could, in part, reflect the degree of drought stress or exposure of the site is suggested by the absence of *Abies* in the forests of Pikes Peak, a xeric mountain (Peet 1978).

Fire, spruce-beetle outbreaks, avalanches, and windthrow all play an important role in shaping the dynamics of spruce-fir forests. Fires in the subalpine forest are typically

stand replacing, resulting in the extensive exposure of mineral soil and initiating the development of new forests. Fifty year return interval for high intensity surface fires and 100-400 years return interval for crown fires which cover 1000 to 10,000 acres are noted for this ecological system (Peet 1981, Mutch 1991 as cited in Rio Grande National Forest USDFA Forest Service –Vice Spero Final Environmental impact statement). Depending on site conditions, spruce and fir may share the post-fire site with shade-intolerant species such as lodgepole pine, limber pine, and quaking aspen. Many stands in the subalpine zone of the Colorado Front range are of post-fire origin from c. mid 1700's (Veblen 1986). In subalpine forests of Rocky Mountain National Park, Colorado, there was an estimated 1 fire /4ha per 8100 sq km per year, prior to 1870 (Clagg 1975).

Spruce beetle (*Dendroctonus rufipennis*) outbreaks may be as significant as fire in the development of spruce-fir forests. In addition to fires and beetle kill, wind disturbance in spruce-fir forests has been well documented (Schaupp et al. 1999). Blowdowns involving multiple treefalls add to the mosaic of spruce-fir stands.

Under a natural disturbance regime, subalpine forests were probably characterized by a mosaic of stands in various stages of recovery from disturbance, with old-growth just one part of the larger forest mosaic (Peet 1981). This mosaic was constantly changing and highly variable from place to place, so the extent of presettlement old-growth forest is uncertain. The current subalpine landscape is perhaps more homogeneous (in terms of stand age) than in the presettlement era, mainly due to the synchronizing effect of very extensive, regional disturbance (e.g., fires in the mid 1700s, beetle outbreak in the mid to late 1800's (Peet 1981)).

Pine martens (*Martes americana*) are mostly a spruce-fir obligate that require a healthy and sizeable occurrence of mature forest. Therefore a viable population of pine martens has been chosen as an indicator of a healthy and viable occurrence of the spruce-fir system.

MINIMUM SIZE: 30,000 acres (minimum size for pine martens). See text under “Size” for more information.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation (includes clearcuts/tree plantations) greater than one wide, major highways (e.g., I-70), or urban development; 2) a non spruce-fir ecological system wider than 1 mile wide.

Justification: Many of these communities occur naturally in a mosaic much of the time so minor breaks or small barriers are probably a very common part of the natural distribution and variability. If the breaks are larger, barriers may exist for some species.

RANK PROCEDURE: 1) size, 2) condition, 3) landscape context. Size is the most important ranking factor for matrix communities. Condition is of secondary importance and while landscape context is still important, it is slightly less so than the overall size and condition of an occurrence given the large extent of these systems.

CONDITION SPECIFICATIONS:

Spruce-fir forests are climax in the range that it occupies. No other tree species will replace spruce-fir, not withstanding disturbance. In younger stands subalpine fir may be the major component of the forest type. However, it is shorter lived than Engelmann spruce. Consequently, most of the overstory in a spruce-fir old-growth stand is Engelmann spruce. The understory may still have an abundance of subalpine fir due to its high tolerance to shade and vegetative layering. Engelmann spruce life span average 350 to 400 years with 500 year old or more trees common. Trees over 250 years are common for subalpine fir but most are 150 to 200 years old.

Romme (1982) established six postfire seral stages in a spruce-fir climax types:

<i>Stage</i>	Age Range, years
Herbaceous	0-20
Seedling-sapling	20-40
Immature spruce-fir forest	150-300
Transitional	300-400
Climax Forest	>400 to >450

Although the above seral stages were developed for Yellowstone National Park, it is thought to hold throughout the spruce-fir range. All of these types should be well represented in an ecoregional portfolio the later seral stages have a higher premium for pine martens (Fitzgerald et al. 1994).

The following condition specifications apply mostly to the late seral stages that pine martens prefer.

A -rated condition: A mature stand (transitional to climax stage) of spruce-fir forest characterized by large-diameter trees (mainly spruce), abundant large snags and logs, and multistoried vegetation. Multiple canopies exist with a wide range of canopy heights, with moderate class diversity. Approximately 10 trees per acre with a minimum DBH of 16 inches and the minimum age of approx. 150 years. Usually this is an uneven aged stand with approximately 2 dead standing trees per acre with a minimum DBH of 10 inches (Mehl 1992). This is a large, intact, unfragmented occurrence with few to no roads or trails. Although most of the occurrence is comprised of mature stands, some 10% is in early seral stages resulting from natural disturbances (e.g., fire, pine-beetle kill, windthrow). Logging, if present is limited to less than 10% of occurrence. The understory is dominated by native species with less than 1% non-natives. Invasive species are absent.

B -rated condition: Little to no evidence of past logging disturbance over a major proportion of the occurrence and majority of stand is > 150 years old, may show evidence of selective logging that has altered their structure. Although most of the occurrence is comprised of mature stands, some 20% or less is in early seral stages resulting from natural disturbances (e.g., fire, pine-beetle kill, windthrow). The understory is dominated

by native species with less than 3% non-natives (no to little impact on ecological processes). Invasive species are absent. The occurrence is relatively unfragmented with few to no roads.

C -rated condition: Stands regenerated naturally after logging or young to mature stands with significant history of selective logging disturbance that altered composition or structure; non-native species may be uncommon to frequent but do not dominate or co-dominate understory (5-10% cover). Young (< 25 years old) even aged stand of spruce or fir with very low species diversity. Roads or trails may be scattered throughout the occurrence. *Note: These types of stands are seral to climax spruce-fir forest and must be represented within an ecoregional portfolio. Therefore, a site should be large enough to hold a mosaic that would have at least 10-20% of the mosaic in early seral stage).*

D -rated condition: Highly fragmented from roads, logging, ski development, mining, or other human activities. Soil loss/erosion is high and therefore negatively impacts the water quality within the immediate watershed.

Justification for A-rated criteria: Frequency of old-growth stands has been much reduced in this ecoregion, so old-growth carries a premium for condition. Pine martens were chosen as an indicator mammal for this system. They prefer undisturbed stands with hollow trees, logs, and diverse structure (Fitzgerald et al. 1994).

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATION:

A -rated size: Very large (>90,000 ac)

B -rated size: Large (50,000-90,000 ac)

C -rated size: Moderate (30,000-50,000 ac)

D -rated size: Small (<30,000 ac)

Justification for A-rated criteria: Occurrences should be large enough to support a mosaic of stand conditions, ages, and disturbance patterns. The home range size of a female lynx in Alberta and Alaska is 12 km² (Brand et al. 1976 cited in Fitzgerald et al. 1994). Assuming you need an area large enough to support 25 mature females the acreage needed is 75,000 acres. An A-ranked size would support more than a minimum viable population of both lynx and pine martens.

Justification for C/D threshold: Occurrences smaller than 30,000 acres is subject to edge effects and total destruction from a catastrophic event, e.g., a crown fire. In addition there is little opportunity for a mosaic of disturbance patterns. Pine martens probably require a minimum of 30,000 acres of a mature (> 150 years old) contiguous patch of forest for a viable population (Major et al. 1981 as cited in Anderson 1999).

LANDSCAPE CONTEXT SPECIFICATIONS:

A -rated landscape context: Occurrence surrounded by a large area of natural vegetation. A few small roads may exist in the surrounding landscape. Fire suppression in surrounding ecological systems are minimal to moderate.

B -rated landscape context: Occurrence surrounded by at least 80% natural or semi-natural vegetation. Fire suppression in surrounding ecological systems may be moderate.

C -rated landscape context: Occurrence surrounded by a mosaic of agricultural or semi-developed areas and natural or semi-natural vegetation, the latter composing 25-80% of the landscape, or landscape is dominated by very young tree plantations (cut within last 20 years).

D -rated landscape context: Occurrence surrounded primarily by urban or agricultural landscape, with <25% landscape cover of natural or semi-natural vegetation.

Justification for A-rated criteria: Connectivity intact. Natural processes can function. Edge effect is a proportionally small area.

Justification for C/D threshold: Landscape connectivity seriously impacted below about 35% cover of natural/semi-natural vegetation.

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DATE: July 17, 2000

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SOUTHERN ROCKY MOUNTAINS ECOREGION
LOGEPOLE PINE FOREST ECOLOGICAL SYSTEM --MATRIX

Pinus contorta / *Arctostaphylos uva-ursi* Forest
Pinus contorta / *Carex geyeri* Forest
Pinus contorta / *Carex rossii* Forest
Pinus contorta / *Juniperus communis* Woodland
Pinus contorta / *Shepherdia canadensis* Forest
Pinus contorta / *Vaccinium scoparium* Forest

SCALE AND RANGE: MATRIX AND WIDESPREAD

Lodgepole pine forest ecological system is a matrix system that occupies nearly 6% of the Southern Rocky Mountain ecoregion. This system is also well represented in the Rocky Mountain ecoregions to the north but not to the south. In fact, lodgepole pine reaches the southernmost extension of its range at about the middle of the upper Gunnison Basin (Johnston 1997) and therefore the southern half of the Southern Rocky Mountains (SRM) ecoregion is void of lodgepole pine entirely. In the SRM ecoregion, lodgepole pine forests generally occur between 8,000-10,000 feet from gentle to steep slopes on all aspects. This system consists of extensive stands of pure lodgepole pine or, to a lesser extent, stands in association with other conifer species. Lodgepole pine is a successional species par excellence but may be climax under certain edaphic conditions, especially cold microclimate and thin, excessively drained soils (Hess and Alexander 1986). Lodgepole pine is shade intolerant and is an aggressive pioneer developing on sites recently opened up due to fire, insects, disease, windstorms, clearcutting, or other major stand removing disturbance. Lodgepole pine stands that are 350 to 400 years old exist but are uncommon (Mehl 1992). The average life span of lodgepole pine is probably closer to 250 years or less because of the frequency of stand replacing disturbances such as fire (Mehl 1992). Fires are more frequent in lodgepole pine than spruce-fir as they occur in a warmer and drier environment.

Lodgepole pine is generally considered a seral species. That is, it will be replaced by the more shade tolerant spruce or fir at the upper elevations and Douglas fir at the lower elevations. Most lodgepole pine stands become established after stand replacing events. There are instances when lodgepole pine can be considered climax (Mehl 1992). In areas where a seed source of more shade tolerant trees species does not exist or the site is marginal for other tree species, the lodgepole pine stand will not be replaced (Mehl 1992). Over successive generations the stand would develop a structure more consistent of old growth in shade tolerant species (Mehl 1992). Prior to fire suppression few stands would have had the opportunity to reach this structure (Mehl 1992).

Shrub and herbaceous layers are often poorly developed in lodgepole pine forests, and plant species diversity is low. This low understory diversity is probably related to the single age class and dense canopy of many stands.

Brown creeper, Williamson sapsucker, Boreal owl, Three-toed woodpecker, and Gray jay are indicators of a functioning lodgepole pine system (Pague, C. pers. com.).

MINIMUM SIZE: 30,000 acres (see Anderson 1999 for a good explanation for choosing size for matrix communities).

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation (includes clearcuts/tree plantations) greater than ½ wide, major highways, or urban development; 2) a different ecological system wider than ½ mile wide; 3) a major break or change in the ecological land unit (e.g. topography, soils, geology).

Justification: Many of these lodgepole pine forests occur naturally in a mosaic much of the time so minor breaks or small barriers are part of the natural distribution and variability. If the breaks are larger, barriers may exist for some species.

RANK PROCEDURE: 1) size, 2) condition, 3) landscape context. Size is the most important ranking factor for matrix communities. Condition is of secondary importance and while landscape context is still important, it is slightly less so than the overall size and condition of an occurrence.

CONDITION SPECIFICATIONS:

A -rated condition: A mature stand of lodgepole pine consists of approximately 10 trees per acre with a minimum DBH of 10 inches and the minimum age of approximately 150 years. Usually this is an even aged stand with approx. 2 dead standing trees per acre with a minimum DBH of 8 inches. Multiple tree species exist, e.g., *Picea engelmannii*, *Abies lasiocarpa*, *Populus tremuloides* (Mehl 1992). Stand is open enough to have multiple canopy cover, e.g., *Shepherdia canadensis*, *Vaccinium* spp., or grasses. Fragmentation due to roads, logging, mining, or other human development is limited to less than 1% of the occurrence.

B -rated condition: Little to no evidence of past logging disturbance over a major proportion of the occurrence. Majority of stand is > 100 years old and may show evidence of selective logging that has altered their structure; non-native species may be present with low to moderate frequency in the understory, but have low percent cover. Fragmentation due to roads, logging, mining, or other human development is limited to less than 3% of the occurrence.

C -rated condition: Stands regenerated naturally after fire, logging, or young to mature stands with significant history of selective logging disturbance that altered composition or structure; non-native species may be uncommon to frequent but do not dominate or co-dominate understory (<10-20% cover). Fragmentation due to roads, logging, mining, or other human development is limited to less than 5% of the occurrence.

D -rated condition: Fragmentation due to roads, recent logging, mining, or other human development occupies more than 5% of the occurrence. Dog-hair stands of lodgepole

pine with very low species diversity that were created due to human disturbance or fire suppression.

Note: Dog-hair stands are within the natural variation of a lodgepole forest and frequently occur after fires. While placing goals for an ecoregion plan it is important to include this natural variation.

Justification for A-rated criteria: Frequency of old-growth stands has been much reduced in this ecoregion, so old-growth carries a premium for condition. Occurrences that have not been logged represent a natural state, often with high species richness and diversity that are free from non-native species.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. Given enough time (approx. 75 years), even D-ranked occurrences of lodgepole pine have an excellent chance of becoming a high ranked occurrence, especially if fire suppression is ceased.

SIZE SPECIFICATIONS:

A -rated size: Very large (>90,000 ac)

B -rated size: Large (50,000-80,000 ac)

C -rated size: Moderate (30,000-50,000 ac)

D -rated size: Small (<30,000 ac)

Justification for A-rated criteria: A 90,000 acre stand is large enough to support a mosaic of stand conditions, ages, and disturbance patterns.

Justification for C/D threshold: A 30,000 acre stand is estimated to be as small as matrix communities can be and still support minimum viable populations of pine martens (Anderson 1999). Smaller than 30,000 acres is subject to edge effects and stand destroying events, e.g., fire, beetle kill.

LANDSCAPE CONTEXT SPECIFICATIONS:

A -rated landscape context: Occurrence surrounded by a large area (>2000 ac/800 ha) of natural vegetation. Few small roads in the surrounding landscape. Frequency and intensities of fires are within expected range.

B -rated landscape context: Landscape composed of at least 80% natural or semi-natural vegetation; or landscape has very little development or agriculture but has major components of non-native vegetation in at least one physiognomic layer or is composed primarily of tree plantations. Frequencies and intensities of fires are within expected range.

C -rated landscape context: Landscape is a mosaic of agricultural or semi-developed areas and natural or semi-natural vegetation, the latter composing 25-80% of the landscape, or landscape is dominated by very young tree plantations (cut within last 20

years). Frequencies and intensities of fires may be out of expected range, but are easily restorable.

D -rated landscape context: Occurrence surrounded primarily by urban or agricultural landscape, with <25% landscape cover of natural or semi-natural vegetation. Frequencies and intensities of fires are out of expected range and not restorable.

Justification for A rated criteria: Connectivity intact. Natural processes can function.

Justification for C/D threshold: Landscape connectivity seriously impacted below about 35% cover of natural/semi-natural vegetation.

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SOUTHERN ROCKY MOUNTAINS ECOREGION ASPEN FOREST--MATRIX

Populus tremuloides - *Pinus ponderosa* Rocky Mountain Forest
Populus tremuloides (*Pinus ponderosa*) / *Danthonia parryi*
Populus tremuloides / *Acer glabrum* Forest
Populus tremuloides / *Amelanchier alnifolia* - *Symphoricarpos oreophilus* / *Thalictrum fendleri* Forest
Populus tremuloides / *Calamagrostis rubescens* Forest
Populus tremuloides / *Carex foenea* Forest
Populus tremuloides / *Carex geyeri* Forest
Populus tremuloides / *Ceanothus velutinus* Forest
Populus tremuloides / *Corylus cornuta* Forest
Populus tremuloides / *Festuca thurberi* Forest
Populus tremuloides / *Juniperus communis* Forest
Populus tremuloides / *Lonicera involucrata* Forest
Populus tremuloides / *Pteridium aquilinum* Forest
Populus tremuloides / *Senecio bigelovii* var. *bigelovii* Forest
Populus tremuloides / *Shepherdia canadensis* Forest
Populus tremuloides / *Symphoricarpos oreophilus* / *Calamagrostis rubescens* Forest
Populus tremuloides / *Symphoricarpos oreophilus* / *Festuca thurberi* Forest
Populus tremuloides / *Symphoricarpos oreophilus* / *Thalictrum fendleri* Forest
Populus tremuloides / *Symphoricarpos oreophilus* Forest
Populus tremuloides / Tall Forbs Forest
Populus tremuloides / *Thalictrum fendleri* Forest
Populus tremuloides / *Vaccinium myrtillus* Forest

SCALE AND RANGE: MATRIX AND WIDESPREAD

Montane aspen forest ecological system is a matrix system found throughout the Southern Rocky Mountains ecoregion between 8,000-10,000 feet in elevation. Nearly 7% of SRM has montane aspen forest. Aspen forest are matrix communities usually maintained by fires. They usually occur as a mosaic of many plant associations and may be surrounded by a diverse array of other systems, including grasslands, wetlands, coniferous forests, etc. Within the Southern Rocky Mountains ecoregion, this system is extremely prevalent on the West slope, with smaller stands represented on the East slope.

Quaking aspen is the most widely distributed native North American tree species and can be found from eastern to western U.S. (Little 1971). Although widespread it often is not a dominant. In the Colorado Plateau and the Southern Rocky Mountains ecoregions aspen reaches its highest abundance and develops expansive forests, with over 3.2 million acres in the Southern Rocky Mountains ecoregion. In contrast Montana has approximately 255,000 acres (Jones 1986). In the Southern Rocky Mountains ecoregion, aspen forests are most prominent west of the Front Range and Sangre de Cristo ranges. Aspen commonly reaches its lowest elevations in canyons and ravines and may be found as low as 5,500 feet. In the Southern Rocky Mountain ecoregion aspen is confined to

relatively moist sites (16 to 40 plus inches annual precipitation) that have cold winters and a reasonably long growing season. These conditions restrict aspen to low elevations in the northern and eastern portions of its range. Aspen grows at progressively higher elevations southward along the Rocky Mountains.

Aspen is usually a seral tree in climax sub-alpine fir associations at the higher elevations. In such situations it may dominate the forest community for many decades following severe disturbance, such as fire or clearcutting, but will gradually decline as the conifers become reestablished. At lower elevations aspen can occur either as a temporarily dominant seral species in a variety of climax conifer associations, or it can achieve permanent dominance as the climax forest type. The environmental conditions related to aspen's role as a seral and as a climax species remain ill-defined (Mueggler and Campbell 1986).

In montane aspen forests, aspen comprise at least 50% of the tree canopy. It typically is less shade tolerant and shorter lived than most conifers. Thus, aspen stands that contain a substantial element of conifers are considered to be at a seral stage leading toward a conifer climax. Stands with a substantial element of conifers are categorized as conifer-aspen types.

Aspen lands have provided prime summer range for both sheep and cattle in Colorado since settlement in the latter half of the 19th century. Some 100 years of grazing at varying intensity and by different classes of livestock have left their mark in often severe alteration of undergrowth composition and production. Some of these alterations are pronounced; others are subtle and difficult to assess (Mueggler and Campbell 1986).

The aspen ecosystem is rich in number and species of animals, especially in comparison to associated coniferous forest types. This natural species diversity and richness has been both increased and influenced by the introduction of domestic livestock. The high value of the aspen type as a forage resource for livestock and as forage and cover for wildlife makes the subject of animal impacts important to understanding and management of this ecosystem (DeByle and Winokur 1985).

MINIMUM SIZE: 5,000 acres

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including urban development greater than ½ mile wide, major highways, 2) a different natural ecological system greater than 1 mile wide, 3) areas of cultural vegetation greater than 1 mile wide.

Justification: Primary criteria to be considered are the reaction of native species to fragmentation, seed dispersal by dominant trees, shrubs, grasses, and forbs and the connectivity for fires and requirements for large native ungulates.

RANK PROCEDURE: 1) size, 2) condition, 3) landscape context. Size is the most important ranking factor for matrix communities. Condition is of secondary importance

and while landscape context is still important, it is slightly less so than the overall size and condition of an occurrence.

CONDITION SPECIFICATIONS:

A-rated conditions: A mosaic of aspen plant communities and a diverse age class structure within these communities. Native species dominant, non-native species may be present but in small amounts, <3% total cover. Invasive exotics with major potential to alter structure and composition are absent, e.g., *Bromus inermis*. Native species that increase with disturbance, e.g., *Balsamorhiza* and *Wyethia*, have less than 3% cover. Ground cover is > 65%. Natural microrelief is undisturbed. Soil erosion is not accelerated by anthropogenic activities. No surficial disturbance is evident or if present than in only small, isolated areas (e.g. mines or ranch activities and buildings; off-road vehicle use). There are few or no roads found within the occurrence.

B-rated condition: A mosaic of aspen plant communities and a diverse age class structure within these communities. Native species dominant, non-native species may be present and even dominant in spots, but not throughout the occurrence and only in disturbed areas. Invasive exotics with major potential to alter structure and composition are nearly absent, e.g., *Bromus inermis*. Native species that increase with disturbance, e.g., *Wyethia* and *Balsamorhiza*, have less than 10% cover. Ground cover is intact in at least 80% of the occurrence. Soil erosion may be accelerated in small patches, or lightly so throughout the occurrence. Natural microrelief is undisturbed. Soil erosion is not accelerated by anthropogenic activities. No surficial disturbance is evident or if present than in only small, isolated areas (e.g. mines or ranch activities and buildings; off-road vehicle use). Surficial disturbances are limited to less than 20% of the occurrence area (e.g., mines or ranch activities and buildings; off-road vehicle use). There are only a few roads found within the occurrence.

C-rated condition: Occurrence is dominated by native species; non-natives can be present and quite abundant in small and large patches. Ground cover is below 60% in more than 25% of the area, or in various stages of degradation throughout the occurrence. Surficial disturbances occur on more than 20% of the area (e.g., mines or ranch activities and buildings; off-road vehicle use). There are more than a few roads found within the occurrence.

D-rated condition: Occurrence is dominated by native perennial increasers or non-natives. Ground cover has been removed from 75% of the area, occurring only in small pockets naturally protected from livestock and off-road vehicle use. Surficial disturbances occur on more than 50% of the area (e.g., mines or ranch activities and buildings; off-road vehicle use). Many roads are found within the occurrence.

Justification for A-rated criteria: characteristic ecological gradients remain intact supporting interactions among component species. Natural disturbances can occur on a scale that permits maintenance of a diverse community patches.

Justification for C/D threshold: C-ranked occurrences would naturally improve in condition resulting from anthropogenic disturbances with a change in the management practices, with significant recovery expected within 25 years. D-ranked occurrences will not likely improve and are prone to irreversible changes in composition. Significant emphasis is placed on the relative extent of introduced plant species and the loss of the topsoil. Emphasis is also placed in the degree of fragmentation from roads and the amount of accelerated soil erosion.

SIZE SPECIFICATIONS:

A-rated size: Very large (>30,000 acres)

B-rated size: Large (10,000-30,000 acres)

C-rated size: Moderate (5,000-10,000 acres)

D-rated size: Small (<5,000 acres)

Justification for A-rated criteria: A-ranked occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance, and may survive accelerated erosion disturbance problems.

Justification for C/D threshold: stands smaller than C-ranked may be viable if they are surrounded by naturally occurring montane vegetation, or if it occupies all of the available habitat in an un-altered, unfragmented valley. As a rule, smaller stands lack variability, have largely disturbed or altered natural geomorphic disturbance processes and are surrounded by altered landscapes. The primary criteria considered are loss of diversity from livestock grazing, fragmentation by roads, and the likelihood of an area completely burning in a single event.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Highly connected – surrounding landscape has been little altered, captures the characteristic ecological gradients (including nested patch communities) and geomorphic processes, and the occurrences are completely surrounded by other high quality communities. Provides habitat for indicator species such as grouse, purple martin, etc.

B-rated landscape context: occurrence is surrounded by moderate-low quality natural communities, some of which may have been logged or disturbed in the past; an expansive semi-natural landscape that has been used extensively for grazing.

C-rated landscape context: Moderately fragmented and isolated -- occurrences are surrounded by a mix of intensive agriculture, small scale urban development, and adjacent semi-natural communities, or the occurrence is a relatively small area (total area smaller than twice the minimum occurrence size (see moderate under size criteria) surrounded by an agriculturally fragmented landscape.

D-rated landscape context: Highly fragmented and isolated -- area around the occurrence is entirely, or almost entirely, surrounded by agricultural or urban land use; occurrence is at best buffered on one side by natural communities. The surrounding landscape is primarily intensive agriculture or urban development.

Justification for A-rated criteria: Characteristic ecological gradients remain intact supporting interactions among component species. Natural disturbances can occur on a scale that permits maintenance of patches of the community in a variety of conditions.

Justification for C/D threshold: Characteristic ecological gradients lacking or otherwise disrupted, with irretrievable impacts on habitat requirements for component species.

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Date: July 2, 2000

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**SOUTHERN ROCKY MOUNTAINS ECOREGION
MONTANE MOIST - MESIC MIXED CONIFER FOREST ECOLOGICAL
SYSTEM--MATRIX**

Abies concolor / *Arctostaphylos uva-ursi* Forest
Abies concolor / *Holodiscus dumosus* Scree Woodland
Abies concolor / *Mahonia repens* Forest
Abies concolor / *Quercus gambelii* Forest
Abies concolor / *Robinia neomexicana* Woodland
Picea pungens / *Arctostaphylos uva-ursi* Forest
Picea pungens / *Festuca arizonica* Woodland
Pseudotsuga menziesii / *Bromus ciliatus* Forest

Mixed conifer mesic-dry forest ecological system is a matrix system that occurs in approximately 3% of the Southern Rocky Mountains ecoregion, primarily in the southern portion, and especially in New Mexico. *Abies concolor*, *Picea pungens*, *Pinus ponderosa*, and *Pseudotsuga menziesii* are the common conifer trees. In the Rocky Mountain, mature white fir trees rarely exceed 125 feet in height or 3 feet dbh and mostly reach ages of 250 to 275 years (Fowells 1965). Within the mixed conifer type, white fir is primarily the climax dominant on moist sites such as northern exposures, while ponderosa pine, Douglas-fir, or juniper tend to dominate at climax on warm and dry sites. On intermediate sites, white fir may co-dominate at climax with these conifers (www.fs.fed.us/database/feis/).

White fir will eventually dominate if the fire-free interval is sufficiently long to allow trees to grow to a fire-resistant size. Each one of these species has a slightly different reaction to the presence of fires and therefore fire history helps to determine the cover of each species. *Pinus ponderosa* and *Pseudotsuga menziesii* are the most fire tolerant, while *Picea pungens* is fire intolerant. *Abies concolor* sapling and pole-sized classes are fire sensitive (Hopkins 1982 in www.fs.fed.us/database/feis/). Trees progressively become more fire resistant as they attain 8 to 10 inch dbh (Hopkins 1982 in www.fs.fed.us/database/feis/).

Presettlement fire frequency in mixed conifer forest of the southern Rocky Mountains was from 7 to 22 years (Alexander et al. 1984, Dieterich 1983 in www.fs.fed.us/database/feis/). In cool, moist white fir habitat types in New Mexico, naturally occurring fires are mostly light, erratic, and infrequent (DeVelice and Ludwig 1983, Moir and Ludwig 1979 in www.fs.fed.us/database/feis/). These frequently occurring fires were generally of low intensity because of the short time span between fires resulted in low accumulations of dead and down fuels. High-intensity, stand-replacing fires were uncommon (Dieterich 1983 in www.fs.fed.us/database/feis/). Before fire suppression began in mixed conifer forests, ponderosa pine and Douglas-fir, often dominated the overstory (Agee 1982, Hopkins 1982 in www.fs.fed.us/database/feis/). As a result of fire suppression since the turn of the century, white fir density has greatly increased in mixed conifer forests. Today, unnatural, heavy accumulations of dead fuels and abundant young white fir (which often form “dog-hair” thickets) greatly increase the

chances for high-intensity, stand-replacing crown fires (Parsons and DeBenedetti 1979 in www.fs.fed.us/database/feis/).

The Jemez Mountains salamander and the Sacramento Mountains salamander are endangered species that occur primarily in mixed conifer forests of New Mexico. Other sensitive and endangered species that use mixed conifer stands, especially with blue spruce, include Flammulated owls and Northern goshawks.

MINIMUM SIZE: 30,000 acres (see Anderson 1997 for a review of minimum size for matrix forming communities)

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation (includes clearcuts/tree plantations) greater than ½ wide, major highways, or urban development; 2) a different ecological system wider than ½ mile wide; 3) a major break or change in the ecological land unit (e.g. topography, soils, geology).

Justification: Many of these communities occur naturally in a mosaic much of the time so minor breaks or small barriers are probably a very common part of the natural distribution and variability. If the breaks are larger, barriers may exist for some species.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Size is the most important ranking factor for matrix communities. Condition is of secondary importance and while landscape context is still important, it is slightly less so than the overall size and condition of an occurrence.

CONDITION SPECIFICATIONS:

A -rated condition: A mature stand of mixed conifer that consists of 10 trees per acre that have an age of at least 150 years old. Usually this is a multi-aged stand with some dead standing trees as well as some fallen mature trees. Where the site is mesic, the stand would be more open-grown compared to a cooler, more moist site such as a north facing slope or drainage bottom. Some of the overstory trees would have large and open branched, flattened or dead tops and contain some rot. Few to no invasive species are present.

B -rated condition: Little to no evidence of past logging disturbance over a major proportion of the occurrence and majority of stand is > 100 years old, may show evidence of selective logging that has altered their structure; non-native species may be present with low to moderate frequency in the understory, but have low percent cover.

C -rated condition: Stands regenerated naturally after logging or young to mature stands with significant history of selective logging disturbance that altered composition or structure; non-native species may be uncommon to frequent but do not dominate or co-dominate understory (<10-20% cover).

D -rated condition: Immature, “dog-hair” stand of conifers, especially white fir with very low species diversity.

Justification for A-rated criteria: Frequency of old-growth stands has been much reduced in this ecoregion, so old-growth carries a premium for condition. In addition, occurrences that have been unaltered by logging, fire suppression, and are primarily dominated by native species are priority stands for conservation of biodiversity.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE.SPECS

A -rated size: Very large (>90,000 ac)

B -rated size: Large (50,000-80,000 ac)

C -rated size: Moderate (30,000-50,000 ac)

D -rated size: Small (<30,000 ac)

Justification for A-rated criteria: Large enough to support a mosaic of stand conditions, ages, and disturbance patterns. The home range size of a female lynx in Alberta and Alaska is 12 km² (Brand et al. 1976 cited in Fitzgerald et al. 1994). Assuming you need an area large enough to support 25 mature females the acreage needed is 75,000 acres. An A-ranked size would support more than a minimum viable population of both lynx and pine martens.

Justification for AC/D@ threshold: Smaller than 30,000 acres is subject to edge effects and total destruction from a catastrophic event, e.g., a crown fire. In addition there is little opportunity for a mosaic of disturbance patterns. Pine martens probably require a minimum of 30,000 acres of a mature (> 150 years old) contiguous patch of forest for a viable population (Major et al. 1981 as cited in Anderson 1999).

LANDSCAPE.CONTEXT.SPECS

A -rated landscape context: Occurrence surrounded by a large area (>2000 ac/800 ha) of natural vegetation. Few small roads in the surrounding landscape.

B -rated landscape context: Landscape composed of at least 80% natural or semi-natural vegetation; or landscape has very little development or agriculture but has major components of non-native vegetation in at least one physiognomic layer or is composed primarily of young tree plantations.

C -rated landscape context: Landscape is a mosaic of agricultural or semi-developed areas and natural or semi-natural vegetation, the latter composing 25-80% of the landscape, or landscape is dominated by very young tree plantations (cut within last 20 years).

D-rated landscape context: Occurrence surrounded primarily by urban or agricultural landscape, with <25% landscape cover of natural or semi-natural vegetation.

Justification for A-rated criteria: Connectivity intact. Natural processes can function.

Justification for C/D threshold: Landscape connectivity seriously impacted below about 35% cover of natural/semi-natural vegetation.

AUTHORSHIP: Renée Rondeau

DATE: July 20, 2000

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SOUTHERN ROCKY MOUNTAINS ECOREGION
**MONTANE DRY-MESIC MIXED CONIFER FOREST ECOLOGICAL SYSTEM-
-MATRIX**

Abies concolor / *Robinia neomexicana* Woodland
Abies concolor / *Arctostaphylos uva-ursi* Forest
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SOUTHERN ROCKY MOUNTAINS ECOREGION
MONTANE/SUBALPINE GRASSLAND—LARGE PATCH

Danthonia intermedia Herbaceous Vegetation
Danthonia parryi Herbaceous Vegetation
Festuca arizonica – *Muhlenbergia filiculmis* Herbaceous Vegetation
Festuca arizonica – *Muhlenbergia montana* Herbaceous Vegetation
Festuca idahoensis – *Pseudoroegneria spicata* Herbaceous Vegetation
Festuca thurberi - *Lathyrus lanszwertii* var. *leucanthus* Herbaceous Vegetation
Leymus cinereus Herbaceous Vegetation [Provisional]
Muhlenbergia filiculmis Herbaceous Vegetation
Pseudoroegneria spicata - *Bouteloua gracilis* Herbaceous Vegetation
Pseudoroegneria spicata - *Poa secunda* Lithosolic Herbaceous Vegetation
Pseudoroegneria spicata Herbaceous Vegetation

SCALE AND RANGE: LARGE PATCH AND WIDESPREAD

Montane/subalpine grassland ecological system is a large patch system that occupies less than 3% of the Southern Rocky Mountains ecoregion. Although the largest occurrences are primarily within Colorado it is scattered throughout the region from Wyoming to New Mexico. This system is usually between 8,000? and 10,000? Feet on flat to rolling plains or lower side slopes that are dry. An occurrence usually consists of a mosaic of two or three plant associations with one of the following dominant bunch grasses: *Danthonia* spp., *Festuca* spp., *Muhlenbergia filiculmis*, or *Pseudoroegneria spicata*. The sub-dominants include *Muhlenbergia montana*, *Bouteloua gracilis*, and *Poa secunda*. Soils resemble prairie soils in that the A-horizon is dark brown, relatively high in organic matter, slightly acid, and usually well-drained (Turner 1975). Frequent fires help to maintain the grassland dominants and may play an important role in restricting the invasion of trees and shrubs (Turner 1975). These large patch grasslands are intermixed with matrix stands of spruce- fir, lodgepole, ponderosa pine, and aspen forests.

Floristic composition varies with site characteristics and grazing history (Turner 1975). Forbs tend to be more prominent at higher elevations, and shrubs at lower elevations (Turner 1975). Forbs are characteristically absent from bunch grass dominated grasslands with a long history of heavy sheep use (Turner 1975). Annual plants seldom are abundant except on recently disturbed or severely overgrazed areas (Turner 1975).

Montane grasslands were initially grazed by domestic livestock about 100 years ago and by 1900 practically all of the available high elevation lands were being grazed, and some already had been overgrazed (Turner 1975). Regulation of grazing on these lands began with establishment of the National Forests in the early 1900's. However, these and other rangelands received maximum use in meeting the demands of World War I. Present use of National Forest rangeland in the West is only about one-fourth the numbers of the former high level (Turner 1975).

Grassland deterioration may be indicated by many changes. In its early stages, an increase in forbs or secondary smaller grasses usually accompanies a decrease in primary grasses such as *Festuca thurberi* and *Danthonia parryi* (Turner 1975). With continued degradation bare soil increases, soil stability decreases, and plant vigor may decrease (Turner 1975). A grassland that is occupied by Gunnison prairie dog, a natural and expected animal of these grasslands, may maintain heavily grazed patches that exhibit the above characters. When this occurs, usually only part of the occurrence exhibits the above characters, whereas an area that has heavy livestock grazing may show these characters throughout the occurrence.

Occurrences of grasslands that are lightly grazed can be noted by an accumulation of ground litter (Turner 1975). Buildup of litter lowers soil temperature, which in turn reduces bacterial activity, ties up nutrients, and slows the general nitrogen cycling process, particularly during cool, wet years (Turner 1975). Certain native rodents tend to be more abundant with increases in litter (Turner 1975). Fires will burn the litter and release nutrients.

MINIMUM SIZE: 25 acres.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than ¼ mile wide, major highways, or urban development, 2) a different natural community from a different ecological system wider than one mile wide or continuous forest wider than ¼ mile, 3) a major break or change in the ecological land unit (e.g., topography, soils, geology).

Justification: Large patch communities are susceptible to fragmentation by cultural vegetation or forest/shrub invasion. Forests are likely to be more significant barriers than woodlands or non-forested wetlands for many species. Primary criteria to be considered is the invasion of woody vegetation, seed dispersal by dominant grasses and forbs, and the dispersal behavior and requirements of invertebrates and small mammals.

RANK PROCEDURE: 1) condition, 2) landscape context, and 3) size. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does occurrence size, although the species-area relationship still holds up for patch type communities.

CONDITION SPECIFICATIONS: (Part of the following condition specifications follow the BLM, NRCS, and USGS “Interpreting indicators of rangeland health” (Shaver et al. 2000).

A –rated condition: Native bunchgrasses are dominant, non-native species occupy less than 3% canopy cover. Invasive species with major potential to alter structure and composition are absent. Native species that increase with disturbance, e.g., *Koeleria micrantha*, and *Artemisia frigida* have less than 3% cover. If trees or shrubs are present, these are widely scattered and mature. Species richness is often high and includes several

native grasses as well as a diverse forb component. Soils have a distinct A-horizon. Water flow patterns show minimal evidence of past or current soil deposition or erosion. Terracettes absent or uncommon. Drainages are represented as natural stable channels; no signs of unnatural erosion. Fairly uniform distribution of litter. Surface soil is stabilized by organic matter decomposition products and/ or a biological crust. Plant cover is adequate to protect from excess soil erosion. Soils are not compacted and are very stable (low erosion rate). Plant vigor is high. Fires are still part of this system. Livestock grazing is light and seasonally compatible.

B- rated condition: Native bunchgrasses dominant, non-native species are present but in small amounts (< 10% total canopy cover). Invasive exotics with major potential to alter structure and composition occupy less than 1% of occurrence. Native species that increase with disturbance, e.g., *Koeleria micrantha*, and *Artemisia frigida* have less than 10% cover. If trees or shrubs are present, these are widely scattered and mature. Species richness is often high, and native bunchgrasses (non-increasers) are dominant. Soils may be slightly modified and may be less stable than for an “A” ranked occurrence. Soils have a distinct A-horizon. Water flow patterns nearly matches what is expected for the site; erosion is minor with some instability and deposition. Slight active pedestalling; most pedestals are in flow paths and interspaces or on exposed slopes. Occasional terracettes present. Bare areas are of moderate size and sporadically connected. Drainages may indicate unnatural active erosion; vegetation is intermittent on drainage slopes. Occasional headcuts may be present. Litter may show some movement of smaller size classes in scattered concentrations around obstructions and in depressions. Soil surfaces resistance to erosion is significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site. Soil surface loss or degradation is moderate in plant interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced. Water infiltration is moderately reduced due to adverse changes in plant community composition and or distribution. Soil compaction moderately widespread and moderately restricts water movement and root penetration.

C-rated condition: Native bunchgrasses present but may be nearly equal in canopy cover to non-native species. Non-native species have less than 20% cover. Native species that increase with livestock grazing may be co-dominant or dominant. Invasive exotics with major potential to alter structure and composition may be prominent in small and discrete patches; trees and shrubs may have seedlings, juveniles, or saplings present. Alteration is extensive but potentially restorable over several decades. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition, soil compaction and stability. Rill formation may be moderately active and well defined throughout most of the occurrence. Water flow patterns are more numerous than expected; deposition and cut areas common; occasionally connected. Moderate active pedestalling; terracettes common. Some rocks and plants are pedestaled with occasional exposed roots. Bare ground is moderate to much higher than expected for the site. Bare areas are large and often connected. Gullies may be present with indications of active erosion; vegetation is intermittent on slopes. Headcuts are active; downcutting is apparent. Litter movement is moderate to extreme;

loosely concentrated near obstructions. Moderate to small size classes of litter have been displaced. Soil surface resistance to erosion significantly reduced in most plant canopy interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches. Soil surface loss or degradation may be severe throughout the site. Minimal differences in soil organic matter content and structure of surface and subsurface layers. Infiltration is greatly decreased due to adverse changes in plant community composition or soil compaction. Detrimental plant cover changes have occurred. Soil compaction may be widespread and greatly restricts water movement and root penetration. Dead plants or decadent plants may be common. Litter is greatly reduced or increased relative to site potential and climate. Reproductive capability of native perennial plants is greatly reduced. Fire frequency may have been altered, although easily restored.

D –rated condition: Non-native species are dominant, native species have less than 10% canopy cover and 20% relative cover. Alteration is extensive and restoration potential is low. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition, soil compaction and stability. System remains fundamentally compromised despite restoration of some processes. Soil compaction and stability is extensive throughout the occurrence. Rill formation may be severe and well defined throughout most of the occurrence. Water flow patterns may be extensive and numerous; unstable with active erosion; usually connected. Abundant active pedestalling and numerous terracettes. Many rocks and plants are pedestaled; exposed plant roots are common. Bare ground is much higher than expected for the site. Bare areas are large and generally connected. Gullies may be common with indications of active erosion and downcutting; vegetation is infrequent on slopes or bed of gully. Nickpoints and headcuts are numerous and active. Litter movement may be extreme and concentrated around obstructions. Most size classes of litter have been displaced. Soil surface resistance to erosion may be extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent. Soil surface horizon may be absent. Soil structure near surface is similar to, or more degraded, than that in subsurface horizons. No distinguishable difference in subsurface organic matter content. Infiltration may be severely decreased due to adverse changes in plant community composition and/or distribution. Adverse plant cover changes have occurred. Soil compaction layer extensive; severely restricting water movement and root penetration. Plant vigor may be poor and dead or decadent plants are common. Litter largely absent relative to site potential. Reproductive capability of native perennial plants severely reduced. Fire frequency may be greatly altered and difficult to restore.

Justification for A-rated criteria: Montane grasslands are dependent on fires and limited grazing. In order to have a healthy and intact invertebrate and small mammal composition an occurrence must be dominated by native grasses with high species richness. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

For all but South Park:

A – rated size: Very large (> 500 acres)

B –rated size: Large (50 to 500 acres)

C –rated size: Moderate (25 - 50 ac)

D –rated size: Small (<25 ac)

Justification for A-rated criteria: A-ranked occurrences are large enough to support viable populations of grassland birds as well as a mosaic of several plant associations.

Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance. They are buffered from edge effects. Occurrences of this size will support fires and grazing animals and allow for a mosaic of different fire and grazing regimes.

Justification for C/D threshold: C-ranked occurrences may still support a small number of grassland birds, small mammals, and a diverse insect fauna. While D-ranked occurrences are subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Occurrence surrounded by a native and unaltered landscape with very little to no urban development or agriculture, and little to no industrial forestry (> 90% natural). No unnatural barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fire to occur.

B-rated landscape context: Landscape composed of at least 75% natural or semi-natural vegetation, with any urban development not directly adjacent to the occurrence. Limited or minor human-caused alteration of landscape. Adjacent systems surrounding occurrence have moderate urban or agricultural alteration (60-90% natural) but retaining much connectivity. Few non-natural barriers present.

C-rated landscape context: Surrounding landscape is a mosaic of agricultural or semi-developed areas with natural or semi-natural vegetation. Adjacent systems surrounding occurrence are fragmented by alteration (20 – 60% natural), with limited connectivity. Some non-natural barriers are present. Significant disturbance, but easily restorable.

D-rated landscape context: Major human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The montane grassland and its adjacent landscape is intact; connectivity to adjacent and nearby systems is intact; non-native species not a

landscape threat; no obvious hindrances to use of prescribed fire, e.g., urban development. The occurrence is fully buffered by a natural landscape. Migration of grassland species remains viable.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. D-ranked occurrences have no buffering, and are subject to altered fire and grazing regimes causing a shift in species composition and altering the entire occurrence.

AUTHORSHIP: Renée Rondeau

Date: July 2, 2000 (edited February 23, 2001)

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SOUTHERN ROCKY MOUNTAINS ECOREGION
SOUTH PARK MONTANE GRASSLAND—MATRIX

Danthonia intermedia Herbaceous Vegetation
Danthonia parryi Herbaceous Vegetation
Festuca arizonica – *Muhlenbergia filiculmis* Herbaceous Vegetation
Festuca arizonica – *Muhlenbergia montana* Herbaceous Vegetation
Festuca idahoensis – *Pseudoroegneria spicata* Herbaceous Vegetation
Festuca thurberi - *Lathyrus lanszwertii* var. *leucanthus* Herbaceous Vegetation
Leymus cinereus Herbaceous Vegetation [Provisional]
Muhlenbergia filiculmis Herbaceous Vegetation
Pseudoroegneria spicata - *Bouteloua gracilis* Herbaceous Vegetation
Pseudoroegneria spicata - *Poa secunda* Lithosolic Herbaceous Vegetation
Pseudoroegneria spicata Herbaceous Vegetation

SCALE AND RANGE: LARGE PATCH AND WIDESPREAD

Montane grasslands occupy less than 3% of the Southern Rocky Mountains ecoregion and are scattered throughout the ecoregion from Wyoming to New Mexico. Most of these grasslands are large patch communities found between 8,000? and 9,000? Feet on flat to rolling plains or lower side slopes that are dry. An occurrence usually consists of a mosaic of two or three plant associations with one of the following dominant bunch grasses: *Danthonia* spp., *Festuca* spp., *Muhlenbergia filiculmis*, and *Pseudoroegneria spicata*. The sub-dominants include *Muhlenbergia montana*, *Bouteloua gracilis*, and *Poa secunda*. These large patch grasslands are intermixed with matrix stands of spruce-fir, lodgepole, ponderosa pine, and aspen forests. Soils resemble prairie soils in that the A-horizon is dark brown, relatively high in organic matter, slightly acid, and usually well-drained (Turner 1975). Frequent fires help to maintain the grassland dominants and may play an important role in restricting the invasion of trees and shrubs (Turner 1975).

Floristic composition varies with site characteristics and grazing history (Turner 1975). Forbs tend to be more prominent at higher elevations, and shrubs at lower elevations (Turner 1975). Forbs are characteristically absent from bunch grass dominated grasslands with a long history of heavy sheep use (Turner 1975). Annual plants seldom are abundant except on recently disturbed or severely overgrazed areas (Turner 1975).

Montane grasslands were initially grazed by domestic livestock about 100 years ago and by 1900 practically all of the available high elevation lands were being grazed, and some already had been overgrazed (Turner 1975). Regulation of grazing on these lands began with establishment of the National Forests in the early 1900's. However, these and other rangelands received maximum use in meeting the demands of World War I. Present use of National Forest rangeland in the West is only about one-fourth the numbers of the former high level. Nevertheless, the grazing of high-altitude grasslands continues to be essential for meeting the annual forage requirements of many livestock ranches (Turner 1975).

Grassland deterioration may be indicated by many changes. In its early stages, an increase in forbs or secondary smaller grasses usually accompanies a decrease in primary grasses such as *Festuca thurberi* and *Danthonia parryi* (Turner 1975). With continued degradation bare soil increases, soil stability decreases, and plant vigor may decrease (Turner 1975). A grassland that is occupied by Gunnison prairie dog, a natural and expected animal of these grasslands, may maintain heavily grazed patches that exhibit the above characters. When this occurs, usually only part of the occurrence exhibits the above characters, whereas an area that has heavy livestock grazing may show these characters throughout the occurrence.

Occurrences of grasslands that are lightly grazed can be noted by an accumulation of ground litter (Turner 1975). Buildup of litter lowers soil temperature, which in turn reduces bacterial activity, ties up nutrients, and slows the general nitrogen cycling process, particularly during cool, wet years (Turner 1975). Certain native rodents tend to be more abundant with increases in litter (Turner 1975). Fires will burn the litter and release nutrients.

Although montane grasslands are scattered throughout the Southern Rocky Mountains ecoregion, the largest occurrence, without a doubt, is on the valley floor of South Park (1.3 million acres—Gap veg map). This occurrence is an exception in that it is a matrix-forming occurrence occupying approx. 1.3 million acres (Gap veg map 1999). Bison and Gunnison prairie dogs used to be abundant in the South Park grasslands (Allen 1874, Cary 1911, Meaney and Van Vuren 1993) and were an integral part of maintaining this system. Due to the extirpation of bison and extreme reduction of Gunnison prairie dog colonies, Mountain plovers have been chosen as an indicator of a viable occurrence of a South Park grassland. If bison were chosen, the minimum size criteria would be much larger.

MINIMUM SIZE: 7,000 acres

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than ¼ mile wide, major highways, or urban development, 2) a different natural community from a different ecological system wider than one mile wide or continuous forest wider than ¼ mile, 3) a major break or change in the ecological land unit (e.g., topography, soils, geology).

Justification: Large patch communities are susceptible to fragmentation by cultural vegetation or forest/shrub invasion. Forests are likely to be more significant barriers than woodlands or non-forested wetlands for many species. Primary criteria to be considered is the invasion of woody vegetation, seed dispersal by dominant grasses and forbs, and the dispersal behavior and requirements of invertebrates and small mammals.

RANK PROCEDURE: 1) condition, 2) landscape context, and 3) size. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does

occurrence size, although the species-area relationship still holds up for patch type communities.

CONDITION SPECIFICATIONS: (Part of the following condition specifications follow the BLM, NRCS, and USGS “Interpreting indicators of rangeland health” (Shaver et al. 2000).

A –rated condition: Native bunchgrasses are dominant, non-native species occupy less than 3% canopy cover. Invasive species with major potential to alter structure and composition are absent. Native species that increase with disturbance, e.g., *Koeleria micrantha*, and *Artemisia frigida* have less than 3% cover. If trees or shrubs are present, these are widely scattered and mature. Species richness is often high and includes several native grasses as well as a diverse forb component. Soils have a distinct A-horizon. Water flow patterns show minimal evidence of past or current soil deposition or erosion. Terracettes absent or uncommon. Drainages are represented as natural stable channels; no signs of unnatural erosion. Fairly uniform distribution of litter. Surface soil is stabilized by organic matter decomposition products and/ or a biological crust. Plant cover is adequate to protect from excess soil erosion. Soils are not compacted and are very stable (low erosion rate). Plant vigor is high. Fires are still part of this system. Livestock grazing is light and seasonally compatible.

B- rated condition: Native bunchgrasses dominant, non-native species are present but in small amounts (< 10% total canopy cover). Invasive exotics with major potential to alter structure and composition occupy less than 1% of occurrence. Native species that increase with disturbance, e.g., *Koeleria micrantha*, and *Artemisia frigida* have less than 10% cover. If trees or shrubs are present, these are widely scattered and mature. Species richness is often high, and native bunchgrasses (non-increasers) are dominant. Soils may be slightly modified and may be less stable than for an “A” ranked occurrence. Soils have a distinct A-horizon. Water flow patterns nearly matches what is expected for the site; erosion is minor with some instability and deposition. Slight active pedestalling; most pedestals are in flow paths and interspaces or on exposed slopes. Occasional terracettes present. Bare areas are of moderate size and sporadically connected. Drainages may indicate unnatural active erosion; vegetation is intermittent on drainage slopes. Occasional headcuts may be present. Litter may show some movement of smaller size classes in scattered concentrations around obstructions and in depressions. Soil surfaces resistance to erosion is significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site. Soil surface loss or degradation is moderate in plant interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced. Water infiltration is moderately reduced due to adverse changes in plant community composition and or distribution. Soil compaction moderately widespread and moderately restricts water movement and root penetration.

C-rated condition: Native bunchgrasses present but may be nearly equal in canopy cover to non-native species. Non-native species have less than 20% cover. Native species that increase with livestock grazing may be co-dominant or dominant. Invasive exotics with major potential to alter structure and composition may be prominent in small

and discrete patches; trees and shrubs may have seedlings, juveniles, or saplings present. Alteration is extensive but potentially restorable over several decades. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition, soil compaction and stability. Rill formation may be moderately active and well defined throughout most of the occurrence. Water flow patterns are more numerous than expected; deposition and cut areas common; occasionally connected. Moderate active pedestalling; terracettes common. Some rocks and plants are pedestaled with occasional exposed roots. Bare ground is moderate to much higher than expected for the site. Bare areas are large and often connected. Gullies may be present with indications of active erosion; vegetation is intermittent on slopes. Headcuts are active; downcutting is apparent. Litter movement is moderate to extreme; loosely concentrated near obstructions. Moderate to small size classes of litter have been displaced. Soil surface resistance to erosion significantly reduced in most plant canopy interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches. Soil surface loss or degradation may be severe throughout the site. Minimal differences in soil organic matter content and structure of surface and subsurface layers. Infiltration is greatly decreased due to adverse changes in plant community composition or soil compaction. Detrimental plant cover changes have occurred. Soil compaction may be widespread and greatly restricts water movement and root penetration. Dead plants or decadent plants may be common. Litter is greatly reduced or increased relative to site potential and climate. Reproductive capability of native perennial plants is greatly reduced. Fire frequency may have been altered, although easily restored.

D –rated condition: Non-native species are dominant, native species have less than 10% canopy cover and 20% relative cover. Alteration is extensive and restoration potential is low. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition, soil compaction and stability. System remains fundamentally compromised despite restoration of some processes. Soil compaction and stability is extensive throughout the occurrence. Rill formation may be severe and well defined throughout most of the occurrence. Water flow patterns may be extensive and numerous; unstable with active erosion; usually connected. Abundant active pedestalling and numerous terracettes. Many rocks and plants are pedestaled; exposed plant roots are common. Bare ground is much higher than expected for the site. Bare areas are large and generally connected. Gullies may be common with indications of active erosion and downcutting; vegetation is infrequent on slopes or bed of gully. Nickpoints and headcuts are numerous and active. Litter movement may be extreme and concentrated around obstructions. Most size classes of litter have been displaced. Soil surface resistance to erosion may be extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent. Soil surface horizon may be absent. Soil structure near surface is similar to, or more degraded, than that in subsurface horizons. No distinguishable difference in subsurface organic matter content. Infiltration may be severely decreased due to adverse changes in plant community composition and/or distribution. Adverse plant cover changes have occurred. Soil compaction layer extensive; severely restricting water movement and root penetration. Plant vigor may be poor and dead or decadent plants are common. Litter

largely absent relative to site potential. Reproductive capability of native perennial plants severely reduced. Fire frequency may be greatly altered and difficult to restore.

Justification for A-rated criteria: Montane grasslands are dependent on fires and limited grazing. In order to have a healthy and intact invertebrate and small mammal composition an occurrence must be dominated by native grasses with high species richness. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A -rated size: Very large (>90,000 ac)

B -rated size: Large (50,000-80,000 ac)

C -rated size: Moderate (30,000-50,000 ac)

D -rated size: Small (<30,000 ac)

A 7,000 acre stand is large enough to support 50 breeding individuals of Mountain Plover, each with a home range of 138 acres (Knopf 1996). This could be chosen as a minimum size for South Park grasslands, but extirpated bison and Gunnison prairie dogs should also be considered. I estimate that 30,000 is the minimum size area that could support a minimum viable herd of bison. Possibly even 30,000 acres is too low.

Justification for A-rated criteria: A-ranked occurrences are large enough to support viable populations of grassland birds as well as a mosaic of several plant associations. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance. They are buffered from edge effects. Occurrences of this size will support fires and grazing animals and allow for a mosaic of different fire and grazing regimes.

Justification for C/D threshold: C-ranked occurrences may still support a small number of grassland birds, small mammals, and a diverse insect fauna. While D-ranked occurrences are subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Occurrence surrounded by a native and unaltered landscape with very little to no urban development or agriculture, and little to no industrial forestry (> 90% natural). No unnatural barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fire to occur.

B-rated landscape context: Landscape composed of at least 75% natural or semi-natural vegetation, with any urban development not directly adjacent to the occurrence. Limited or minor human-caused alteration of landscape. Adjacent systems surrounding

occurrence have moderate urban or agricultural alteration (60-90% natural) but retaining much connectivity. Few non-natural barriers present.

C-rated landscape context: Surrounding landscape is a mosaic of agricultural or semi-developed areas with natural or semi-natural vegetation. Adjacent systems surrounding occurrence are fragmented by alteration (20 – 60% natural), with limited connectivity. Some non-natural barriers are present. Significant disturbance, but easily restorable.

D-rated landscape context: Major human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The montane grassland and its adjacent landscape is intact; connectivity to adjacent and nearby systems is intact; non-native species not a landscape threat; no obvious hindrances to use of prescribed fire, e.g., urban development. The occurrence is fully buffered by a natural landscape. Migration of grassland species remains viable.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. D-ranked occurrences have no buffering, and are subject to altered fire and grazing regimes causing a shift in species composition and altering the entire occurrence.

AUTHORSHIP: Renée Rondeau

Date: July 2, 2000

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SOUTHERN ROCKY MOUNTAINS ECOREGION SAGEBRUSH SHRUBLAND --MATRIX

Artemisia cana / *Festuca idahoensis* Shrub Herbaceous Vegetation
Artemisia cana / *Festuca thurberi* Shrubland
Artemisia tridentata ssp. *vaseyana* / *Carex geyeri* Shrubland
Artemisia tridentata ssp. *vaseyana* / *Festuca idahoensis* Shrub Herbaceous Vegetation
Artemisia tridentata ssp. *vaseyana* / *Festuca kingii* Shrub Herbaceous Vegetation
Artemisia tridentata ssp. *vaseyana* / *Festuca thurberi* Shrubland
Artemisia tridentata ssp. *vaseyana* / *Pascopyrum smithii* Shrubland
Artemisia tridentata ssp. *vaseyana* / *Pseudoroegneria spicata* Shrubland
Artemisia tridentata ssp. *wyomingensis* / *Leymus ambiguus* Shrubland
Artemisia tridentata ssp. *wyomingensis* / *Pascopyrum smithii* Shrubland
Artemisia tridentata ssp. *tridentata* / *Leymus cinereus* Shrubland
Artemisia tridentata ssp. *tridentata* / *Pascopyrum smithii* Shrubland

SCALE AND RANGE: MATRIX AND WIDESPREAD

Sagebrush shrubland ecological system is a matrix system that occupies nearly 10% of the Southern Rocky Mountains ecoregion. Although it can be found on the east slope of the ecoregion the largest occurrences are on the western slope. North Park, Middle Park, and the upper Gunnison Basin are areas with very large and continuous stands of sagebrush shrublands. This system is usually found on flat to rolling hills with well-drained clay soils slopes between 7,000 to 10,000 feet in elevation. It is characterized by a dense shrubland with a significant herbaceous understory. The dominant shrub species include *Artemisia tridentata* or *A. cana*, with occasional component shrubs, e.g., *Chrysothamnus* spp., *Purshia tridentata*, and *Krascheninnikovia lanata*. Dominant herbaceous species include: *Festuca idahoensis*, *F. thurberi*, *Leymus cinereus*, *Pseudoroegneria spicata*, *Stipa comata*, *Pascopyrum smithii*, *Carex geyeri*, and *Bouteloua gracilis*.

Presettlement stand-replacing fire frequency was 40-60 years, with smaller fires every 20-25 years (Wright et al. 1979 as cited in Johnston 1997). Repeated burning every few years or burning in summer will deplete a stand of perennial grasses and allow weeds, invasive forbs, and cheatgrass to increase (Wright et al. 1979 as cited in Johnston 1997).

Cheatgrass (*Bromus tectorum*) increases the likelihood of fire in mixed sagebrush-cheatgrass sites, but burning may produce dominance by cheatgrass and weeds (Bunting et al. 1987 as cited in Johnston 1997). Following a fire sagebrush must reestablish itself by seeds, growth is slow and recovery is slow (Bunting et al. 1997 as cited in Johnston 1997). Fire favors shrubs like *Chrysothamnus nauseosus* that can re-sprout after fire (Wambolt et al. 1999). However, fire suppression of the montane grasslands could lead to conversion to *Artemisia tridentata* shrublands.

Heavy grazing increases soil water losses, so heavily grazed sites are dryer; grazing also reduces the biomass of deep (>40 cm) roots and reduces the depth and cover of litter.

Trampling from livestock grazing significantly decreases the number of sagebrush and grass seedlings (Eckert et al. 1978, Pearson 1965 as cited in Johnston 1997). Watts and Wambolt (1996 as cited in Johnston 1997) conclude that exclusion of grazing has no effect on sagebrush canopy cover after 30 years.

This system differs from the sagebrush steppe in that the steppe is dominated by dwarf sagebrush. Due to the low shrub stature of *Artemisia arbuscula* and *A. nova* these dwarf shrublands are less susceptible to natural fire than taller *Artemisia* spp. shrublands. Although if burnt, these sagebrush will also die (Bunting et al. 1987 as cited in Johnston 1997). These dwarf shrublands are often found on poorly drained, low areated soils whereas the big sagebrush shrublands are usually on well drained and areated soils (Johnston 1997, Fosberg and Hironaka 1964 as cited in Johnston 1997).

MINIMUM SIZE: 30,000 acres (minimum size needed for Gunnison sage grouse)

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than 1 mile wide, major highways, or urban development greater than ½ mile wide, 2) different ecological system greater than 5 miles wide.

Justification: Sagebrush shrubland communities are susceptible to fragmentation by cultural vegetation or tree invasion. Primary criteria to be considered is the invasion of trees, non-native forbs, seed dispersal by dominant species and the dispersal behavior and requirements of shrubland fauna, especially sage sparrow, Gunnison sage grouse, and sharp-tailed grouse.

RANK PROCEDURE: For Matrix communities size is the most important factor. Condition is of secondary importance and while landscape context is still important, it is slightly less so than the overall size and condition of an occurrence.

CONDITION SPECIFICATIONS:

A –rated condition: Native species dominant, non-native species may be present but in small amounts (< 5% total cover). Native species that increase with disturbance, e.g., *Wyethia*, *Balsamorhizza*, and *Gutierrezia sarothrae*, have less than 3% relative cover. Invasive exotics with major potential to alter structure and composition are absent or less than 1% cover, e.g., non-native thistle, *Bromus inermis*, *Poa pratensis*, *Bromus tectorum*. If trees are present, these are widely scattered and mature. Species richness is often high, and native bunch grasses or sedges (non-increasers) are the dominant herbaceous cover. Soil erosion is not accelerated by anthropogenic activities. There are few to no roads found within the occurrence.

B- rated condition: Native species dominant, non-native species are present but in small amounts (< 10% total cover). Native species that increase with disturbance, e.g., *Wyethia*, *Balsamorhizza*, and *Gutierrezia sarothrae* have less than 5% relative cover. Invasive exotics with major potential to alter structure and composition may be present, but with less than 3% cover. If trees are present, these are widely scattered and mature. Species

richness is often high, and native grasses (no n-increasers) are dominant. Accelerate soil erosion may be present in isolated patches. There are few roads fragmenting the occurrence.

C-rated condition: Herbaceous cover is co-dominated by native and non-native species. Alteration of vegetation is extensive but potentially restorable over several decades. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition, soil compaction, and soil erosion.

D –rated condition: Non-native species are dominant. Alteration of vegetation is extensive and restoration potential is low. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction. System remains fundamentally compromised despite restoration of some processes. Soil compaction and continued disturbance is extensive throughout the occurrence.

Justification for A-rated criteria: Sagebrush shrublands are dependent on periodic fires that provide a diverse mosaic of shrubs, graminoids, and forbs. In order to have a healthy and intact native fauna composition an occurrence must have an intact and diverse shrub and herbaceous canopy cover dominated by native species. A-ranked occurrences have processes, species composition, and the physical environment intact and may support indicator species, esp. Sage grouse and Sage sparrow that require high quality sagebrush habitat.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A -rated size: Very large (>90,000 ac)

B -rated size: Large (50,000-80,000 ac)

C -rated size: Moderate (30,000-50,000 ac)

D -rated size: Small (<30,000 ac)

Justification for A-rated criteria: A-ranked occurrences are predicted to be large enough to support an A-ranked occurrence of Gunnison sage grouse (3 times the minimum viable size) as well as a mosaic of several plant associations. Sage grouse depend primarily upon sagebrush-dominated habitats and prefer large contiguous areas of sagebrush on flat or gently rolling terrain (Levad 1998). Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance. They are buffered from edge effects. Occurrences of this size will support fires and allow for a mosaic of different fire regimes.

Justification for C/D threshold: C-ranked occurrences would support a minimum viable population of sage grouse. The mean estimated breeding home range size for Gunnison

Sage Grouse is 1379 ha (Commons 1997). I used the Dry Creek site as the smallest area needed to maintain a viable population of Gunnison Sage Grouse. This site is 30,000 acres.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Occurrence surrounded by at least 90% native and unaltered landscape with very little to no urban development or agriculture, and little to no industrial forestry. No unnatural barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fire and species migrations to occur.

B-rated landscape context: Surrounding landscape composed of at least 75% natural or semi-natural vegetation, with little urban development within or adjacent to the occurrence. Adjacent systems surrounding occurrence retain much connectivity. Few non-natural barriers present.

C-rated landscape context: Adjacent systems surrounding occurrence are fragmented by alteration with limited connectivity. Surrounding landscape is a mosaic of agricultural or semi-developed areas with >50% natural or semi-natural vegetation. Some non-natural barriers are present. Significant disturbance, but easily restorable.

D-rated landscape context: Major human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The sagebrush shrubland and its adjacent landscape is intact; connectivity to adjacent and nearby systems is intact; non-native species not a landscape threat; no obvious hindrances to fires, e.g., urban development. The occurrence is fully buffered by a natural landscape. Migration of shrubland species remains viable.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. D-ranked occurrences have no buffering, and are subject to altered fire regimes and invasive species causing a shift in species composition and altering the entire occurrence.

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Date: July 2, 2000

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SOUTHERN ROCKY MOUNTAINS ECOREGION
SAGEBRUSH STEPPE --MATRIX

Artemisia arbuscula / *Pseudoroegneria spicata* Dwarf-shrub Herbaceous Vegetation
Artemisia nova Dwarf-shrubland [Provisional]
Artemisia nova / *Pseudoroegneria spicata* Dwarf-shrubland
Artemisia nova / *Stipa comata* Dwarf-shrubland
Artemisia nova Dwarf-shrubland [Provisional]
Artemisia nova - *Gutierrezia sarothrae* / *Bouteloua gracilis* - *Hilaria jamesii* Dwarf-shrubland
Artemisia tripartita / *Festuca idahoensis* Shrub Herbaceous Vegetation

SCALE AND RANGE: MATRIX AND WIDESPREAD

Sagebrush steppe ecological system is a matrix system that occupies nearly 3% of the Southern Rocky Mountains ecoregion. Although it can be found on the east slope of the ecoregion the largest occurrences are on the western slope. North Park, Middle Park, and the upper Gunnison Basin are areas with very large and continuous stands of sagebrush steppe. This system is usually found on flat to rolling hills between 7,000 to 10,000 feet in elevation. It is characterized by a dwarf shrubland with an herbaceous component. The dominant shrub species include *Artemisia nova*, *A. arbuscula* or *A. tripartita* with occasional component shrubs, e.g., *Chrysothamnus* spp. and *Krascheninnikovia lanata*. Dominant herbaceous species include: *Festuca idahoensis*, *Pseudoroegneria spicata*, *Stipa comata*, *Pascopyrum smithii*, *Carex geyeri*, and *Bouteloua gracilis*.

Due to the low shrub stature of *Artemisia arbuscula* and *A. nova* these dwarf-shrublands are less susceptible to natural fire than taller *Artemisia* spp. shrublands. Although if burnt, these sagebrush will also die (Bunting et al. 1987 as cited in Johnston 1997). These dwarf shrublands are often found on poorly drained, low areated soils whereas the big sagebrush shrublands are usually on well drained and areated soils (Johnston 1997, Fosberg and Hironaka 1964 as cited in Johnston 1997).

MINIMUM SIZE: 30,000 acres

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than 1 mile wide, major highways, or urban development greater than ½ mile wide, 2) different ecological system greater than 5 miles wide.

Justification: Sagebrush shrubland communities are susceptible to fragmentation by cultural vegetation or tree invasion. Primary criteria to be considered is the invasion of trees, non-native forbs, seed dispersal by dominant species and the dispersal behavior and requirements of shrubland fauna, especially sage sparrow, Gunnison sage grouse, and sharp-tailed grouse.

RANK PROCEDURE: For Matrix communities size is the most important factor. Condition is of secondary importance and while landscape context is still important, it is slightly less so than the overall size and condition of an occurrence.

CONDITION SPECIFICATIONS:

A –rated condition: Native species dominant, non-native species may be present but in small amounts (< 5% total cover). Native species that increase with disturbance, e.g., *Wyethia*, *Balsamorhizza*, and *Gutierrezia sarothrae*, have less than 3% relative cover. Invasive exotics with major potential to alter structure and composition are absent or less than 1% cover, e.g., non-native thistle, *Bromus inermis*, *Poa pratensis*, *Bromus tectorum*. If trees are present, these are widely scattered and mature. Species richness is often high, and native bunch grasses or sedges (non-increasers) are the dominant herbaceous cover. Soil erosion is not accelerated by anthropogenic activities. There are few to no roads found within the occurrence.

B- rated condition: Native species dominant, non-native species are present but in small amounts (< 10% total cover). Native species that increase with disturbance, e.g., *Wyethia*, *Balsamorhizza*, and *Gutierrezia sarothrae* have less than 5% relative cover. Invasive exotics with major potential to alter structure and composition may be present, but with less than 3% cover. If trees are present, these are widely scattered and mature. Species richness is often high, and native grasses (non-increasers) are dominant. Accelerate soil erosion may be present in isolated patches. There are few roads fragmenting the occurrence.

C-rated condition: Herbaceous cover is co-dominated by native and non-native species. Alteration of vegetation is extensive but potentially restorable over several decades. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition, soil compaction, and soil erosion.

D –rated condition: Non-native species are dominant. Alteration of vegetation is extensive and restoration potential is low. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction. System remains fundamentally compromised despite restoration of some processes. Soil compaction and continued disturbance is extensive throughout the occurrence.

Justification for A-rated criteria: Sagebrush shrublands are dependent on periodic fires that provide a diverse mosaic of shrubs, graminoids, and forbs. In order to have a healthy and intact native fauna composition an occurrence must have an intact and diverse shrub and herbaceous canopy cover dominated by native species. A-ranked occurrences have processes, species composition, and the physical environment intact and may support indicator species, esp. Sage grouse and Sage sparrow that require high quality sagebrush habitat.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A -rated size: Very large (>90,000 ac)

B -rated size: Large (50,000-80,000 ac)

C -rated size: Moderate (30,000-50,000 ac)

D -rated size: Small (<30,000 ac)

Justification for A-rated criteria: A-ranked occurrences are predicted to be large enough to support an A-ranked occurrence of sage grouse (3 times the minimum viable size) as well as a mosaic of several plant associations. Sage grouse depend primarily upon sagebrush-dominated habitats and prefer large contiguous areas of sagebrush on flat or gently rolling terrain. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance. They are buffered from edge effects. Occurrences of this size will support fires and allow for a mosaic of different fire regimes.

Justification for C/D threshold: C-ranked occurrences would support a minimum viable population of sage grouse.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Occurrence surrounded by at least 90% native and unaltered landscape with very little to no urban development or agriculture, and little to no industrial forestry. No unnatural barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fire and species migrations to occur.

B-rated landscape context: Surrounding landscape composed of at least 75% natural or semi-natural vegetation, with little urban development within or adjacent to the occurrence. Adjacent systems surrounding occurrence retain much connectivity. Few non-natural barriers present.

C-rated landscape context: Adjacent systems surrounding occurrence are fragmented by alteration with limited connectivity. Surrounding landscape is a mosaic of agricultural or semi-developed areas with >50% natural or semi-natural vegetation. Some non-natural barriers are present. Significant disturbance, but easily restorable.

D-rated landscape context: Major human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The sagebrush shrubland and its adjacent landscape is intact; connectivity to adjacent and nearby systems is intact; non-native species not a

landscape threat; no obvious hindrances to fires, e.g., urban development. The occurrence is fully buffered by a natural landscape. Migration of shrubland species remains viable.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. D-ranked occurrences have no buffering, and are subject to altered fire regimes and invasive species causing a shift in species composition and altering the entire occurrence.

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SOUTHERN ROCKY MOUNTAINS ECOREGION
MONTANE FEN—SMALL PATCH

Carex aquatilis - *Sphagnum* spp.
Betula glandulosa/ *Sphagnum* spp.
Kobresia myosuroides - *Thalictrum alpinum*
Kobresia simpliciuscula - *Scirpus pumilus*

SCALE AND RANGE: SMALL PATCH AND LIMITED

Montane fen ecological system is a small patch system confined to specific environments defined by ground water discharge, soil chemistry, and peat accumulation of at least 40 cm. This system includes extreme rich fens and iron fens, both rare within the Southern Rocky Mountains ecoregion. Fens form at low points in the landscape or near slopes where ground water intercepts the soil surface. Ground water 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 accumulation of organic material. In addition to peat accumulation and perennially saturated soils, the extreme rich and iron fens have distinct soil and water chemistry, with high levels of one or more minerals such as calcium, magnesium, or iron. They usually occur as a mosaic of several plant associations dominated by either *Carex aquatilis*, *Betula glandulosa*, *Kobresia myosuroides*, *K. simpliciuscula* and *Scirpus pumilus*. Moss (*Sphagnum* spp.) is indicative of iron fens. The surrounding landscape may be ringed with other wetland systems, e.g., riparian shrublands, or a variety of upland systems from grasslands to forest. Within the Southern Rocky Mountains ecoregion, this system is limited to a few small areas, notably South Park, Mount Evans, Grand Mesa, and Iron Creek.

The montane fen ecological system is rare in the Southern Rocky Mountains ecoregion. Since this system is reliant on groundwater any disturbances that impact water quality or quantity are a threat. These threats include groundwater pumping, mining, and improper placement of septic systems.

MINIMUM SIZE: 0.5 acre

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than ¼ mile wide, major highways, urban development, or large bodies of water. 2) natural community from a different ecological system wider than ½ mile wide, 3) major break in topography, soils, geology, etc., especially one resulting in a hydrologic break.

Justification: Primary criteria to be considered are the hydrologic system and the surrounding landscape. The separation distance for intervening natural or semi-natural communities assumes a different hydrologic regime. They are often isolated hydrologically from other wetlands, and easily impacted by surrounding land use.

RANK PROCEDURE: 1) condition, 2) landscape context, 3) size. Condition and landscape context are the primary ranking factors, with size secondary.

CONDITION SPECIFICATIONS:

A –rated condition: Natural hydrologic regime intact. No or little evidence of wetland alteration due to increased or decreased drainage, clearing, livestock grazing, mining (esp. peat mining), etc. Native species that increase with hydrologic and surface disturbance e.g., *Deschampsia cespitosa* and *Carex aquatilis* are present in typical proportions in diverse communities, rather than in expansive, low diversity stands. Non-native species are generally not a problem in fens of the Southern Rockies, and A-ranked occurrences should exemplify this pattern by having no or very few exotic species present. Roads or other anthropogenically induced fragmentation is limited to less than 1% of the occurrence.

B- rated condition: Natural hydrologic regime nearly intact. Alteration from local drainage, upstream water diversions, groundwater pumping, haying, or livestock grazing is easily restorable by ceasing such activities. Alterations that are generally recognized as unrestorable (e.g., peat mining) may be present, but on less than 10% of the occurrence. Native species that increase with hydrologic and physical disturbance are absent, low in abundance, or very restricted. Few exotic species are present, with little potential for expansion if restoration occurs. The occurrence is virtually intact with fragmentation from roads, etc. limited to less than 3% of the occurrence.

C-rated condition: Natural hydrologic regime altered by local drainage or groundwater pumping. Alteration may be from clearing, mining or livestock grazing and may be locally severe. Native species that increase with disturbance or changes in hydrology/nutrients may be prominent, but with restoration activities diversity in these communities can potentially be enhanced.

D –rated condition: Natural hydrologic regime or disturbance not restorable. Fundamental structure of the substrate has been destroyed to such an extent that the occurrence is effectively unrestorable. System remains fundamentally compromised despite restoration of some processes. Native species that increase with disturbance or changes in hydrology/nutrients are prominent to dominant. Exotic species may be present in significant numbers.

Justification for A-rated criteria: Montane fens in the Southern Rocky Mountains depend on perennial water regime, seasonally to permanently saturated soils, and occasional flooding disturbance. A-ranked occurrences have these processes intact, with no history of alteration to the hydrology or surface structure.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades with significant resources. In D-ranked occurrences, hydrologic alterations and surface structure have been altered so extensively that there is little or no potential for restoration of these fundamental aspects of fens.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 2 acres)

B –rated size: Large (1 to 2 acres)

C –rated size: Moderate (.5 to 1 ac)

D –rated size: Small (< .5 ac)

Justification for A-rated criteria: Fens are usually composed of mosaics of different plant associations included within this system. Very large fen complexes contain the maximum diversity of species and plant associations. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients, natural geomorphic features, and hydrologic variation. In A-ranked occurrences, the majority of the occurrence is buffered from edge effects (e.g., cattle grazing along the edges of the wetlands) and small hydrology alterations.

Justification for C/D threshold: C-ranked occurrences generally contain moderate species and plant association diversity, and are large enough to sustain some natural or human caused perturbations. D-ranked occurrences have noticeably reduced species and plant association diversity, and are too small to remain viable with changes to the hydrology. They are also extremely susceptible to invasions by native and non-native ruderal species making them subject to loss of typical fen plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Uplands or any other system within the ground watershed are largely unaltered by urban or agricultural uses (>90% natural), and include few to no recent clearcuts, peat or gravel mines, pastures that are excessively grazed, or roads. There are no barriers to movement of species, water, nutrients, or other natural forms of energy and material between the occurrence and the surrounding systems. There are also few barriers to movement between this occurrence and other occurrence of the same system that may be necessary to maintain population dynamics.

B-rated landscape context: Uplands surrounding occurrence and within ground watershed may have moderate urban or agricultural alteration (60 to 90% natural), or natural vegetation is heavily managed (e.g., grazing, haying). There are few unnatural barriers to the movement of species and materials, and the occurrence retains much connectivity with adjacent systems and nearby occurrences of the same system. Some natural processes such as flooding and fire may be compromised.

C-rated landscape context: Uplands surrounding occurrence and within ground watershed are fragmented by urban or agricultural alteration (20 to 60% natural). However sufficient upland allows some degree of natural interactions between wetland and upland systems. Sufficient natural or semi-natural vegetation around the occurrence exists that the occurrence is not heavily influenced by human induced changes in hydrologic regimes, nutrient cycles, or in the uplands. Some barriers to movement of species and materials are present limited connectivity exists among upland fragments. Natural patterns of water flow, fire, or nutrient cycling have been heavily altered by

human influences. Restoration of most of these natural processes to near their historic patterns is feasible.

D-rated landscape context: Uplands surrounding occurrence within ground watershed are mostly converted to agricultural or urban uses. Connectivity among natural vegetation patches and natural processes are almost nonexistent. Restoration is not feasible within reason.

Justification for A-rated criteria: These occurrences are within nearly intact watersheds and ecological processes, fully supporting the occurrences natural structure, composition, and function. Native systems surrounding the occurrence buffer the fens from any unnatural human influences resulting from changes in water flows, nutrient status, or other hydrologic alterations. Connectivity of habitats allows natural processes and species migration to occur.

Justification for C/D threshold: C-ranked occurrences receive at least some benefit from adjacent natural or semi-natural vegetation (e.g., there is movement across wetland and native upland boundaries), and there is limited buffering from upland influences. D-ranked occurrences receive very little benefit from natural surroundings, so they are subject to altered hydrology, nutrient influxes, invasive species, and population and diversity declines resulting from a cessation of organismal immigration

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**SOUTHERN ROCKY MOUNTAINS ECOREGION
UPPER MONTANE/SUBALPINE RIPARIAN FOREST AND WOODLAND
ECOLOGICAL SYSTEM—LINEAR**

Abies concolor - *Picea pungens* - *Populus angustifolia* / *Acer glabrum* Forest
Abies lasiocarpa / *Acer glabrum* Forest
Abies lasiocarpa / *Calamagrostis canadensis* Forest
Abies lasiocarpa / *Mertensia ciliata* Forest
Abies lasiocarpa / *Trautvetteria caroliniensis* Forest
Abies lasiocarpa-*Picea engelmannii*/*Alnus incana* Woodland
Abies lasiocarpa-*Picea engelmannii*/*Salix drummondiana* Woodland
Picea engelmannii / *Calamagrostis canadensis* Forest
Picea engelmannii / *Caltha leptosepala* Forest
Picea engelmannii / *Cornus sericea* Forest
Picea engelmannii / *Equisetum arvense* Forest
Picea pungens / *Alnus incana* Woodland
Picea pungens / *Cornus sericea* Woodland
Picea pungens / *Equisetum arvense* Woodland
Populus tremuloides / *Alnus incana* - *Cornus sericea* Forest
Populus tremuloides / *Betula occidentalis* Forest
Populus tremuloides / *Calamagrostis canadensis* Forest
Populus tremuloides / *Cornus sericea* Forest
Populus tremuloides / *Corylus cornuta* Forest
Populus tremuloides / *Ribes montigenum* Forest
Populus tremuloides / *Salix drummondiana* Forest

SCALE AND RANGE: LINEAR AND WIDESPREAD

Upper montane/subalpine riparian forest and woodland ecological system is a linear system confined to specific environments occurring on floodplains or terraces of rivers and streams. This ecological system is widespread and found in other Rocky Mountain ecoregions as well as the Southern Rocky Mountains ecoregion. Although this system occupies less than 1% of the Southern Rocky Mountains ecoregion it can be found throughout the region, primarily between 8,000 and 11,000 feet. It is also the primary riparian matrix of the Southern Rocky Mountain ecoregion. The montane/subalpine riparian shrubland ecological system forms small patches within this linear-matrix system. Occurrences often contain a mosaic of one or two communities dominated by one of the following trees: *Abies concolor*, *A. lasiocarpa*, *Picea engelmannii*, *P. pungens*, or *Populus tremuloides*. Generally the vegetation surrounding these riparian systems are dominated by the same tree as that in the riparian area, e.g., if the riparian forest is *Picea engelmannii* the dominant upland vegetation is a *Picea engelmannii* forest.

The primary ecological process necessary to maintain this ecological system is hydrology and more specifically surface flow, although ground water is important. Annual and episodic flooding is important in maintaining this system. Alteration of the flooding regime due to water impoundment, diversions, etc. may produce changes to plant

composition as well as community composition (Kittel et al. 1999). In addition, upstream activities that effect water quality, e.g., mining, may be important to the vertebrates and invertebrate species that use this system.

Aquatic species and water quality may be as important an indicator of health of the system as is the vegetation. For example one study on ptarmigan show that what appears to be a healthy willow community is in reality a sink for ptarmigan due to the excessive heavy metals that are found in the willows below mining areas.

MINIMUM SIZE: 3 miles by 30 feet.

SEPERATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation or very degraded example of same community greater than ¼ mile long, major highways, urban development, large bodies of water, 2) different natural community (system) longer than 1 mile along a river corridor, or ¼ mile in other situations, 3) major break in topography, soils, geology, etc., especially one resulting in a hydrologic break. Natural breaks include changes in the stream gradient and other features of the geomorphic setting (e.g. waterfalls). Unnatural breaks are bridges, roads, channelized sections, and heavily degraded reaches that alter the natural hydrologic flow, scour and deposition dynamics of the stream/river.

Justification: Primary criteria to be considered is the reaction to natural flooding/seasonal saturation of the soil profile. The separation distance for intervening natural or semi-natural communities assumes dynamic movements due to natural flooding regimes.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Equal weighting should be given to all ranking factors.

CONDITION SPECIFICATIONS:

A –rated condition: Natural hydrologic regime intact, including an unaltered floodplain. No or little evidence of alteration due to drainage, flood control, irrigation canals, livestock grazing, soil compaction, digging, burming, mining or vehicle use. No or very few exotic species present with no potential for expansion. Species composition is primarily of native species with a diverse physiognomic structure. Stream banks are not overly steepened, the channel not widened, nor unvegetated by excessive livestock grazing.

B- rated condition: Natural hydrologic regime intact or slightly altered by local drainage, flood control, irrigation canals, livestock grazing, digging, mining, vehicle use or roads. Alteration is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. Although species composition is primarily of native species, the physiognomic structure is less diverse than above. Stream banks may show some local deleterious effects from excessive livestock grazing.

C-rated condition: Natural hydrologic regime altered by upstream dams, local drainage, diking, filling, digging, mining, or dredging. Alteration may be extensive but potentially restorable over several decades. Vehicle use or grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction, causing excessive erosion. Exotic species (e.g., *Taraxacum officianalis*, *Poa pratensis*, *Agrostis stolonifera*) may be widespread but potentially manageable with restoration of most natural processes. Stream banks have been severely altered by excessive grazing or other human caused reasons, e.g, channeling, or road construction.

D –rated condition: Natural hydrologic regime or disturbance to site not restorable. System remains fundamentally compromised despite restoration of some processes. Invasive exotic species, e.g, *Tamarix*, may be dominant over significant portions of area, with little potential for control.

Justification for A-rated criteria: Subalpine riparian forest and woodlands are dependent on specific hydrologic regimes, soils, and ability to move both up and down the stream as well as side to side within the floodplain. A-ranked occurrences have natural flooding processes, species composition, and physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 5 linear miles)

B –rated size: Large (4 to 5 linear miles)

C –rated size: Moderate (3 to 4 linear miles)

D –rated size: Small (< 3 linear mile)

Justification for A-rated criteria: Subalpine riparian woodlands are often composed of one or two different plant associations, and may include small patches of shrublands and herbaceous vegetation. Occurrences of this size have a wide range of plant associations within the complex that show a wide range of variation in hydrology, soil texture, and geomorphology. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic and hydrologic disturbance. They are buffered from edge effects by the intact surrounding upland forest and can withstands small hydrologic alterations.

Justification for C/D threshold: C-ranked occurrences are large enough to sustain some natural or human caused perturbations. While D-ranked occurrences are too small to remain viable with changes to the hydrology. They are also extremely susceptible to invasions by non-natives making them subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: No evidence of human-caused alteration of hydrology, especially upstream of occurrence and within the watershed. Uplands surrounding occurrence and within the watershed are largely unaltered by urban or agricultural uses (> 90% natural), and have few to no recent (< 20 years) clearcuts adjacent to occurrence. No unnatural barriers present. Connectivity to habitats allows natural processes and species migration to occur.

B-rated landscape context: Little evidence of human-caused alteration of hydrology, especially upstream of occurrence and within the watershed. Uplands surrounding occurrence and within the watershed are largely unaltered by urban or agricultural uses (60 to 90% natural), but retaining much connectivity, or uplands are heavily managed forest landscape with clearcuts, mining, or numerous roads. Few barriers present. Some natural processes such as flooding may be slightly compromised. No regional dam upstream.

C-rated landscape context: Uplands surrounding occurrence or upstream watershed are fragmented by urban or agricultural alteration (20 to 60% natural), with limited connectivity. Some barriers are present, and natural ecological processes are altered. For example, local or moderate human-caused alteration of hydrology may be present including small dams or irrigation ditches.

D-rated landscape context: Major human-caused alteration of hydrology. Uplands surrounding occurrence mostly converted to agricultural or urban uses, including ski area development. Riparian occurrence may be reduced to a narrow strip with a significant edge effect. Connectivity and natural processes are nonexistent. Large dams and numerous diversions are within watershed.

Justification for A-rated criteria: These are occurrences with nearly intact watersheds and natural flooding processes in place. Riparian areas are fully connected with uplands, and fully buffer upland influences.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from upland influences. D-ranked occurrences have no buffering, and are subject to siltation, pollutions, or invasive species. Large dams disrupt the natural flooding process as well as regulating the annual flows.

AUTHORSHIP: Renée Rondeau

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SOUTHERN ROCKY MOUNTAINS ECOREGION
MONTANE/SUBALPINE RIPARIAN SHRUBLAND ECOLOGICAL SYSTEM—
LINEAR

Alnus incana - *Salix drummondiana* Shrubland
Alnus incana -(mixed *Salix*) Shrubland
Alnus incana / *Cornus sericea* Shrubland
Alnus incana / *Equisetum arvense* Shrubland
Alnus incana / Mesic Forbs Shrubland
Alnus incana / Mesic Graminoids Shrubland
Betula glandulosa / Mesic forb-mesic graminoid
Betula occidentalis / *Cornus sericea* Shrubland
Betula occidentalis / Mesic Forb Shrubland
Betula occidentalis / Mesic Graminoid Shrubland
Cornus sericea Shrubland [Provisional]
Pentaphylloides floribunda / *Deschampsia cespitosa* Shrubland
Pentaphylloides floribunda Shrubland [Provisional]
Salix bebbiana / Mesic Graminoids Shrubland
Salix bebbiana Shrubland
Salix boothii / *Calamagrostis canadensis* Shrubland
Salix boothii / *Carex rostrata* Shrubland
Salix boothii / *Deschampsia cespitosa*-*Geum rossii* Shrubland
Salix boothii / Mesic Forbs Shrubland
Salix boothii / Mesic Graminoids Shrubland
Salix brachycarpa / *Calamagrostis canadensis* Shrubland
Salix brachycarpa / *Carex aquatilis* Shrubland
Salix brachycarpa / Mesic Forbs Shrubland
Salix drummondiana - *Salix monticola* / Mesic Forbs Shrubland
Salix drummondiana - *Salix planifolia* / *Calamagrostis canadensis* Shrubland
Salix drummondiana / *Calamagrostis canadensis* Shrubland
Salix drummondiana / *Carex rostrata* Shrubland
Salix eriocephala var. *ligulifolia* Shrubland
Salix geyeriana - *Salix monticola* / *Calamagrostis canadensis* Shrubland
Salix geyeriana - *Salix monticola* / *Carex aquatilis* Shrubland
Salix geyeriana - *Salix monticola* / Mesic graminoid Shrubland
Salix geyeriana / *Calamagrostis canadensis* Shrubland
Salix geyeriana / *Carex aquatilis* Shrubland
Salix geyeriana / *Carex rostrata* Shrubland
Salix geyeriana / Mesic Graminoids Shrubland
Salix ligulifolia - *Cornus sericea* Shrubland
Salix lucida ssp. *caudata* Shrubland [Provisional]
Salix monticola / *Calamagrostis canadensis* Shrubland
Salix monticola / *Carex aquatilis* Shrubland
Salix monticola / *Carex rostrata* Shrubland
Salix monticola / Mesic Forb Shrubland
Salix monticola / Mesic Graminoids Shrubland

Salix planifolia / *Calamagrostis canadensis* Shrubland
Salix planifolia / *Caltha leptosepala* Shrubland
Salix planifolia / *Carex aquatilis* Shrubland
Salix planifolia / *Carex scopulorum* Shrubland
Salix planifolia / *Deschampsia caespitosa* Shrubland
Salix planifolia / mesic forb Shrubland
Salix pseudomonticola Thicket Shrubland
Salix wolfii / *Carex aquatilis* Shrubland
Salix wolfii / *Carex rostrata* Shrubland
Salix wolfii / *Deschampsia cespitosa* Shrubland
Salix wolfii / Mesic Forbs Shrubland
Shepherdia argentea Shrubland [Provisional]

SCALE AND RANGE: LINEAR AND SMALL PATCH; WIDESPREAD

Montane/subalpine riparian shrubland ecological system is a linear and small patch system, confined to specific environments occurring on floodplains or terraces of rivers and streams and shallow broad valleys. This ecological system is also found in other Rocky Mountain ecoregions. Although the montane/subalpine riparian shrubland ecological system occupies less than 1% of the Southern Rocky Mountains ecoregion it can be found throughout the region within a broad elevation range from approximately 8,000 to 11,000 feet. This system often occurs as a mosaic of multiple communities that are shrub dominated. The dominant shrubs reflect the large elevational gradient and include *Alnus incana*, *Betula glandulosa*, *B. occidentalis*, *Cornus sericea*, *Salix bebbiana*, *S. boothii*, *S. brachycarpa*, *S. drummondiana*, *S. eriocephala*, *S. geyreiana*, *S. moniticola*, *S. planifolia*, and *S. wolfii*. Generally the upland vegetation surrounding these riparian systems are of either conifer or aspen forests, while adjacent riparian systems range from herbaceous dominated communities to tree dominated communities.

Beavers are primary users as well as maintainers to this system. In addition to beavers, the primary abiotic ecological process necessary to maintain this ecological system is hydrology and more specifically surface flow. Annual and episodic flooding is important in maintaining this system. Alteration of the flooding regime due to water impoundment, diversions, etc. may produce changes to plant composition as well as community composition (Kittel et al. 1999). In addition, upstream activities that effect water quality, e.g., mining, may be important to the vertebrates and invertebrate species that use this system.

Aquatic species and water quality may be as important an indicator of health of the system as is the vegetation. For example one study on ptarmigan show that what appears to be a healthy willow community is in reality a sink for ptarmigan due to the excessive heavy metals that are found in the willows below mining areas.

MINIMUM SIZE: 0.5 mile by 30 feet.

SEPERATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation or very degraded example of same community greater than ¼ mile long, major highways, urban development, large bodies of water, 2) different natural community (system) longer than 1 mile along a river corridor, or ¼ mile in other situations, 3) major break in topography, soils, geology, etc., especially one resulting in a hydrologic break. Natural breaks include changes in the stream gradient and other features of the geomorphic setting (e.g. waterfalls). Unnatural breaks are bridges, roads, channelized sections, and heavily degraded reaches that alter the natural hydrologic flow, scour and deposition dynamics of the stream/river.

Justification: Primary criteria to be considered is the reaction to natural flooding. The separation distance for intervening natural or semi-natural communities assumes dynamic movements due to natural flooding regimes.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Equal weighting should be given to all ranking factors.

CONDITION SPECIFICATIONS:

A –rated condition: Natural hydrologic regime intact, including an unaltered floodplain. No or little evidence of alteration due to drainage, flood control, irrigation canals, livestock grazing, digging, burning, mining, or vehicle use. No or very few exotic species present with no potential for expansion. Species composition is primarily of native species with a diverse physiognomic structure. Stream banks are not overly steepened, the channel not overly widened, nor unvegetated by excessive grazing.

B- rated condition: Natural hydrologic regime intact or slightly altered by local drainage, flood control, irrigation canals, livestock grazing, digging, mining, vehicle use, or roads. Alteration is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. Although species composition is primarily of native species, the physiognomic structure is less diverse than above. Stream banks may show some local deleterious effects from excessive livestock grazing or other human activity.

C-rated condition: Natural hydrologic regime altered by upstream dams, local drainage, diking, filling, digging, mining, or dredging. Alteration is extensive but potentially restorable over several decades. Vehicle use or grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction, causing excessive erosion. Exotic species (e.g., *Taraxacum officianalis*, *Trifolium repens*, *Poa pratensis*, *Agrostis stolonifera*) may be widespread but potentially manageable with restoration of most natural processes. Stream banks have been severely altered by excessive grazing or other human activity, e.g, channeling, or road construction.

D –rated condition: Natural hydrologic regime or disturbance to site not restorable. System remains fundamentally compromised despite restoration of some processes.

Invasive exotic species, e.g. *Phalaris arundinaceae*, may be dominant over significant portions of area, with little potential for control.

Justification for A-rated criteria: Subalpine/montane riparian shrublands are dependent on specific hydrologic regimes, soils, and ability to move both up and down the stream as well as side to side within the floodplain. A-ranked occurrences have natural flooding processes, species composition, and physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 1.5 linear miles)

B –rated size: Large (1 to 1.5 linear miles)

C –rated size: Moderate (.5 to 1 linear miles)

D –rated size: Small (< .5 linear mile)

Justification for A-rated criteria: Subalpine/montane riparian shrublands are often composed of a mosaic of different plant associations, often including patches of herbaceous vegetation dictated by soils and hydrology. Occurrences of this size have a wide range of plant associations within the complex that show a wide range of variation in hydrology, soil texture, and geomorphology. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic and hydrologic disturbance. They are long enough to respond to inundations, burial and scour disturbance, and wide enough to allow for lateral migration of the active channel and associated response of the vegetation to that change. Riparian areas of this size can adequately buffer runoff, sedimentation and non-point pollution from uplands. In addition, stands of this size can withstand the impacts of small hydrologic alterations.

Justification for C/D threshold: C-ranked occurrences are large enough to sustain some natural or human caused perturbations. While D-ranked occurrences are too small to remain viable with a catastrophic event. They are also extremely susceptible to invasions by non-natives making them subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: No evidence of human-caused alteration of hydrology, especially upstream of occurrence and within the watershed. Uplands surrounding occurrence and within the watershed are largely unaltered by urban or agricultural uses (> 90% natural), and have few to no recent (< 20 years) clearcuts (<25% of landscape). No unnatural barriers present. Connectivity to habitats allows natural processes and species migration to occur.

B-rated landscape context: Little evidence of human-caused alteration of hydrology, especially upstream of occurrence and within the watershed. Uplands surrounding occurrence and within the watershed are largely unaltered by urban or agricultural uses (60 to 90% natural), and retain much connectivity. Uplands may be managed forest landscape with limited clearcuts, mining, or numerous roads. Few barriers present. Some natural processes such as flooding, may be slightly compromised. No regional dam upstream.

C-rated landscape context: Uplands surrounding occurrence or upstream watershed are fragmented by urban or agricultural alteration (20 to 60% natural), with limited connectivity. Some barriers are present, and natural processes few. Local or moderate human-caused alteration of hydrology may be present, for example small tributary dams or irrigation ditches.

D-rated landscape context: Major human-caused alteration of hydrology. Uplands surrounding occurrence mostly converted to agricultural or urban uses, including ski area development. Riparian occurrence may be reduced to a narrow strip with a significant edge effect. Connectivity and natural processes are nonexistent. Large dams and numerous diversions are within watershed.

Justification for A-rated criteria: These are occurrences with nearly intact watersheds exhibiting excellent water quality and natural hydrologic regime. Riparian areas are fully connected with uplands, and can fully buffer upland influences.

Justification for C/D threshold: C-ranked occurrences have limited buffering capacity from upland influences. D-ranked occurrences offer no buffering capacity, and are subject to siltation, pollutions, and invasive species. Large dams disrupt the natural flooding process as well as regulating the annual flows.

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**SOUTHERN ROCKY MOUNTAINS ECOREGION
DOUGLAS FIR-PONDEROSA PINE FOREST ECOLOGICAL SYSTEM –
LARGE PATCH**

Pseudotsuga menziesii / *Acer glabrum* Forest
Pseudotsuga menziesii / *Arctostaphylos uva-ursi* Forest
Pseudotsuga menziesii / *Carex geyeri* Forest
Pseudotsuga menziesii / *Carex rossii* Forest
Pseudotsuga menziesii / *Festuca arizonica* Forest
Pseudotsuga menziesii / *Festuca idahoensis* Woodland
Pseudotsuga menziesii / *Festuca kingii* Woodland
Pseudotsuga menziesii / *Holodiscus dumosus* Scree Woodland
Pseudotsuga menziesii / *Jamesia americana* Forest
Pseudotsuga menziesii / *Juniperus communis* Forest
Pseudotsuga menziesii / *Mahonia repens* Forest
Pseudotsuga menziesii / *Muhlenbergia montana* Forest
Pseudotsuga menziesii / *Paxistima myrsinites* Forest
Pseudotsuga menziesii / *Physocarpus monogynus* Forest
Pseudotsuga menziesii / *Purshia tridentata* Woodland
Pseudotsuga menziesii / *Quercus gambelii* Forest
Pseudotsuga menziesii / *Symphoricarpos oreophilus* Forest
Pinus ponderosa / *Arctostaphylos uva-ursi* Woodland
Pinus ponderosa / *Physocarpus monogynus* Forest

SCALE AND RANGE: LARGE PATCH AND WIDESPREAD

Douglas fir – ponderosa pine ecological system is a large patch system that occurs in approximately 2% of the Southern Rocky Mountains ecoregion, primarily in the Colorado portion. It is also distributed in other western U.S. mountain ecoregions. It has a rather large elevation range from 6,000 to 10,000 feet. Douglas fir plant associations are found over a wide range of aspects, slopes, landforms, and soils. Often, Douglas fir occurs on north-facing slopes while ponderosa pine occupies south-facing slopes. Douglas-fir is more shade tolerant than pine and aspen but less tolerant than Engelmann spruce or subalpine fir (Mehl 1992). When growing in association with spruce-fir, Douglas fir will be seral giving way eventually to the more shade tolerant spruce-fir (Mehl 1992). When growing in association with ponderosa pine, lodgepole pine or aspen it often dominates becoming the climax if succession is not interrupted by a major disturbance such as fire (Mehl 1992).

Douglas-fir is shade tolerant, reproducing under its own canopy (Mehl 1992). This results in old stands of pure Douglas-fir that tend to be mixed-aged (Mehl 1992). While old Douglas-fir develop a resistance to fire due to a thick corky bark, the young trees are easily killed by fires. The oldest stands generally reach a maximum age of 400 years old although some have reached an age of 700 years (Mehl 1992). Trees 200 to 300 years old are commonly 100 to 120 feet tall and between 15 and 40 inches dbh.

<http://www.fs.fed.us/database/feis/>.

Mature Douglas fir is generally more fire resistant than spruces and true firs, and equally or slightly less fire resistant than ponderosa pine (<http://www.fs.fed.us/database/feis/>). Douglas-fir saplings are more susceptible to mortality from surface fires than ponderosa pine saplings (Arno et al. 1983 and Weaver 1970 as cited in <http://www.fs.fed.us/database/feis/>). Mature trees can survive moderately severe ground fires because the lower bole is covered by thick, corky bark that insulates the cambium from heat damage (Revill Associates 1978 and Fischer and Bradley 1987 as cited in <http://www.fs.fed.us/database/feis/>). Frequent low intensity fires keep Douglas-fir from becoming established in the ponderosa pine type (<http://www.fs.fed.us/database/feis/>).

In general trees that survive a fire tend to be taller and have larger bole diameters than trees that died (Bevins 1980 as cited in <http://www.fs.fed.us/database/feis/>). Following a fire in Colorado, live trees averaged 9.5 inches dbh and 32 feet in height, while dead trees averaged 5.6 inches dbh and 22.6 feet in height (Wyant et al. 1986 as cited in <http://www.fs.fed.us/database/feis/>).

Fire suppression has altered the distribution and frequency of Douglas fir in the Southern Rocky Mountains ecoregion. J. Coles (pers. com.) believes that historically, Douglas fir stands that are nearly pure were limited to the Roan/Piceance Basin region and to north-facing slopes in a narrow elevational belt along the east slope of the Front Range. Along with fire frequency and intensity, insects (tussock moth, spruce budworm, Douglas-fir beetle) are major factors in stand structure and density of Douglas-fir plant communities (J. Coles pers. com.).

Three-toed woodpeckers are primarily associated with spruce-fir forests but will also inhabit Ponderosa pine, Douglas-fir, and Lodgepole pine forests when insect infestations or fires occur. The three-toed woodpecker thrives in conifer forests that have either just burned or succumbed to an insect infestation (Andrews and Righter 1992). From three to five years after a fire, the burned area will support a local increase in woodpeckers, including the three-toed woodpecker (Spahr et al. 1991). The three-toed woodpecker gleans insects from the trunks of dead trees, for this reason, local burns and insect kills should be considered part of a natural and healthy forest ecosystem.

Major threats to this system include fire suppression, clear-cut logging, and fragmentation by development and roads.

MINIMUM SIZE: 30,000 acres (See Anderson (1999) for a review of minimum size criteria for matrix communities.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation (includes clearcuts/tree plantations) greater than ½ wide, major highways, or urban development; 2) a different ecological system wider than ½ mile wide; 3) a major break or change in the ecological land unit (e.g. topography, soils, geology).

Justification: Many of these communities occur naturally in a mosaic much of the time so minor breaks or small barriers are probably a very common part of the natural distribution and variability. If the breaks are larger, barriers may exist for some species.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Size is the most important ranking factor for matrix communities. Condition is of secondary importance and while landscape context is still important, it is slightly less so than the overall size and condition of an occurrence.

CONDITION SPECIFICATIONS:

A -rated condition: Compiled from Mehl (1992) and <http://www.fs.fed.us/database/feis/>. A mature stand of Douglas fir consists of approximately 10 trees per acre with a minimum DBH of 18 inches and the minimum age of approximately 200 years. Usually this is a multi-aged stand with approx. 2 dead standing trees per acre with a minimum DBH of 15 inches. Some downed trees are evident. An old-growth Douglas-fir stand would consist of an overstory of trees that are predominately or entirely Douglas-fir. On the cooler more moist, north facing slopes Douglas fir may be growing in association with spruce-fir or white fir. On drier sites old-growth Douglas fir could be associated with ponderosa pine, lodgepole pine and aspen. Where the site is dry, the stand would be more open compared to a cooler, more moist site such as a north facing slopes or drainage bottoms. Some dead standing trees and down dead trees should be present. Some of the overstory trees would have large and open branched, flattened or dead tops and contain some rot. Roads occupy less than 1% of the occurrence; no evidence of logging; no development.

B -rated condition: Little to no evidence of past logging disturbance over a major proportion of the occurrence and majority of stand is > 100 years old, may show evidence of selective logging that has altered the structure; non-native species may be present with low to moderate frequency in the understory, but have low percent cover. Multi-aged stands with some dead and down trees. Roads occupy less than 5% of the occurrence; logging occupies less than 5% of the occurrence, and development is less than 1% of the occurrence.

C -rated condition: Stands regenerated naturally after logging or fire or young to mature stands with significant history of selective logging disturbance that altered composition or structure; non-native species may be uncommon to frequent but do not dominate or co-dominate understory (<10-20% cover). Roads occupy less than 15% of the occurrence; logging occupies less than 15 % of the occurrence, and development is less than 5% of the occurrence.

D -rated condition: Immature stand of Douglas fire with very low species diversity. Logging and other surface disturbance evident throughout.

Justification for A-rated criteria: Frequency of old-growth stands has been much reduced in this ecoregion, so old-growth carries a premium for condition. In addition,

occurrences that have been unaltered by logging, fire suppression, and are primarily dominated by native species are priority stands for conservation of biodiversity.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE.SPECS

A -rated size: Very large (>90,000 ac)

B -rated size: Large (50,000-80,000 ac)

C -rated size: Moderate (30,000-50,000 ac)

D -rated size: Small (<30,000 ac)

Justification for A-rated criteria: A 90,000 acre stand is large enough to support a mosaic of stand conditions, ages, and disturbance patterns.

Justification for C/D threshold: A 30,000 acre stand is estimated to be as small as matrix communities can be and still support minimum viable populations of pine martens (Anderson 1999). Smaller than 30,000 acres is subject to edge effects and stand destroying events, e.g., fire, beetle kill.

LANDSCAPE.CONTEXT.SPECS

A -rated landscape context: Occurrence surrounded by a large area (>2000 ac/800 ha) of natural vegetation. None to a few small roads in the surrounding landscape. Little to no development or logging in surrounding systems.

B -rated landscape context: Landscape composed of at least 90% natural or semi-natural vegetation; or landscape has very little development or agriculture but has major components of non-native vegetation in at least one physiognomic layer or is composed primarily of young tree plantations.

C -rated landscape context: Landscape is a mosaic of agricultural or semi-developed areas and natural or semi-natural vegetation, the latter composing 25-90% of the landscape, or landscape is dominated by very young tree plantations (cut within last 20 years).

D -rated landscape context: Occurrence surrounded primarily by urban or agricultural landscape, with <25% landscape cover of natural or semi-natural vegetation.

Justification for A-rated criteria: Connectivity is intact and allows for natural migration of flora and fauna as well as completely buffered from perturbations outside of the occurrence. Landscape also allows fire to sweep naturally from adjacent ecological systems.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from adjacent system perturbations, they are connected (although minimally) with other natural systems in the surrounding landscape. With some effort, system function for C-ranked occurrences could be improved. D-ranked occurrences have no buffering, and are subject to altered hydrology and invasive species. D-ranked occurrences are missing fundamental components that prohibit restoration.

AUTHORSHIP: Renée Rondeau

DATE: July 20, 2000

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SOUTHERN ROCKY MOUNTAINS ECOREGION
**MONTANE / FOOTHILL CLIFF AND CANYON ECOLOGICAL SYSTEM –
LARGE PATCH**

Sparse non-vascular vegetation (on rock and unconsolidated substrates)

Pseudotsuga menziesii / *Holodiscus dumosus* Scree Woodland

Pseudotsuga menziesii / *Jamesia americana* Forest

Pseudotsuga menziesii / *Physocarpus monogynus* Forest

Pinus ponderosa / Rockland Woodland

Abies concolor / *Holodiscus dumosus* Scree Woodland

Montane/foorthill cliff and canyon ecological system are large patch found in lower, middle, and upper elevations, generally from 6,000 to 10,000 feet in the Southern Rocky Mountains. Douglas-fir, ponderosa pine, or white fir are widely spaced with a limited shrubland understory of *Holodiscus*, *Jamesia*, or *Physocarpus*. Soil development is limited as is herbaceous cover. Due to the sparse nature of the vegetation, fires seldom occur, therefore the trees can be quite old.

MINIMUM SIZE: 100 acres

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation (includes clearcuts/tree plantations) greater than ½ wide, major highways, or urban development; 2) a different ecological system wider than ½ mile wide; 3) a major break or change in the ecological land unit (e.g. topography, soils, geology).

Justification: Many of these communities occur naturally in a mosaic much of the time so minor breaks or small barriers are probably a very common part of the natural distribution and variability. If the breaks are larger, barriers may exist for some species.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does occurrence size, although the species-area relationship still holds up for patch type communities.

CONDITION SPECIFICATIONS:

A -rated condition: A mature and widely scatted stand of conifers. Usually this is a multi-aged stand with a few dead standing trees per acre. Some downed trees are evident.

B -rated condition:

C -rated condition:

D -rated condition: Immature stand of conifers with very low species diversity.

Justification for A-rated criteria:

Justification for C/D threshold:

SIZE.SPECS

A – rated size: Very large (> 600 acres)

B –rated size: Large (200 to 600 acres)

C –rated size: Moderate (100 - 200 ac)

D –rated size: Small (<100 ac)

Justification for A-rated criteria: Large enough to support a mosaic of stand conditions, ages, and disturbance patterns.

Justification for C/D@ threshold: Occurrences smaller than 100 acres are subject to catastrophic events that may eliminate the entire occurrence and leave little to no opportunity for a mosaic of disturbance patterns.

LANDSCAPE.CONTEXT.SPECS

A -rated landscape context: Occurrence surrounded by a large area (>2000 ac/800 ha) of natural vegetation. None to a few small roads in the surrounding landscape.

B -rated landscape context: Landscape composed of at least 90% natural or semi-natural vegetation; or landscape has very little development or agriculture but has major components of non-native vegetation in at least one physiognomic layer or is composed primarily of young tree plantations.

C -rated landscape context: Landscape is a mosaic of agricultural or semi-developed areas and natural or semi-natural vegetation, the latter composing 25-90% of the landscape, or landscape is dominated by very young tree plantations (cut within last 20 years).

D -rated landscape context: Occurrence surrounded primarily by urban or agricultural landscape, with <25% landscape cover of natural or semi-natural vegetation.

Justification for A-rated criteria: Connectivity is intact and allows for natural migration of flora and fauna as well as completely buffered from perturbations outside of the occurrence.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from adjacent system perturbations, they are connected (although minimally) with other natural systems in the surrounding landscape. With some effort, system function for C-ranked occurrences could be improved. D-ranked occurrences have no buffering, and are

subject to altered hydrology and invasive species. D-ranked occurrences are missing fundamental components that prohibit restoration.

AUTHORSHIP: Renée Rondeau

DATE: July 20, 2000

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SOUTHERN ROCKY MOUNTAINS ECOREGION
PONDEROSA PINE WOODLAND ECOLOGICAL SYSTEM –MATRIX

Pinus ponderosa / *Cercocarpus montanus* / *Andropogon gerardii* Wooded Herbaceous Vegetation

Pinus ponderosa / *Bouteloua gracilis* Woodland

Pinus ponderosa / *Cercocarpus montanus* Woodland

Pinus ponderosa / *Arctostaphylos patula* Woodland

Pinus ponderosa / *Festuca arizonica* Woodland

Pinus ponderosa / *Festuca kingii* Woodland

Pinus ponderosa / *Muhlenbergia montana* Woodland

Pinus ponderosa / *Pseudoroegneria spicata* Woodland

Pinus ponderosa / *Quercus gambelii* Woodland

Pinus ponderosa / *Quercus X pauciloba* Woodland

Pinus ponderosa / *Ribes cereum* Woodland

SCALE AND RANGE: MATRIX PATCH AND WIDESPREAD

Ponderosa pine woodlands ecological system is a matrix system that occupies 10% of the Southern Rocky Mountains ecoregion and are found throughout the area. This ecological system is primarily in the foothills and montane zones from approximately 6,000 to 9,000 feet on rolling plains or dry slopes with both north and south aspect. The northerly aspects may have a mixture of ponderosa pine and Douglas fir, while the southerly aspects tend to be dominated by ponderosa pine. A century of anthropogenic changes have altered the density and distribution of ponderosa pines. A healthy occurrence often consists of open and park-like stands dominated by *Pinus ponderosa*. Understory vegetation varies from shortgrass to tall shrubs, e.g., *Quercus gambelii* or grasses, e.g., *Festuca arizonica*, and *Bouteloua gracilis*.

Fire has played a very important role in shaping ponderosa pine woodlands. In the past, low intensity fires would burn through ponderosa pine stands every 8-15 years, removing competing understory vegetation and down material (Mehl 1992, Harrington and Sackett 1992). This resulted in irregular shaped stands of even-aged groups of trees varying in size, age and density (Mehl 1992).

Ponderosa pine is more fire resistant and less shade tolerant than Douglas-fir (Mehl 1992). Where periodic low intensity fires have been eliminated from the ecosystem more shade tolerant species such as Douglas-fir or white fir survive and ponderosa pine is seral.

Ponderosa pine has been heavily used since the mining days of the 1850's. It has been harvested for wood and provided forage for livestock. The combination of fire suppression, logging, and heavy livestock grazing has altered most ponderosa pine forests in the Southern Rocky Mountains ecoregion.

Mehl (1992) states the following: Where fire has been present, stands will be climax and contain groups of large, old trees with little understory vegetation or down woody material and few standing dead trees. The age difference of the groups of trees would be large. Where fire is less frequent there will also be smaller size trees in the understory giving the stand some structure with various canopy layers. Dead, down material will be present in varying amounts along with some standing dead trees. In both cases the large old trees will have irregular open, large branched crowns. The bark will be lighter in color, almost yellow, thick and some will like have basal fire scars.

Grace's warbler, Pygmy nuthatch, and flammulated owl are indicators of a healthy ponderosa pine woodland. All of these birds prefer mature trees in an open woodland setting (Winn 1998, Jones 1998, Levad 1998).

MINIMUM SIZE: 30,000 acres (see Anderson (1999) for determining minimum size for matrix communities)

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation (includes clearcuts/tree plantations) greater than ½ wide, major highways, or urban development; 2) a different ecological system wider than ½ mile wide; 3) a major break or change in the ecological land unit (e.g. topography, soils, geology).

Justification: Many of these communities occur naturally in a mosaic much of the time so minor breaks or small barriers are probably a very common part of the natural distribution and variability. If the breaks are larger, barriers may exist for some species.

RANK PROCEDURE: 1) condition, 2) landscape context, 3) size. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does occurrence size, although the species-area relationship still holds up for patch type communities.

CONDITION SPECIFICATIONS:

A –rated condition: Compiled from Mehl (1992) and <http://www.fs.fed.us/database/feis/>. A mature stand of ponderosa pine consists of approximately 10 trees per acre with a minimum DBH of 18 inches and the minimum age of approx. 160 years. Usually this is a multi-aged stand with approximately two dead standing trees per acre with a minimum DBH of 10 inches. Downed trees are none to few. An old-growth ponderosa pine stand would consist of an overstory of trees that are predominately or entirely ponderosa pine. On the cooler more moist, north facing slopes it may be growing in association with Douglas-fir. Frequent low intensity fires are still part of this system. Roads or other development are mostly non-existent

B –rated condition: Little to no evidence of past logging disturbance over a major proportion of the occurrence and majority of stand is > 100 years old, may show evidence

of selective logging that has altered the structure; non-native species may be present with low to moderate frequency in the understory, but have low percent cover. Fire frequency may be lower or more intense than expected. Roads or other development may be present but these occupy less than 3% of the occurrence.

C –rated condition: Stands regenerated naturally after logging or young to mature stands with significant history of selective logging disturbance that altered composition or structure; non-native species may be uncommon to frequent but do not dominate or co-dominate understory (<10-20% cover). If roads or other development are present they occupy less than 5% of the occurrence.

D –rated condition: Immature stand of ponderosa pine, often high density of trees, low shrub and herbaceous cover, and very low species diversity. Roads or other development occupy more than 5% of the occurrence.

Justification for A-rated criteria: Frequency of old-growth stands has been much reduced in this ecoregion, so old-growth carries a premium for condition. In addition, occurrences that have been unaltered by logging, fire suppression, and are primarily dominated by native species are priority stands for conservation of biodiversity. A-ranked occurrences provide suitable habitat for indicator species.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A –rated size: Very large (>90,000 ac)

B –rated size: Large (50,000-80,000 ac)

C –rated size: Moderate (30,000-50,000 ac)

D –rated size: Small (<30,000 ac)

Justification for A-rated criteria: A-ranked occurrences are large enough to support excellent occurrences of ponderosa pine woodland birds, especially Flamulated owls, Pygmy nuthatch, and Grace’s warbler. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance. They are buffered from edge effects. Occurrences of this size will support fires and the above mentioned birds and allow for a mosaic of different fire and grazing regimes.

Justification for C/D threshold: C-ranked occurrences could support a minimum viable population of ponderosa pine woodland birds and a diverse insect fauna. While D-ranked occurrences are subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS

A –rated landscape context: Occurrence surrounded by at least 2000 acres of natural vegetation. None to a few small roads in the surrounding landscape.

B –rated landscape context: Landscape composed of at least 90% natural or semi-natural vegetation; or landscape has very little development or agriculture but has major components of non-native vegetation in at least one physiognomic layer or is composed primarily of young tree plantations.

C –rated landscape context: Landscape is a mosaic of agricultural or semi-developed areas and natural or semi-natural vegetation, the latter composing 25-90% of the landscape, or landscape is dominated by very young tree plantations (cut within last 20 years).

D –rated landscape context: Occurrence surrounded primarily by urban or agricultural landscape, with <25% landscape cover of natural or semi-natural vegetation.

Justification for A-rated criteria: Connectivity is intact and allows for natural migration of flora and fauna as well as completely buffered from perturbations outside of the occurrence.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from adjacent system perturbations, they are connected (although minimally) with other natural systems in the surrounding landscape. With some effort, system function for C-ranked occurrences could be improved. D-ranked occurrences have no buffering, and are subject to altered hydrology and invasive species. D-ranked occurrences are missing fundamental components that prohibit restoration.

AUTHORSHIP: Renée Rondeau

DATE: October 23, 2000 (edited February 23, 2001)

LITERATURE CITED:

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Jones S. L. 1998. Pygmy nuthatch. Pages 360-361 in H. E. Kingery, ed., Colorado breeding bird atlas. Colorado Bird Atlas Partnership and Colorado Division of Wildlife, Denver, CO . 636.

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SOUTHERN ROCKY MOUNTAINS ECOREGION
PONDEROSA PINE SAVANNA ECOLOGICAL SYSTEM –MATRIX

Pinus ponderosa / *Cercocarpus montanus* / *Andropogon gerardii* Wooded Herbaceous Vegetation

Pinus ponderosa / *Festuca arizonica* Woodland

Pinus ponderosa / *Bouteloua gracilis* Woodland

SCALE AND RANGE: MATRIX PATCH AND WIDESPREAD

Ponderosa pine savanna ecological system is a large patch system that occupies less than 1% of the Southern Rocky Mountains ecoregion and is found throughout the area. This ecological system is primarily in the foothills and montane zones from approximately 6,000 to 9,000 feet on rolling plains or dry slopes usually on a more southerly aspect. This system is best described as a savanna that has widely spaced (>150 years old) ponderosa pines. A century of anthropogenic changes have altered the density and distribution of ponderosa pines. A healthy occurrence often consists of open and park-like stands dominated by *Pinus ponderosa*. Understory vegetation varies from shortgrass to tall shrubs, e.g., *Quercus gambelii* or grasses, e.g., *Festuca arizonica*, and *Bouteloua gracilis*.

Fire has played a very important role in shaping ponderosa pine woodlands. In the past, low intensity fires would burn through ponderosa pine stands every 8-15 years, removing competing understory vegetation and down material (Mehl 1992, Harrington and Sackett 1992). This resulted in irregular shaped stands of even-aged groups of trees varying in size, age and density (Mehl 1992).

Ponderosa pine is more fire resistant and less shade tolerant than Douglas-fir (Mehl 1992). Where periodic low intensity fires have been eliminated from the ecosystem more shade tolerant species such as Douglas-fir or white fir survive and ponderosa pine is seral.

Ponderosa pine has been heavily used since the mining days of the 1850's. It has been harvested for wood and provided forage for livestock. The combination of fire suppression, logging, and heavy livestock grazing has altered most ponderosa pine forests in the Southern Rocky Mountains ecoregion.

Mehl (1992) states the following: Where fire has been present, stands will be climax and contain groups of large, old trees with little understory vegetation or down woody material and few standing dead trees. The age difference of the groups of trees would be large. Where fire is less frequent there will also be smaller size trees in the understory giving the stand some structure with various canopy layers. Dead, down material will be present in varying amounts along with some standing dead trees. In both cases the large old trees will have irregular open, large branched crowns. The bark will be lighter in color, almost yellow, thick and some will like have basal fire scars.

Grace's warbler, Pygmy nuthatch, and flammulated owl are indicators of a healthy ponderosa pine woodland. All of these birds prefer mature trees in an open woodland setting (Winn 1998, Jones 1998, Levad 1998).

MINIMUM SIZE: 30,000 acres (see Anderson (1999) for determining minimum size for matrix communities)

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation (includes clearcuts/tree plantations) greater than ½ wide, major highways, or urban development; 2) a different ecological system wider than ½ mile wide; 3) a major break or change in the ecological land unit (e.g. topography, soils, geology).

Justification: Many of these communities occur naturally in a mosaic much of the time so minor breaks or small barriers are probably a very common part of the natural distribution and variability. If the breaks are larger, barriers may exist for some species.

RANK PROCEDURE: 1) condition, 2) landscape context, 3) size. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does occurrence size, although the species-area relationship still holds up for patch type communities.

CONDITION SPECIFICATIONS:

A –rated condition: Compiled from Mehl (1992) and <http://www.fs.fed.us/database/feis/>. A mature stand of ponderosa pine consists of approximately 10 trees per acre with a minimum DBH of 18 inches and the minimum age of approx. 160 years. Usually this is a multi-aged stand with approximately two dead standing trees per acre with a minimum DBH of 10 inches. Downed trees are none to few. An old-growth ponderosa pine stand would consist of an overstory of trees that are predominately or entirely ponderosa pine. On the cooler more moist, north facing slopes it may be growing in association with Douglas-fir. Frequent low intensity fires are still part of this system. Roads or other development are mostly non-existent

B –rated condition: Little to no evidence of past logging disturbance over a major proportion of the occurrence and majority of stand is > 100 years old, may show evidence of selective logging that has altered the structure; non-native species may be present with low to moderate frequency in the understory, but have low percent cover. Fire frequency may be lower or more intense than expected. Roads or other development may be present but these occupy less than 3% of the occurrence.

C –rated condition: Stands regenerated naturally after logging or young to mature stands with significant history of selective logging disturbance that altered composition or structure; non-native species may be uncommon to frequent but do not dominate or co-

dominate understory (<10-20% cover). If roads or other development are present they occupy less than 5% of the occurrence.

D –rated condition: Immature stand of ponderosa pine, often high density of trees, low shrub and herbaceous cover, and very low species diversity. Roads or other development occupy more than 5% of the occurrence.

Justification for A-rated criteria: Frequency of old-growth stands has been much reduced in this ecoregion, so old-growth carries a premium for condition. In addition, occurrences that have been unaltered by logging, fire suppression, and are primarily dominated by native species are priority stands for conservation of biodiversity. A-ranked occurrences provide suitable habitat for indicator species.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A –rated size: Very large (>90,000 ac)

B –rated size: Large (50,000-80,000 ac)

C –rated size: Moderate (30,000-50,000 ac)

D –rated size: Small (<30,000 ac)

Justification for A-rated criteria: A-ranked occurrences are large enough to support excellent occurrences of ponderosa pine woodland birds, especially Flamulated owls, Pygmy nuthatch, and Grace’s warbler. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance. They are buffered from edge effects. Occurrences of this size will support fires and the above mentioned birds and allow for a mosaic of different fire and grazing regimes.

Justification for C/D threshold: C-ranked occurrences could support a minimum viable population of ponderosa pine woodland birds and a diverse insect fauna. While D-ranked occurrences are subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS

A –rated landscape context: Occurrence surrounded by at least 2000 acres of natural vegetation. None to a few small roads in the surrounding landscape.

B –rated landscape context: Landscape composed of at least 90% natural or semi-natural vegetation; or landscape has very little development or agriculture but has major components of non-native vegetation in at least one physiognomic layer or is composed primarily of young tree plantations.

C –rated landscape context: Landscape is a mosaic of agricultural or semi-developed areas and natural or semi-natural vegetation, the latter composing 25-90% of the landscape, or landscape is dominated by very young tree plantations (cut within last 20 years).

D –rated landscape context: Occurrence surrounded primarily by urban or agricultural landscape, with <25% landscape cover of natural or semi-natural vegetation.

Justification for A-rated criteria: Connectivity is intact and allows for natural migration of flora and fauna as well as completely buffered from perturbations outside of the occurrence.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from adjacent system perturbations, they are connected (although minimally) with other natural systems in the surrounding landscape. With some effort, system function for C-ranked occurrences could be improved. D-ranked occurrences have no buffering, and are subject to altered hydrology and invasive species. D-ranked occurrences are missing fundamental components that prohibit restoration.

AUTHORSHIP: Renée Rondeau

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- Levad R. 1998. Grace's warbler. Pages 424-425 in H. E. Kingery, ed., Colorado breeding bird atlas. Colorado Bird Atlas Partnership and Colorado Division of Wildlife, Denver, CO .
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Forest and Range Experiment Station, Fort Collins, CO: USDA Forest Service,
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breeding bird atlas. Colorado Bird Atlas Partnership and Colorado Division of
Wildlife, Denver, CO . 636.

SOUTHERN ROCKY MOUNTAINS ECOREGION
PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM --MATRIX

Pinus edulis - *Juniperus scopulorum*
Pinus edulis / *Bouteloua curtipendula* Woodland
Pinus edulis / *Bouteloua gracilis* Woodland
Pinus edulis / *Cercocarpus montanus* Woodland
Pinus edulis / *Leymus ambiguus* Woodland
Pinus edulis / *Poa fendleriana* Woodland
Pinus edulis / *Pseudoroegneria spicata* Woodland
Pinus edulis / *Purshia tridentata* Woodland
Pinus edulis / *Quercus gambelii* Woodland
Pinus edulis / *Quercus x pauciloba* Woodland
Pinus edulis / Rockland Woodland
Pinus edulis / Sparse Understory Forest
Pinus edulis / *Stipa comata* Woodland
Pinus edulis / *Stipa scribneri* Woodland

SCALE AND RANGE: MATRIX AND WIDESPREAD

Pinyon-juniper woodland ecological system is a matrix system that occupies in approximately 11% of the Southern Rocky Mountains ecoregion, primarily in the southern half. Woodlands dominated by a mix of *Pinus edulis* and *Juniperus* spp. or pure or nearly pure stands of *Pinus edulis*, comprise the pinyon-juniper woodland ecological group. On the west slope of the Southern Rocky Mountains ecoregion *Juniperus osteosperma* or *J. scopulorum* are the dominant junipers, while on the east slope *J. monosperma* and *J. scopulorum* are the dominants. It occupies the lower and warmest elevations growing from 4,500? to 9,000? feet growing in a semiarid climate. It grows best just below the lower elevational range of ponderosa pine and above the grassland/shrublands of the foothills.

The stands exhibit considerable diversity in appearance and composition. Stands may consist of all ages or one age (Mehl 1992). Dominant trees are often 400 years old (Mehl 1992). Trees 800 to 1000 years old have been recorded (Mehl 1992). Some stands may have closed canopies with single or both tree species, with little or no understory, but many stands are open with widely scattered trees of one or both species with a wide variety of understory vegetation.

The p-j woodland is shade intolerant. It is the climax cover type remaining on the site until disturbed by fire. When disturbed by fire it will revert to grasses and eventually return to p-j woodalnd (Mehl 1992).

Although pinyon-juniper woodlands are a natural system the extent and quality has been severely altered since the early 1900's. Numerous studies have shown that pinyon-juniper, especially juniper have encroached on shrublands and grasslands (e.g., Blackburn and Tueller 1970, West 1999). Numerous processes influence pinyon-juniper woodlands, including climate, grazing, fires, tree harvest, and insect-pathogen outbreaks (West 1999; Eager 1999). Within a given region, the density of woodland, both historically and currently, is strongly related to topographic gradients. The trees persisted throughout past centuries on steeper, rockier, and thus less burned sites (West 1999). Less steep sites, especially those with finer textured soils are where savannas, grasslands, and shrub steppes have occurred in the past. Pinyon-juniper stands on these gentler slopes may have been large, but more savanna-like with very open upper canopy and high grass production. Due to alteration of fires, grazing, etc. we now see various densities of younger trees occurring on sites that were once shrublands or grasslands (West 1999, Commons et al. 1999).

Mitchell and Roberts (1999) determined that the extent of pinyon-juniper woodlands in the Western United States occupies approx. 55.6 million acres. SRM has approximately 2.3 million acres.

MINIMUM SIZE: 30,000 acres (see Anderson 1999 for a good explanation for choosing size for matrix communities).

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation (includes clearcuts/tree plantations) greater than ½ wide, major highways, or urban development; 2) a different ecological system wider than ½ mile wide; 3) a major break or change in the ecological land unit (e.g. topography, soils, geology).

Justification: Many of these communities occur naturally in a mosaic much of the time so minor breaks or small barriers are part of the natural distribution and variability. If the breaks are larger, barriers may exist for some species.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Size is the most important ranking factor for matrix communities. Condition is of secondary importance and while landscape context is still important, it is slightly less so than the overall size and condition of an occurrence.

CONDITION SPECIFICATIONS:

The number of trees per hectare is a good indicator of landuse history of a *Pinyon-Juniper* woodland. Studies of fire scars on Juniper and Pinyon pines have shown that the tree density of Pinyon-Juniper woodlands was much lower prior to European settlement (West and Young 2000, Young and Evans 1981). Prior to 1800, stands had from 1 to 140 trees per acre. After about 1831, stands contained 100 to nearly 600 trees per acre (Blackburn and Tueller 1970). The density of trees varies depending upon site conditions. Sites with fewer trees (both historically and currently) had relatively deep

soils and enough herbaceous undergrowth to support fire at regular intervals. Sites with a greater number of trees occurred on shallow, rocky soils, often on steeper slopes. Depth and rockiness of the soil along with percent slope directly effect the amount of herbaceous cover available to carry fire. Favorable deep and less-rocky soils support the fewest trees per ha, where the herbaceous cover is sufficient to carry fire at frequent intervals. Steep, rocky sites with shallow soils support less herbaceous cover and are often the location of the oldest surviving trees (Figure 1).

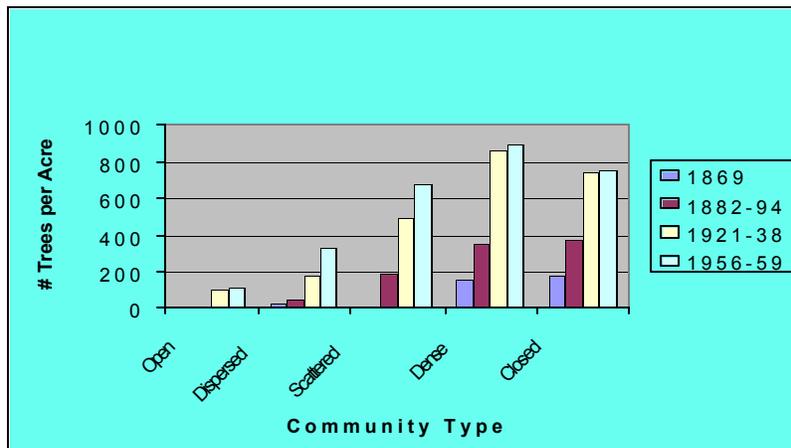


Figure 1. Pinyon-juniper woodland tree density pre-European settlement by community type. Community types were distributed on a gradient of decreasing soil depth and increasing soil rockiness. Open stands were farthest from the mountains and Closed communities were located adjacent to or on the foothills (based on Blackburn and Tueller 1970).

A -rated condition:

Tree density is <30 per ha on favorable sites, and up to 200 trees per ha on rocky, less favorable sites (Young and Evans 1981). Herbaceous cover between trees is heavy enough to carry regular fires. This is less important on steep, rocky sites. Non-native annual grasses are absent or incidental. Native perennial increaser species may be present <5% of the area. Microbiotic crusts are intact. Natural microrelief is undisturbed. Soil erosion is not accelerated by anthropogenic activities. No surficial disturbance is evident, the stand has never been “chained” and re-seeded. Some disturbance may be evident in small, isolated areas (e.g. mines or ranch activities and buildings; minor off-road vehicle use--<1%). There are few or no roads found within the occurrence. Fire has occurred within the stand within the last 10 years for deep soil sites. Accelerated soil erosion had not occurred, or if in the past, the herbaceous cover has increased sufficiently to check this problem.

B -rated condition: Tree density is <40 ha on favorable sites, but not more than 600 trees per ha on rocky, less favorable sites. Community dominated by natives, herbaceous undergrowth is present but may be declining, native perennial increasers may be present

and even dominant in spots, but not throughout the occurrence. Non-natives annuals may be present in disturbed areas only, and are not found throughout the occurrences (e.g. *Bromus tectorum*). Microbiotic crusts are intact in at least 80% of the occurrence. No surficial disturbance is evident, the stand has never been “chained” and re-seeded. If some disturbance is evident it is limited to less than 20% of the occurrence area (e.g. mines or ranch activities and buildings; off-road vehicle use--<5%). There are no to only a few roads found within the occurrence. Fire has occurred within the stand within the last 20-50 years for deep soil sites. Soil erosion may be accelerated in small patches, or lightly so throughout the occurrence. Soil erosion can be easily reversed by relatively simple, straightforward, and inexpensive changes in management.

C -rated condition:

Tree density is >40 trees per ha on favorable sites, >600 per ha on rocky, less favorable sites. Community dominated by native species; herbaceous undergrowth is becoming sparse. Non-native annuals can be abundant in small and large patches (e.g. *Bromus tectorum*). Herbaceous fuel load is not sufficient to carry fire. Microbiotic crusts are removed from more than 25% of the area, or are in various stages of degradation throughout the occurrence.

Surficial disturbances occur on more than 20% of the area (e.g. mines or ranch activities and buildings; off-road vehicle use). Less than 50% of the stand may have been “chained” and re-seeded. There are more than a few roads found within the occurrence. Fire has not occurred within the stand for 50-100 years. Soil erosion and gullyng may be observed in patches (up to 30%) within the stand.

D -rated condition:

Tree density is very high (>800 ha) on both favorable and poor sites. Community is dominated by natives. The herbaceous undergrowth is nearly absent. Non-native annual are present and abundant (e.g. *Bromus tectorum*). Microbiotic crusts are >75% removed, occurring only in small pockets naturally protected from livestock and off-road vehicle use. Surficial disturbances occur on more than 50% of the area (e.g. mines or ranch activities and buildings; off-road vehicle use). The stand may have been “chained”, but not more than 50% of the occurrence. Many roads are found within the occurrence. Fire has not occurred within the stand for >100 years. Soil erosion may be severe in places.

Justification for A-rated criteria: “Fair/Poor”rating threshold: this threshold is intended to separate “Fair” from “Poor” –rated occurrences. Fair occurrences would naturally improve in condition resulting from anthropogenic disturbances with a change in the management practices (prescribed burns, reduced grazing intensity), with significant recovery expected within 25 years.

Justification for C/D threshold: Poor occurrences will not likely improve and are prone to irreversible changes in composition. Significant emphasis is placed on the density of trees and the risk of loosing the entire stand from an intense crown fire and the subsequent severe erosion. In addition, the relative extent of introduced plant species and the loss of the microbiotic soil crust also speaks to the irreversible damage to the stand. Emphasis

can also be placed in the degree of fragmentation from roads and the amount of accelerated soil erosion from sources other than those mentioned.

SIZE.SPECS

A -rated size: Very large (>90,000 ac)

B -rated size: Large (50,000-80,000 ac)

C -rated size: Moderate (30,000-50,000 ac)

D -rated size: Small (<30,000 ac)

Justification for A-rated criteria: A 90,000 acre stand is large enough to support a mosaic of stand conditions, ages, and disturbance patterns.

Justification for C/D threshold: A 30,000 acre stand is estimated to be as small as matrix communities can be and still support minimum viable populations of pine martens (Anderson 1999). Smaller than 30,000 acres is subject to edge effects and stand destroying events, e.g., fire, beetle kill.

Bird indicators include Black throated gray warbler, Bushtit, Brown towhee, Bewick's wren, Pinon Jay, Juniper titmouse, Poorwill, Black-chinned hummingbird, Gray flycatcher, Ash-throated flycatcher, Scrubjay. Large mammal indicator species are bighorn sheep, pronghorn antelope, and black bear.

LANDSCAPE CONTEXT SPECIFICATIONS:

A -rated landscape context: Occurrence surrounded by a large area (>2000 ac/800 ha) of natural vegetation. Few small roads in the surrounding landscape. Highly connected – surrounding landscape has been little altered, captures the characteristic ecological gradients (including adjacent large patch and surrounding matrix communities, e.g. sagebrush shrublands, ponderosa pine and other higher elevation conifer forests) and geomorphic processes, and the occurrences is completely surrounded by other high quality ecological systems.

B -rated landscape context: Landscape composed of at least 80% natural or semi-natural vegetation. Moderately connected—occurrence is surrounded by moderate-low quality sagebrush or other montane scrub. The pinyon-juniper may be invading the neighboring shrubland due to a lack of fire. Or the stand may be surrounded by an expansive semi-natural landscape that has been used extensively for grazing or military training currently or in the past.

C -rated landscape context: Landscape is a mosaic of agricultural or semi-developed areas and natural or semi-natural vegetation, the latter composing 25-80% of the landscape. Moderately fragmented and isolate.

D -rated landscape context: Occurrence surrounded primarily by urban or agricultural landscape, with <25% landscape cover of natural or semi-natural vegetation. Highly fragmented and isolated.

Justification for A rated criteria: Characteristic ecological gradients remain intact supporting interactions among component species. Natural disturbances (fire) can occur on a scale that permits maintenance of patches of the community in a variety of conditions.

Justification for C/D threshold: Landscape connectivity seriously impacted below about 35% cover of natural/semi-natural vegetation. Characteristic ecological gradients lacking or otherwise disrupted, with irretrievable impacts on habitat requirements for component species. Damage to microbiotic crust is essentially permanent.

AUTHORSHIP: Renée Rondeau and Great Basin ecoregion folks

DATE: October 24, 2000

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SOUTHERN ROCKY MOUNTAINS ECOREGION
JUNIPER SAVANNA ECOLOGICAL SYSTEM –LARGE PATCH

Juniperus monosperma / *Andropogon hallii* Woodland
Juniperus monosperma / *Bouteloua curtipendula* Woodland
Juniperus monosperma / *Bouteloua gracilis* Woodland
Juniperus monosperma / *Cercocarpus montanus* - *Ribes cereum* Woodland
Juniperus monosperma / *Krascheninnikovia lanata* Woodland
Juniperus monosperma / *Stipa neomexicana* Woodland
Juniperus scopulorum / *Artemisia tridentata* Woodland
Juniperus scopulorum / *Cercocarpus montanus* Woodland
Juniperus scopulorum / *Pseudoroegneria spicata* Woodland
Juniperus scopulorum / *Purshia tridentata* Woodland
Juniperus osteosperma / *Artemisia tridentata* Woodland
Juniperus osteosperma / *Leymus salinus* ssp. *salmonis* Wooded Herbaceous Vegetation
Juniperus osteosperma / *Stipa comata* Wooded Herbaceous Vegetation
Juniperus osteosperma / *Coleogyne ramosissima* Woodland

SCALE AND RANGE: LARGE PATCH AND WIDESPREAD

Juniper savanna ecological system is a large patch system that occurs in approximately 2% of the Southern Rocky Mountains ecoregion, primarily in the Mew Mexico portion. It occupies the lower and warmest elevations growing from 4,500 to 6,000 feet in a semiarid climate. It grows best just below the lower elevational range of ponderosa pine and often intermingles with grasslands and shrublands. This system is best described as a savanna that has widely spaced mature (>150 years old) juniper trees and occasionally *Pinus edulis*. On the west slope of the Southern Rocky Mountains ecoregion *Juniperus osteosperma* or *J. scopulorum* are the dominant junipers, while on the east slope *J. monosperma* and *J. scopulorum* are the dominants.

Although juniper savannas are expected to occur naturally on the landscape the extent and quality has been severely altered since the early 1900's. Numerous studies have shown that juniper has encroached on shrublands and grasslands (e.g., Blackburn and Tueller 1970, West 1999). Numerous processes influence pinyon-juniper savannas including climate, grazing, fires, tree harvest, and insect-pathogen outbreaks (West 1999; Eager 1999). Within a given region, the density of trees, both historically and currently, is strongly related to topographic gradients. Less steep sites, especially those with finer textured soils are where savannas, grasslands, and shrub steppes have occurred in the past. Juniper stands on these gentler slopes may have been large, but more savanna-like with very open upper canopy and high grass production. Due to alteration of fire intensity and frequency, grazing, and changes in climate we now see various densities of younger trees occurring on sites that were once shrublands or grasslands (West 1999, Commons et al. 1999).

It is unclear as to the number of acres we would expect to have in a juniper savanna system if fire suppression, livestock grazing, and climate change is considered.

Therefore, finding occurrences of juniper savannas that are dominated by widely spaced mature trees where fires are still part of the system are set at a premium.

MINIMUM SIZE: 1000 acres

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation (includes clearcuts/tree plantations) greater than 1 wide, major highways, or urban development; 2) a different ecological system wider than 1 mile wide; 3) a major break or change in the ecological land unit (e.g. topography, soils, geology).

Justification: Many of these communities occur naturally in a mosaic much of the time so minor breaks or small barriers are part of the natural distribution and variability. If the breaks are larger, barriers may exist for some species.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Weighting is equal amongst these ranking factors.

CONDITION SPECIFICATIONS:

The number of trees per hectare is a good indicator of landuse history of a juniper savanna. Studies of fire scars on Juniper and Pinyon pines have shown that the tree density of Pinyon-Juniper woodlands was much lower prior to European settlement (West and Young 2000, Young and Evans 1981). Prior to 1800, stands had from 1 to 140 trees per acre. After about 1831, stands contained 100 to nearly 600 trees per acre (Blackburn and Tueller 1970). The density of trees varies depending upon site conditions. Sites with fewer trees (both historically and currently) had relatively deep soils and enough herbaceous undergrowth to support fire at regular intervals. Sites with a greater number of trees occurred on shallow, rocky soils, often on steeper slopes. Depth and rockiness of the soil along with percent slope directly effect the amount of herbaceous cover available to carry fire. Favorable deep and less-rocky soils support the fewest trees per ha, where the herbaceous cover is sufficient to carry fire at frequent intervals. Steep, rocky sites with shallow soils support less herbaceous cover and are often the location of the oldest surviving trees (Figure 1).

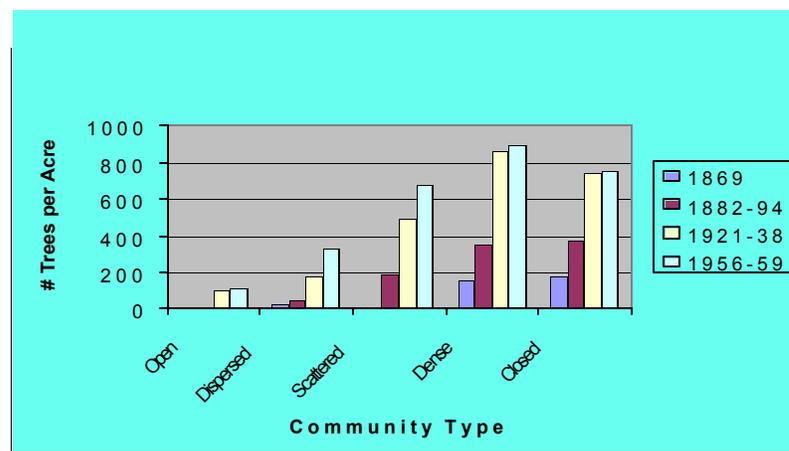


Figure 1. Pinyon-juniper woodland tree density pre-European settlement by community type. Community types were distributed on a gradient of decreasing soil depth and increasing soil rockiness. Open stands were farthest from the mountains and Closed communities were located adjacent to or on the foothills (based on Blackburn and Tueller 1970).

A -rated condition:

Tree density is <30 per ha on favorable sites, and up to 200 trees per ha on rocky, less favorable sites (Young and Evans 1981). Herbaceous cover between trees is heavy enough to carry regular fires. This is less important on steep, rocky sites. Non-native annual grasses are absent or incidental. Native perennial increaser species may be present <5% of the area. Microbiotic crusts are intact. Natural microrelief is undisturbed. Soil erosion is not accelerated by anthropogenic activities. No surficial disturbance is evident, the stand has never been “chained” and re-seeded. Some disturbance may be evident in small, isolated areas (e.g. mines or ranch activities and buildings; minor off-road vehicle use--<1%). There are few or no roads found within the occurrence. Fire has occurred within the stand within the last 10 years for deep soil sites. Accelerated soil erosion had not occurred, or if in the past, the herbaceous cover has increased sufficiently to check this problem.

B -rated condition: Tree density is <40 ha on favorable sites, but not more than 600 trees per ha on rocky, less favorable sites. Community dominated by natives, herbaceous undergrowth is present but may be declining, native perennial increasers may be present and even dominant in spots, but not throughout the occurrence. Non-natives annuals may be present in disturbed areas only, and are not found throughout the occurrences (e.g. *Bromus tectorum*). Microbiotic crusts are intact in at least 80% of the occurrence. No surficial disturbance is evident, the stand has never been “chained” and re-seeded. If some disturbance is evident it is limited to less than 20% of the occurrence area (e.g. mines or ranch activities and buildings; off-road vehicle use--<5%). There are no to only a few roads found within the occurrence. Fire has occurred within the stand within the last 20-50 years for deep soil sites. Soil erosion may be accelerated in small patches, or lightly so throughout the occurrence. Soil erosion can be easily reversed by relatively simple, straightforward, and inexpensive changes in management.

C -rated condition: Tree density is >40 trees per ha on favorable sites, >600 per ha on rocky, less favorable sites. Community dominated by native species; herbaceous undergrowth is becoming sparse. Non-native annuals can be abundant in small and large patches (e.g. *Bromus tectorum*). Herbaceous fuel load is not sufficient to carry fire.

Microbiotic crusts are removed from more than 25% of the area, or are in various stages of degradation throughout the occurrence.

Surficial disturbances occur on more than 20% of the area (e.g. mines or ranch activities and buildings; off-road vehicle use). Less than 50% of the stand may have been “chained” and re-seeded. There are more than a few roads found within the occurrence. Fire has not occurred within the stand for 50-100 years. Soil erosion and gullyng may be observed in patches (up to 30%) within the stand.

D -rated condition: Tree density is very high (>800 ha) on both favorable and poor sites. Community is dominated by natives. The herbaceous undergrowth is nearly absent. Non-native annual are present and abundant (e.g. *Bromus tectorum*). Microbiotic crusts are >75% removed, occurring only in small pockets naturally protected from livestock and off-road vehicle use. Surficial disturbances occur on more than 50% of the area (e.g. mines or ranch activities and buildings; off-road vehicle use). The stand may have been “chained”, but not more than 50% of the occurrence. Many roads are found within the occurrence. Fire has not occurred within the stand for >100 years. Soil erosion may be severe in places.

Justification for A-rated criteria: Juniper savannas are dependent on fires and limited grazing. In order to have a healthy and intact vertebrate, invertebrate, and small mammal composition an occurrence must be dominated by native grasses with high species richness and widely spaced mature trees that would support a ground fire. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D criteria: Poor occurrences will not likely improve and are prone to irreversible changes in composition. Significant emphasis is placed on the density of trees and the risk of losing the entire stand from an intense crown fire and the subsequent severe erosion. In addition, the relative extent of introduced plant species and the loss of the microbiotic soil crust also speaks to the irreversible damage to the stand. Emphasis can also be placed in the degree of fragmentation from roads and the amount of accelerated soil erosion from sources other than those mentioned.

SIZE.SPECS

A – rated size: Very large (> 5000 acres)

B –rated size: Large (2000 to 5000 acres)

C –rated size: Moderate (1000 - 2000 ac)

D –rated size: Small (<1000 ac)

Justification for A-rated criteria: Large enough to support a mosaic of stand conditions, ages, and disturbance patterns.

Justification for C/D threshold: Smaller than 100 acres is subject to edge effects. No opportunity for mosaic disturbance patterns.

Bird indicators include Black throated gray warbler, Bushtit, Brown towhee, Bewick's wren, Pinon Jay, Juniper titmouse, Poorwill, Black-chinned hummingbird, Gray flycatcher, Ash-throated flycatcher, and Scrubjay.

LANDSCAPE CONTEXT:

A -rated landscape context: Occurrence surrounded by a large area (>2000 ac/800 ha) of natural vegetation. Few small roads in the surrounding landscape. Highly connected – surrounding landscape has been little altered, captures the characteristic ecological gradients (including adjacent large patch and surrounding matrix communities, e.g. sagebrush shrublands, ponderosa pine and other higher elevation conifer forests) and geomorphic processes, and the occurrences is completely surrounded by other high quality ecological systems.

B -rated landscape context: Landscape composed of at least 80% natural or semi-natural vegetation. Moderately connected—occurrence is surrounded by moderate-low quality sagebrush or other montane scrub. The pinyon-juniper may be invading the neighboring shrubland due to a lack of fire. Or the stand may be surrounded by an expansive semi-natural landscape that has been used extensively for grazing or military training currently or in the past.

C -rated landscape context: Landscape is a mosaic of agricultural or semi-developed areas and natural or semi-natural vegetation, the latter composing 25-80% of the landscape. Moderately fragmented and isolate.

D -rated landscape context: Occurrence surrounded primarily by urban or agricultural landscape, with <25% landscape cover of natural or semi-natural vegetation. Highly fragmented and isolated.

Justification for A rated criteria: Characteristic ecological gradients remain intact supporting interactions among component species. Natural disturbances (fire) can occur on a scale that permits maintenance of patches of the community in a variety of conditions.

Justification for C/D threshold: Landscape connectivity seriously impacted below about 35% cover of natural/semi-natural vegetation. Characteristic ecological gradients lacking or otherwise disrupted, with irretrievable impacts on habitat requirements for component species. Damage to microbiotic crust is essentially permanent.

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DATE: February 22, 2001

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SOUTHERN ROCKY MOUNTAINS ECOREGION
LOWER MONTANE-FOOTHILLS SHRUBLAND --LARGE PATCH

Arctostaphylos patula / *Ceanothus velutinus* - *Ceanothus prostratus* Shrubland
Cercocarpus montanus / *Bouteloua curtipendula* Shrubland
Cercocarpus montanus / *Elymus lanceolatus* ssp. *lanceolatus* Shrubland
Cercocarpus montanus / *Muhlenbergia montana* Shrubland
Cercocarpus montanus / *Pseudoroegneria spicata* Shrubland
Cercocarpus montanus / *Stipa comata* Shrubland
Cercocarpus montanus / *Stipa neomexicana* Shrubland
Cercocarpus montanus / *Stipa scribneri* Shrubland
Cercocarpus montanus-*Rhus trilobata* / *Andropogon gerardii* Shrubland
Purshia tridentata / *Artemisia frigida* / *Stipa comata* Shrubland
Purshia tridentata / *Muhlenbergia montana* Shrubland
Purshia tridentata / *Stipa comata* Shrub Herbaceous Vegetation
Rhus trilobata Shrubland
Ribes cereum / *Leymus ambiguus* Shrubland
Symphoricarpos occidentalis Shrubland [Provisional]

SCALE AND RANGE: LARGE PATCH AND WIDESPREAD

Lower montane-foothills shrubland ecological system is a large patch system that is found in over 5% of the Southern Rocky Mountains ecoregion and well represented from the most northern latitudes to the most southern area of the ecoregion. This system is found between 5,000-9,000 feet in elevation and usually associated with rocky substrates. This system may have scattered trees but is a shrub dominated system with a variety of shrubs including *Cercocarpus montanus*, *Purshia tridentata*, *Rhus trilobata*, or *Ribes cereum*. The lower montane-foothills shrublands may occur as a mosaic of two or three plant associations often surrounded by grasslands or woodlands. Fires play an important role in this system as the dominant shrubs usually have a severe die back, although some plants will stump sprout (<http://www.fs.fed.us/database/feis>). Fire suppression has allowed an invasion of trees into some shrublands as well as an invasion of shrubs into grasslands. Additional threats to this system include fragmentation by roads and development, both provide an unnatural fire break as well as a conduit for weeds.

Viable populations of Green-tailed towhee and Scrub jay (especially oaks) indicate a healthy occurrence.

MINIMUM SIZE: 1000 acres.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than ¼ mile wide, major highways, or urban development, 2) different ecological system greater than ½ mile wide.

Justification: Large patch, lower montane-foothills shrubland system is susceptible to fragmentation by cultural vegetation or tree invasion. Primary criteria to be considered is

the invasion of trees, non-native forbs, seed dispersal by dominant species and the dispersal behavior and requirements of shrubland fauna.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Weighting is equal amongst these ranking factors.

CONDITION SPECIFICATIONS:

A –rated condition: Native species dominant, non-native species may be present but in small amounts (< 1% total cover). Native species that increase with disturbance, e.g., *Yucca*, *Artemisia frigida*, and *Opuntia* spp., have less than 3% relative cover. Invasive exotics with major potential to alter structure and composition are nearly absent (<1% cover), e.g., leafy spurge, knapweed, non-native thistle, *Bromus inermis*, *Poa pratensis*, *Bromus tectorum*. If trees are present, these are widely scattered and mature. Species richness is often high, and native grasses or sedges (non-increasers) are the dominant herbaceous cover. Fragmentation is limited to less than 1% of the occurrence and the fire and grazing regimes are largely intact.

B- rated condition: Native species dominant, non-native species are present but in small amounts (< 3% total cover). Native species that increase with disturbance, e.g., *Yucca*, *Artemisia frigida*, and *Opuntia* spp., have less than 5% relative cover. Invasive exotics with major potential to alter structure and composition may be present, but with less than 3% cover. If trees are present, these are widely scattered and mature. Species richness is often high, and native grasses (non-increasers) are dominant. Fragmentation is limited to less than 5% of the occurrence and the fire and grazing regimes are relatively intact.

C-rated condition: Herbaceous cover is co-dominated by native and non-native species. Alteration of vegetation is extensive but potentially restorable over several decades. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction. Fragmentation is limited to less than 15% of the occurrence; invasive woody species are present but still controllable. The fire and grazing regimes may need immediate management in order for the occurrence to not deteriorate.

D –rated condition: Non-native species are dominant. Alteration of vegetation is extensive and restoration potential is low. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction. System remains fundamentally compromised despite restoration of some processes. Soil compaction and continued disturbance is extensive throughout the occurrence.

Justification for A-rated criteria: Lower montane-foothills shrublands may encounter periodic fires that may alter the seral stage of the system. A- ranked occurrences provide a diverse mosaic of shrubs, graminoids, and forbs that will respond positively to a fire event. In order to have a healthy and intact native fauna composition an occurrence must have an intact and diverse shrub and herbaceous canopy cover dominated by native

species. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 5000 acres)

B –rated size: Large (2000 to 5000 acres)

C –rated size: Moderate (1000 - 2000 ac)

D –rated size: Small (<1000 ac)

Justification for A-rated criteria: A-ranked occurrences are large enough to support excellent occurrences of shrubland birds as well as a mosaic of several plant associations. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance. They are buffered from edge effects. Occurrences of this size will most likely allow for a mosaic pattern in the event of a fire leaving some patches unburned, therefore providing several seral stages within an occurrence.

Justification for C/D threshold: C-ranked occurrences would support minimum viable populations of shrubland birds and other fauna. While D-ranked occurrences are subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Occurrence surrounded by at least 90% native and unaltered landscape with very little to no urban development or agriculture, and little to no industrial forestry. No unnatural barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fire and species migrations to occur.

B-rated landscape context: Surrounding landscape composed of at least 75% natural or semi-natural vegetation, with little urban development within or adjacent to the occurrence. Adjacent systems surrounding occurrence retain much connectivity. Few non-natural barriers present.

C-rated landscape context: Adjacent systems surrounding occurrence are fragmented by alteration with limited connectivity. Surrounding landscape is a mosaic of agricultural or semi-developed areas with >50% natural or semi-natural vegetation. Some non-natural barriers are present. Significant disturbance, but easily restorable.

D-rated landscape context: Major human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The lower montane-foothills shrubland and its adjacent landscape is intact. Connectivity to adjacent and nearby systems is intact. Non-native species are not a landscape threat. No obvious hindrances to fires exist, e.g., urban development. The occurrence is fully buffered by a natural landscape. Migration of shrubland species remains viable.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. D-ranked occurrences have no buffering, and are subject to altered fire regimes and invasive species causing a shift in species composition and altering the entire occurrence.

AUTHORSHIP: Renée Rondeau

Date: July 2, 2000

SOUTHERN ROCKY MOUNTAINS ECOREGION
GAMBEL'S OAK / SERVICEBERRY SHRUBLAND --LARGE PATCH

Amelanchier utahensis - *Cercocarpus montanus* Shrubland
Amelanchier utahensis / *Carex geyeri* Shrubland
Amelanchier utahensis / *Pseudoroegneria spicata* Shrubland
Quercus gambelii - *Cercocarpus montanus* / *Carex geyeri* Shrubland
Quercus gambelii / *Amelanchier utahensis* Shrubland
Quercus gambelii / *Carex inops* Shrubland
Quercus gambelii / *Pachystima myrsinites* Shrubland
Quercus gambelii / *Robinia neomexicana* / *Symphoricarpos rotundifolius* Shrubland
Quercus gambelii / *Stipa comata* Shrubland
Quercus gambelii / *Symphoricarpos oreophilus* Shrubland

SCALE AND RANGE: LARGE PATCH AND WIDESPREAD

Oak / serviceberry shrubland ecological system is a large patch system that occurs in approximately 3% of the Southern Rocky Mountains ecoregion, primarily on the lower elevations of the western slope. It is most commonly found along canyon walls, dry foothills, lower mountain slopes, and at the edge of the plains from approximately 5,000 to 9,500 feet in the Southern Rocky Mountains ecoregion. These shrublands are often situated above pinyon-juniper woodlands or sagebrush-grasslands, although at the interface of the plains these shrublands are often below the pinyon-juniper woodlands. *Quercus gambelii* grows on a wide variety of soil types ranging from calcareous, heavy, fine-grained loams but also on sandy loams, gravelly loams, clay loams, deep alluvial sand, and coarse gravel (Christensen 1955). *Amelanchier* grows best on coarse to medium well-drained soils (<http://www.fs.fed.us/database/feis/>). This ecological system may intergrade with the lower montane-foothills shrubland ecological system and share many of the same site characteristics. The effect of fire is an important distinguishing factor between the two systems. *Purshia tridentata* and *Cercocarpus montanus* usually have a severe die back following a fire, although some plants will stump sprout, while *Amelanchier* and *Quercus gambelii* are more resistant to fires. Both *Quercus* and *Amelanchier* generally sprout vigorously from stembases or from underground rhizomes following fire (<http://www.fs.fed.us/database/feis/>). Density and cover of oak and serviceberry often increase after fire (e.g., Harrington 1985).

Viable populations of Green-tailed towhee and Scrub jay (especially oaks) indicate a healthy occurrence.

MINIMUM SIZE: 1000 acres.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than ¼ mile wide, major highways, or urban development, 2) different ecological system greater than ½ mile wide.

Justification: Large patch, oak/serviceberry shrubland communities are susceptible to fragmentation by cultural vegetation or tree invasion. Primary criteria to be considered is the invasion of trees, non-native forbs, seed dispersal by dominant species and the dispersal behavior and requirements of shrubland fauna.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Weighting is equal amongst these ranking factors.

CONDITION SPECIFICATIONS:

A –rated condition: Native species dominant, non-native species may be present but in small amounts (< 5% total cover). Native species that increase with disturbance, e.g., *Yucca*, *Artemisia frigida*, and *Opuntia* spp., have less than 3% relative cover. Invasive exotics with major potential to alter structure and composition are nearly absent (<1% cover), e.g., leafy spurge, non-native thistle, *Bromus inermis*, *Poa pratensis*, *Bromus tectorum*. If trees are present, these are widely scattered and mature. Species richness is often high, and native grasses or sedges (non-increasers) are the dominant herbaceous cover. Fragmentation is limited to less than 1% of the occurrence and the fire and grazing regimes are largely intact.

B- rated condition: Native species dominant, non-native species are present but in small amounts (< 10% total cover). Native species that increase with disturbance, e.g., *Yucca*, *Artemisia frigida*, and *Opuntia* spp., have less than 5% relative cover. Invasive exotics with major potential to alter structure and composition may be present, but with less than 3% cover. If trees are present, these are widely scattered and mature. Species richness is often high, and native grasses (non-increasers) are dominant. Fragmentation is limited to less than 5% of the occurrence and the fire and grazing regimes are relatively intact.

C-rated condition: Herbaceous cover is co-dominated by native and non-native species. Alteration of vegetation is extensive but potentially restorable over several decades. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction. Fragmentation is limited to less than 15% of the occurrence; invasive woody species are present but still controllable. The fire and grazing regimes may need immediate management in order for the occurrence to not deteriorate.

D –rated condition: Non-native species are dominant. Alteration of vegetation is extensive and restoration potential is low. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction. System remains fundamentally compromised despite restoration of some processes. Soil compaction and continued disturbance is extensive throughout the occurrence.

Justification for A-rated criteria: Lower montane-foothills shrublands may encounter periodic fires that may alter the seral stage of the system. A- ranked occurrences provide a diverse mosaic of shrubs, graminoids, and forbs that will respond positively to a fire event. In order to have a healthy and intact native fauna composition an occurrence must

have an intact and diverse shrub and herbaceous canopy cover dominated by native species. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 5000 acres)

B –rated size: Large (2000 to 5000 acres)

C –rated size: Moderate (1000 - 2000 ac)

D –rated size: Small (<1000 ac)

Justification for A-rated criteria: A-ranked occurrences are large enough to support excellent occurrences of shrubland birds as well as a mosaic of several plant associations. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance. They are buffered from edge effects. Occurrences of this size will most likely allow for a mosaic pattern in the event of a fire leaving some patches unburned, therefore providing several seral stages within an occurrence.

Justification for C/D threshold: C-ranked occurrences would support minimum viable populations of shrubland birds and other fauna. While D-ranked occurrences are subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Occurrence surrounded by at least 90% native and unaltered landscape with very little to no urban development or agriculture, and little to no industrial forestry. No unnatural barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fire and species migrations to occur.

B-rated landscape context: Surrounding landscape composed of at least 75% natural or semi-natural vegetation, with little urban development within or adjacent to the occurrence. Adjacent systems surrounding occurrence retain much connectivity. Few non-natural barriers present.

C-rated landscape context: Adjacent systems surrounding occurrence are fragmented by alteration with limited connectivity. Surrounding landscape is a mosaic of agricultural or semi-developed areas with >50% natural or semi-natural vegetation. Some non-natural barriers are present. Significant disturbance, but easily restorable.

D-rated landscape context: Major human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The lower montane-foothills shrubland and its adjacent landscape is intact. Connectivity to adjacent and nearby systems is intact. Non-native species are not a landscape threat. No obvious hindrances to fires exist, e.g., urban development. The occurrence is fully buffered by a natural landscape. Migration of shrubland species remains viable.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. D-ranked occurrences have no buffering, and are subject to altered fire regimes and invasive species causing a shift in species composition and altering the entire occurrence.

AUTHORSHIP: Renée Rondeau

Date: January 10, 2001

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**SOUTHERN ROCKY MOUNTAINS ECOREGION
WINTERFAT SHRUB STEPPE—LARGE PATCH**

Krascheninnikovia lanata / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
Krascheninnikovia lanata / *Pascopyrum smithii* - *Bouteloua gracilis* Dwarf-shrub
Herbaceous Vegetation
Krascheninnikovia lanata / *Oryzopsis hymenoides*-(*Stipa comata*) Dwarf-shrub
Herbaceous Vegetation
Chrysothamnus Greenei / *Bouteloua gracilis* (*Krascheninnikovia lanata*) Herbaceous
Vegetation

SCALE AND RANGE: LARGE PATCH AND WIDESPREAD

The winterfat shrub steppe ecological system occupies approximately 2% of the Southern Rocky Mountain ecoregion, primarily situated in the San Luis Valley and the Gunnison Basin (Johnston 1997) areas (See San Luis Valley Winterfat Shrub Steppe Ecological System below). Small occurrences are also documented in the Colorado River basin and North Park. This system is comprised of dwarf shrubs and prior to anthropogenic changes the dominant shrub was *Krascheninnikovia lanata* (Johnston 1997). Shrubs that have increased from historic heavy livestock grazing include *Chrysothamnus parryi*, *C. viscidiflorus*, and *Gutierrezia sarothrae* (Johnston 1997). *Krascheninnikovia lanata*, *Stipa comata*, and *Oryzopsis hymenoides* are considered decreaseers with grazing. *Bouteloua gracilis* is a common grass of this system. Winterfat shrub steppe occurs between 7,500-9,500 feet in elevation, on windswept mesas, valley floors, gentle slopes, or shoulders of ridges. A conspicuous gravel pavement is found on the surface (Tiedeman and Terwilliger 1978 as cited in Johnston 1997) and often persists throughout the profile (Johnston 1997). Pinyon-juniper woodlands and sagebrush shrublands commonly are adjacent to this system at the upper elevations.

The large-scale natural ecological processes maintaining this ecological system is fire and grazing. Anthropogenic changes that have altered this system include fire suppression and historic heavy livestock grazing.

MINIMUM SIZE: 1,000 acres

SEPERATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation or urban development greater than ¼ mile wide, 2) a different natural community from a different ecological system wider than one mile wide or continuous forest wider than ¼ mile, 3) a major break or change in the ecological land unit (e.g., topography, soils, geology).

Justification: Large patch communities are susceptible to fragmentation by cultural vegetation or forest/shrub invasion. Forests are likely to be more significant barriers than woodlands or non-forested wetlands for many species. Primary criteria to be considered is the invasion of woody vegetation, seed dispersal by dominant grasses and forbs, and the dispersal behavior and requirements of invertebrates and small mammals.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does occurrence size, although the species-area relationship still holds up for patch type communities. See additional notes under “Size”.

CONDITION SPECIFICATIONS:

(Part of the following condition specifications follow the BLM, NRCS, and USGS “Interpreting indicators of rangeland health” (Shaver et al. 2000).

A –rated condition: *Krascheninnikovia lanata* is dominant at least in large patches. Native grasses are dominant, non-native species occupy less than 3% canopy cover. Invasive species with major potential to alter structure and composition are absent. Native species that increase with disturbance, e.g., *Koeleria micrantha*, and *Artemisia frigida* have less than 3% cover. If trees or rabbitbrush are present, these are widely scattered and mature. Species richness is often high and includes several native grasses as well as a diverse forb component. Soils have a distinct A-horizon. Water flow patterns show minimal evidence of past or current soil deposition or erosion. Terracettes absent or uncommon. Drainages are represented as natural stable channels; no signs of unnatural erosion. Fairly uniform distribution of litter is present. Surface soil is stabilized by organic matter decomposition products and/ or a biological crust. Soils are not overly compacted and are very stable (low erosion rate). Plant vigor is high. Fires are still part of this system.

B- rated condition: *Krascheninnikovia lanata* is dominant in large patches. Native grasses dominant, non-native species are present but in small amounts (< 5% total canopy cover). Invasive exotics with major potential to alter structure and composition occupy less than 1% of occurrence. Native species that increase with disturbance, e.g., *Koeleria micrantha*, and *Artemisia frigida* have less than 5% cover. If trees or rabbitbrush are present, these are scattered and mature. Species richness is often high, and native bunchgrasses are dominant. Soils may be slightly modified but still have a distinct A-horizon. Water flow patterns nearly matches what is expected for the site; erosion is minor with some instability and deposition. Slight active pedestalling; most pedestals are in flow paths and interspaces or on exposed slopes. Occasional terracettes present. Bare areas are of moderate size and sporadically connected. Occasional headcuts may be present. Litter may show some movement of smaller size classes in scattered concentrations around obstructions and in depressions. Soil surface resistance to erosion is significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site. Soil surface loss or degradation is moderate in plant interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced. Water infiltration is moderately reduced due to adverse changes in plant community composition and or distribution. Soil compaction moderately widespread and moderately restricts water movement and root penetration. ORV use, if present, occupies less than 1% of the occurrence. Livestock

grazing is well managed with less than 3% of the occurrence showing signs of a C condition.

C-rated condition: *Krascheninnikovia lanata* is limited to small patches or scanty cover throughout occurrence. Non-native species are present and may dominate small patches, although native species still dominate the occurrence. Total canopy cover is at least 20% grasses. Native species that increase with livestock grazing may be co-dominant or dominant. Invasive exotics with major potential to alter structure and composition may be present although still manageable if attended to within the next few years; trees and shrubs may have seedlings, juveniles, or saplings present. Rill formation may be moderately active and well defined throughout most of the occurrence; gullies may be present with indications of active erosion. Some rocks and plants are pedestaled with occasional exposed roots. Bare ground is moderate to much higher than expected for the site with bare areas large and occasionally connected. Vegetation is intermittent on slopes. Headcuts are active but downcutting is not apparent. Litter movement is moderate and loosely concentrated near obstructions; moderate to small size classes of litter have been displaced. Soil surface resistance to erosion is significantly reduced in most interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches. Soil surface loss or degradation may be severe throughout the site. Infiltration is greatly decreased due to adverse changes in plant community composition or distribution. Detrimental plant cover changes have occurred. Soil compaction may be widespread and greatly restricts water movement and root penetration. Dead plants or decadent plants may be common. Reproductive capability of native perennial plants is reduced. ORV use, if present, occupies less than 5% of the occurrence. Livestock grazing is well managed with less than 10% of the occurrence showing signs of a D condition.

D –rated condition: Non-native species are dominant, native species have less than 10% canopy cover and 20% relative cover. Alteration is extensive and restoration potential is low. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition, soil compaction and stability. System remains fundamentally compromised despite restoration of some processes. Rill formation may be severe and well defined throughout most of the occurrence. Water flow patterns may be extensive and numerous causing active erosion. Many rocks and plants are pedestaled; exposed plant roots are common. Bare ground is much higher than expected for the site (large and generally connected). Gullies may be common with indications of active erosion and downcutting. Nickpoints and headcuts are numerous and active. Litter movement may be extreme and concentrated around obstructions. Most size classes of litter have been displaced. Soil surface resistance to erosion may be extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent. Soil surface horizon may be absent. Infiltration may be severely decreased due to adverse changes in plant community composition and/or distribution. Soil compaction layer extensive; severely restricting water movement and root penetration. Plant vigor may be poor and dead or decadent plants are common. Litter largely absent relative to site potential.

Justification for A-rated criteria: Winterfat shrub steep may be dependent on periodic fires and limited grazing. In order to have a healthy and intact invertebrate and small mammal composition an occurrence must be dominated by native grasses with high species richness. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 5000 acres)

B –rated size: Large (2000 to 5000 acres)

C –rated size: Moderate (1000 - 2000 ac)

D –rated size: Small (<1000 ac)

Justification for A-rated criteria:

Outside of the San Luis Valley, this ecological system is usually represented as a large patch type and therefore a 1000 acre occurrence is deemed a viable size.

A-ranked occurrences are large enough to support viable populations of grassland birds as well as a mosaic of several plant associations. Occurrences of this size will allow for a mosaic of different fire and grazing regimes.

Justification for C/D threshold: C-ranked occurrences may still support a small number of grassland birds and a diverse insect fauna. While D-ranked occurrences are subject to loss of plant associations and their associated plants and animals. Edge effects are much more pronounced in D sized occurrences.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Occurrence surrounded by a native and unaltered landscape with very little to no urban development or agriculture (>90% natural). No unnatural barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fire to occur.

B-rated landscape context: Landscape composed of at least 75% natural or semi-natural vegetation, with any urban development not directly adjacent to the occurrence. Limited or minor human-caused alteration of landscape. Adjacent systems surrounding occurrence have moderate urban or agricultural alteration (60-90% natural) but retain much connectivity. Few non-natural barriers present.

C-rated landscape context: Surrounding landscape is a mosaic of agricultural or semi-developed areas with natural or semi-natural vegetation. Adjacent systems surrounding

occurrence are fragmented by alteration (20 – 60% natural), with limited connectivity. Some non-natural barriers are present. Significant disturbance, but restorable.

D-rated landscape context: Major human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The winterfat shrub steppe and its adjacent landscape is intact; connectivity to adjacent and nearby systems is intact; non-native species not a landscape threat; no obvious hindrances to use of prescribed fire, e.g., urban development. The occurrence is fully buffered by a natural landscape. Migration of grassland species remains viable.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. D-ranked occurrences have no buffering, and are subject to altered fire and grazing regimes causing a shift in species composition and altering the entire occurrence.

AUTHORSHIP: Renée Rondeau

Date: July 2, 2000

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SOUTHERN ROCKY MOUNTAINS ECOREGION
SAN LUIS VALLEY WINTERFAT SHRUB STEPPE—MATRIX

Krascheninnikovia lanata / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
Krascheninnikovia lanata / *Pascopyrum smithii* - *Bouteloua gracilis* Dwarf-shrub
Herbaceous Vegetation
Krascheninnikovia lanata / *Oryzopsis hymenoides*-(*Stipa comata*) Dwarf-shrub
Herbaceous Vegetation
Chrysothamnus Greenei / *Bouteloua gracilis* (*Krascheninnikovia lanata*) Herbaceous
Vegetation

SCALE AND RANGE: MATRIX AND WIDESPREAD

The winterfat shrub steppe ecological system occupies approximately 2% of the Southern Rocky Mountain ecoregion, primarily situated in the San Luis Valley and the Gunnison Basin (Johnston 1997) areas. Small occurrences are also documented in the Colorado River basin and North Park (See Winterfat Shrub Steppe Ecological System above). This system is comprised of dwarf shrubs and prior to anthropogenic changes the dominant shrub was *Krascheninnikovia lanata* (Johnston 1997). Today, *Chrysothamnus Greenei* is the dominant shrub in the San Luis Valley although the wetter areas still have significant amounts of winterfat. Other shrubs that have increased from historic heavy livestock grazing include *Chrysothamnus parryi*, *C. viscidiflorus*, and *Gutierrezia sarothrae* (Johnston 1997). *Krascheninnikovia lanata*, *Stipa comata*, and *Oryzopsis hymenoides* are considered decreaseers with grazing. *Bouteloua gracilis* is a common grass of this system. Winterfat shrub steppe occurs between 7,500-9,500 feet in elevation, on windswept mesas, valley floors, gentle slopes, or shoulders of ridges. A conspicuous gravel pavement is found on the surface (Tiedeman and Terwilliger 1978 as cited in Johnston 1997) and often persists throughout the profile (Johnston 1997). Pinyon-juniper woodlands and sagebrush shrublands commonly are adjacent to this system at the upper elevations.

The large-scale natural ecological processes maintaining this ecological system is fire and grazing. Anthropogenic changes that have altered this system include fire suppression and historic heavy livestock grazing.

MINIMUM SIZE : 30,000 acres

SEPERATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation or urban development greater than ¼ mile wide, 2) a different natural community from a different ecological system wider than one mile wide or continuous forest wider than ¼ mile, 3) a major break or change in the ecological land unit (e.g., topography, soils, geology).

Justification: Large patch communities are susceptible to fragmentation by cultural vegetation or forest/shrub invasion. Forests are likely to be more significant barriers than woodlands or non-forested wetlands for many species. Primary criteria to be considered

is the invasion of woody vegetation, seed dispersal by dominant grasses and forbs, and the dispersal behavior and requirements of invertebrates and small mammals.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does occurrence size, although the species-area relationship still holds up for patch type communities. See additional notes under “Size”.

CONDITION SPECIFICATIONS:

(Part of the following condition specifications follow the BLM, NRCS, and USGS “Interpreting indicators of rangeland health” (Shaver et al. 2000).

A –rated condition: *Krascheninnikovia lanata* is dominant at least in large patches. Native grasses are dominant, non-native species occupy less than 3% canopy cover. Invasive species with major potential to alter structure and composition are absent. Native species that increase with disturbance, e.g., *Koeleria micrantha*, and *Artemisia frigida* have less than 3% cover. If trees or rabbitbrush are present, these are widely scattered and mature. Species richness is often high and includes several native grasses as well as a diverse forb component. Soils have a distinct A-horizon. Water flow patterns show minimal evidence of past or current soil deposition or erosion. Terracettes absent or uncommon. Drainages are represented as natural stable channels; no signs of unnatural erosion. Fairly uniform distribution of litter is present. Surface soil is stabilized by organic matter decomposition products and/ or a biological crust. Soils are not overly compacted and are very stable (low erosion rate). Plant vigor is high. Fires are still part of this system.

B- rated condition: *Krascheninnikovia lanata* is dominant in large patches. Native grasses dominant, non-native species are present but in small amounts (< 5% total canopy cover). Invasive exotics with major potential to alter structure and composition occupy less than 1% of occurrence. Native species that increase with disturbance, e.g., *Koeleria micrantha*, and *Artemisia frigida* have less than 5% cover. If trees or rabbitbrush are present, these are scattered and mature. Species richness is often high, and native bunchgrasses are dominant. Soils may be slightly modified but still have a distinct A-horizon. Water flow patterns nearly matches what is expected for the site; erosion is minor with some instability and deposition. Slight active pedestalling; most pedestals are in flow paths and interspaces or on exposed slopes. Occasional terracettes present. Bare areas are of moderate size and sporadically connected. Occasional headcuts may be present. Litter may show some movement of smaller size classes in scattered concentrations around obstructions and in depressions. Soil surface resistance to erosion is significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site. Soil surface loss or degradation is moderate in plant interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced. Water infiltration is moderately reduced due to adverse changes in plant community composition and or distribution. Soil

compaction moderately widespread and moderately restricts water movement and root penetration. ORV use, if present, occupies less than 1% of the occurrence. Livestock grazing is well managed with less than 3% of the occurrence showing signs of a C condition.

C-rated condition: *Krascheninnikovia lanata* is limited to small patches or scanty cover throughout occurrence. Non-native species are present and may dominate small patches, although native species still dominate the occurrence. Total canopy cover is at least 20% grasses. Native species that increase with livestock grazing may be co-dominant or dominant. Invasive exotics with major potential to alter structure and composition may be present although still manageable if attended to within the next few years; trees and shrubs may have seedlings, juveniles, or saplings present. Rill formation may be moderately active and well defined throughout most of the occurrence; gullies may be present with indications of active erosion. Some rocks and plants are pedestaled with occasional exposed roots. Bare ground is moderate to much higher than expected for the site with bare areas large and occasionally connected. Vegetation is intermittent on slopes. Headcuts are active but downcutting is not apparent. Litter movement is moderate and loosely concentrated near obstructions; moderate to small size classes of litter have been displaced. Soil surface resistance to erosion is significantly reduced in most interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches. Soil surface loss or degradation may be severe throughout the site. Infiltration is greatly decreased due to adverse changes in plant community composition or distribution. Detrimental plant cover changes have occurred. Soil compaction may be widespread and greatly restricts water movement and root penetration. Dead plants or decadent plants may be common. Reproductive capability of native perennial plants is reduced. ORV use, if present, occupies less than 5% of the occurrence. Livestock grazing is well managed with less than 10% of the occurrence showing signs of a D condition.

D –rated condition: Non-native species are dominant, native species have less than 10% canopy cover and 20% relative cover. Alteration is extensive and restoration potential is low. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition, soil compaction and stability. System remains fundamentally compromised despite restoration of some processes. Rill formation may be severe and well defined throughout most of the occurrence. Water flow patterns may be extensive and numerous causing active erosion. Many rocks and plants are pedestaled; exposed plant roots are common. Bare ground is much higher than expected for the site (large and generally connected). Gullies may be common with indications of active erosion and downcutting. Nickpoints and headcuts are numerous and active. Litter movement may be extreme and concentrated around obstructions. Most size classes of litter have been displaced. Soil surface resistance to erosion may be extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent. Soil surface horizon may be absent. Infiltration may be severely decreased due to adverse changes in plant community composition and/or distribution. Soil compaction layer extensive; severely restricting

water movement and root penetration. Plant vigor may be poor and dead or decadent plants are common. Litter largely absent relative to site potential.

Justification for A-rated criteria: Winterfat shrub steep may be dependent on periodic fires and limited grazing. In order to have a healthy and intact invertebrate and small mammal composition an occurrence must be dominated by native grasses with high species richness. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A -rated size: Very large (>90,000 ac)

B -rated size: Large (50,000-80,000 ac)

C -rated size: Moderate (30,000-50,000 ac)

D -rated size: Small (<30,000 ac)

Justification for A-rated criteria: Winterfat shrub steppe is composed of a mosaic of plant communities. The San Luis valley occurrences appear to have a combination of large patch and matrix-forming attributes. For example large patches are usually more specific in their ecological tolerances than matrix, while matrix communities are more resilient and resistant to large scale disturbances than large patch communities (Anderson 1999). The winterfat shrub steppe fits large patch for its ecological tolerance and fits matrix for its ability to be resilient and resistant to large-scale disturbances, e.g., fire. Therefore, in the San Luis Valley an occurrence larger than or equal to 30,000 acres would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance as well as recover from major sand movement. They are also adequately buffered from edge effects.

A-ranked occurrences are large enough to support viable populations of grassland birds as well as a mosaic of several plant associations. Occurrences of this size will allow for a mosaic of different fire and grazing regimes.

Justification for C/D threshold: C-ranked occurrences may still support a small number of grassland birds and a diverse insect fauna. While D-ranked occurrences are subject to loss of plant associations and their associated plants and animals. Edge effects are much more pronounced in D sized occurrences.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Occurrence surrounded by a native and unaltered landscape with very little to no urban development or agriculture (>90% natural). No unnatural barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fire to occur.

B-rated landscape context: Landscape composed of at least 75% natural or semi-natural vegetation, with any urban development not directly adjacent to the occurrence. Limited or minor human-caused alteration of landscape. Adjacent systems surrounding occurrence have moderate urban or agricultural alteration (60-90% natural) but retain much connectivity. Few non-natural barriers present.

C-rated landscape context: Surrounding landscape is a mosaic of agricultural or semi-developed areas with natural or semi-natural vegetation. Adjacent systems surrounding occurrence are fragmented by alteration (20 – 60% natural), with limited connectivity. Some non-natural barriers are present. Significant disturbance, but restorable.

D-rated landscape context: Major human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The winterfat shrub steppe and its adjacent landscape is intact; connectivity to adjacent and nearby systems is intact; non-native species not a landscape threat; no obvious hindrances to use of prescribed fire, e.g., urban development. The occurrence is fully buffered by a natural landscape. Migration of grassland species remains viable.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. D-ranked occurrences have no buffering, and are subject to altered fire and grazing regimes causing a shift in species composition and altering the entire occurrence.

AUTHORSHIP: Renée Rondeau

Date: July 2, 2000

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**SOUTHERN ROCKY MOUNTAINS ECOREGION
FOOTHILL GRASSLAND—LARGE PATCH**

Andropogon gerardii - *Schizachyrium scoparium* Western Great Plains Herbaceous Vegetation
Andropogon gerardii - *Sorghastrum nutans* Western Great Plains Herbaceous Vegetation
Andropogon gerardii - *Sporobolus heterolepis* Western Great Plains Herbaceous Vegetation
Bouteloua gracilis - *Bouteloua curtipendula* Herbaceous Vegetation
Bouteloua gracilis - *Bouteloua hirsuta* Herbaceous Vegetation
Bouteloua gracilis - *Buchloe dactyloides* Herbaceous Vegetation
Bouteloua hirsuta - *Bouteloua curtipendula* Herbaceous Vegetation
Bouteloua hirsuta - *Stipa neomexicana* Herbaceous Vegetation
Muhlenbergia montana - *Stipa comata* Herbaceous Vegetation
Muhlenbergia montana Herbaceous Vegetation
Pascopyrum smithii - *Bouteloua gracilis* Herbaceous Vegetation
Poliomintha incana / *Bouteloua gracilis* Shrubland
Schizachyrium scoparium - *Bouteloua curtipendula* Western Great Plains Herbaceous Vegetation
Stipa comata - *Bouteloua gracilis* Colorado Front Range Herbaceous Vegetation
Stipa neomexicana Herbaceous Vegetation

SCALE AND RANGE: LARGE PATCH AND WIDESPREAD

Foothill grassland ecological system is a large patch system found primarily in the foothills of the Southern Rocky Mountains (SRM) ecoregion, usually between 5,000-7,000 feet in elevation. It is best characterized as a mid-grass to tallgrass prairie on gentle slopes, usually at the base of foothill slopes, e.g., the hogbacks of the Front Range. A combination of precipitation, temperature, and soils limit this system to the lower elevations within the Southern Rocky Mountains ecoregion, usually between 5,000-7,000 feet with approx. 16 inches of precip/year. This system often occurs, but is not limited, to the edge of the ecoregion and especially intergrades with the Central shortgrass prairie ecoregion. It is maintained by frequent fires and associated with specific soils, especially well-drained clay soils. Usually occurrences of this system have multiple plant associations that may be dominated by any of the following species: *Andropogon gerardii*, *Bouteloua gracilis*, *Muhlenbergia montana*, *Pascopyrum smithii*, *Schizachyrium scoparium*, *Stipa comata*, or *S. neomexicana*. Typical adjacent ecological systems include foothill shrublands, ponderosa pine savannas and woodlands, and pinyon-juniper savannas and woodlands as well as shortgrass prairie. The SRM tallgrass prairies are disjunct from the Great Plains tallgrass prairie with large expanses of mid-grass and shortgrass prairies in between.

Opler and Krizek (1984) considers the Colorado Front Range the fourth richest butterfly region in the United States. The reason for this richness has to do with many ecotones coming together of which the foothill grasslands system is an extremely important part. Examples of the skippers and butterflies that are SRM targets that need this system to

survive are: Ottoe skipper (*Hesperia ottoe*), Cross-line skipper (*Polites origenes rhena*), Arogos skipper (*Atrytone arogos iowa*), Dusted skipper (*Atrytonopsis hianna turneri*), and Regal fritillary (*Speyeria idalia*). Viable populations of these skippers and butterflies are indicators of a healthy and functioning occurrence of a foothills grasslands system.

This system is one of the most severely altered systems in the Southern Rocky Mountains ecoregion. Alteration is due to fire suppression, housing and water developments, conversion to hay meadows, overgrazing, etc. Fire suppression has allowed for shrub and tree invasion into the grassland and alters the species composition as well (Mast et al. 1997, Mast et al. 1998). Housing and water developments severely fragment and usually destroy the habitat, while agricultural use has converted tall grass prairies into hay meadows dominated by exotic grasses, e.g., smooth brome (*Bromus inermis*). It is very unusual to find excellent occurrences of this system in the Southern Rocky Mountains ecoregion. Threats are very high for this system and therefore, a premium is set on protecting the existing occurrences. Restoration may be needed to obtain ecoregional goals.

MINIMUM SIZE: 1000 acres

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than ¼ mile wide, major highways, or urban development, 2) a different natural community from a different ecological system wider than one mile wide or continuous forest wider than ¼ mile, 3) a major break or change in the ecological land unit (e.g., topography, soils, geology).

Justification: Large patch grassland communities are susceptible to fragmentation by cultural vegetation or tree/shrub invasion. Forests are likely to be more significant barriers than woodlands or non-forested wetlands for many grassland species. Primary criteria to be considered is the invasion of woody plants, seed dispersal by dominant grasses and forbs, and the dispersal behavior and requirements of invertebrates and small mammals.

RANK PROCEDURE: 1) condition, 2) landscape context, 3) size. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does occurrence size, although the species-area relationship still holds up for patch type communities.

CONDITION SPECIFICATIONS:

A –rated condition: Native species dominate while non-native species if present, typically occupy a small area (< 5% total canopy cover). Invasive exotics with major potential to alter structure and composition are absent, e.g., *Bromus tectorum* and *Euphorbia esula*. Native species that increase with disturbance, e.g., *Koeleria micrantha*, *Guitierrezia sarothrae*, and *Artemisia frigida*, have less than 3% cover. If trees or shrubs are present, these are widely scattered and mature. Species richness is often high, and

native grasses (non-increasers) are dominant. Fragmentation from roads and developments are less than 1% of the occurrence.

B- rated condition: Native species dominate while non-native species occupy less than 10% of the canopy cover. Invasive exotics with major potential to alter structure and composition may be present but in low abundance, e.g., *Bromus tectorum*. Native species that increase with disturbance, e.g., *Koeleria micrantha*, *Gutierrezia sarothrae*, and *Artemisia frigida*, have less than 10% cover. If trees or shrubs are present, these are widely scattered and mature. Species richness is often high, and native grasses (non-increasers) are common. Fragmentation from roads and developments are less than 5% of the occurrence.

C-rated condition: Vascular plant cover is co-dominated by native and non-native species, each typically >10% total cover, with native species > 20% relative cover. Native but “increaser” graminoids, may be co-dominant or dominant; invasive exotics with major potential to alter structure and composition may be prominent but still controllable. Trees and shrubs may have seedlings, juveniles, or saplings present. Alteration is extensive but potentially restorable over several decades. Fragmentation, vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction.

D –rated condition: Non-native species are dominant, native grassland species < 10% cover and 20% relative cover. Alteration is extensive and restoration potential is low. Vehicle use or livestock grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction. System remains fundamentally compromised despite restoration of some processes. Soil compaction and disturbance are extensive throughout the occurrence.

Justification for A-rated criteria: Foothill grasslands are dependent on fires and limited grazing. In order to have a healthy and intact invertebrate and small mammal composition an occurrence must be dominated by native grasses with high species richness. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 5000 acres)

B –rated size: Large (2000 to 5000 acres)

C –rated size: Moderate (1000 - 2000 ac)

D –rated size: Small (<1000 ac)

Justification for A-rated criteria: A-ranked occurrences are large enough to support A-ranked occurrences of disjunct butterflies and skippers, grassland birds as well as a mosaic

of several plant associations. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance. They are buffered from edge effects. Occurrences of this size will support fires and grazing animals and allow for a mosaic of different fire and grazing regimes.

Justification for C/D threshold: C-ranked occurrence size is the minimum size necessary to maintain a minimum viable population of the disjunct skippers, butterflies, and grassland birds. While D-ranked occurrences are subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Occurrence surrounded by a native and unaltered landscape with very little to no urban development or agriculture, and little to no industrial forestry (> 90% natural). No unnatural barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fire to occur.

B-rated landscape context: Landscape composed of at least 75% natural or semi-natural vegetation, with any urban development not directly adjacent to the occurrence. Limited or minor human-caused alteration of landscape. Adjacent systems surrounding occurrence have moderate urban or agricultural alteration (60-90% natural) but retaining much connectivity. Few non-natural barriers present.

C-rated landscape context: Surrounding landscape is a mosaic of agricultural or semi-developed areas with natural or semi-natural vegetation. Adjacent systems surrounding occurrence are fragmented by alteration (20 – 60% natural), with limited connectivity. Some non-natural barriers are present. Significant disturbance, but easily restorable.

D-rated landscape context: Major human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The foothills grassland and its adjacent landscape is intact; connectivity to adjacent and nearby systems is intact. Non-native species are not a landscape threat. Natural fire regime exists or can easily be recreated. The occurrence is fully buffered by a natural landscape. Migration of grassland species remains viable.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. D-ranked occurrences have no buffering, and are subject to altered fire and grazing regimes causing a shift in species composition and altering the entire occurrence.

AUTHORSHIP: Renée Rondeau

Date: June 27, 2000 (edited February 27, 2001)

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**SOUTHERN ROCKY MOUNTAINS ECOREGION
ACTIVE SAND DUNE AND SWALE COMPLEX ECOLOGICAL SYSTEM—
LARGE PATCH**

Oryzopsis hymenoides - *Psoralidium lanceolatum* Herbaceous Vegetation

Redfieldia flexuosa Herbaceous Vegetation

Scirpus pungens Herbaceous Vegetation

Carex simulata Herbaceous Vegetation

Salix exigua Shrubland

Unvegetated sand dunes

SCALE AND RANGE: LARGE PATCH AND LIMITED

The active sand dune and swale complex is a large patch ecological system that is limited to a few adjacent ecoregions and only found in the San Luis Valley within the Southern Rocky Mountains ecoregion. Large dunes comprise this dune system for which Great Sand Dunes National Park is named. These dunes cover about 27 km² (Fryberger et al. 1990) and lie at the base of the Sangre de Cristo Mountains from approximately 7,800 to 8,800 feet in elevation. The southwest winds and the east winds are nearly balanced, resulting in continued and upward growth of the dunes, and an imperceptible migration to the east. Here, the massive dunes form “star” formations reaching a height of over 700 feet (200 m) above the valley floor.

This system is comprised of multiple sparsely vegetated plant associations that often occur as a mosaic of two or three plant associations intermixed with unvegetated dunes. This system is best characterized as wind deposited sand dunes and swales that are sparsely vegetated with grasses and forbs. Vegetation mostly occurs in swales where the moisture content is high. The less stabilized vegetated dunes are dominated by *Redfieldia flexuosa*-*Psoralidium lanceolatum* while the more stabilized dunes are dominated by *Oryzopsis hymenoides*. Small isolated wetlands occur along the western edge of the active sand dune and swale complex and may be dominated by *Salix exigua*, *Scirpus pungens*, or *Carex simulata*.

The *Redfieldia flexuosa*-*Psoralidium lanceolatum* community is tightly correlated with the Great Sand Dunes tiger beetle (G1). While five other sand dune endemic beetles are also restricted to the Great Sand Dunes (Pineda et al. 1999).

Adjacent ecological systems include stabilized sand dune at the lower elevation and pinyon-juniper at the upper elevations.

MINIMUM SIZE: 10,000 acres.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation or urban development greater than ½ mile wide
2) natural community from a different ecological system wider than one mile wide, or 3) major break in topography, soils, geology, etc.

Justification: Primary criteria to be considered are the reactions of endemic beetles and other sand dune insects to fragmentation, seed dispersal by dominant grasses and forbs, and the dispersal behavior and requirements of the Sand Dunes tiger beetle (*Cicindela theatina*). The separation distance for intervening natural or semi-natural communities assumes a distinct landscape difference that is not conducive to species migration.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does occurrence size, although the species-area relationship still holds up for patch type communities. See additional notes under “Size”.

CONDITION SPECIFICATIONS:

A –rated condition: A natural source of sand exists and is renewed and removed on a yearly basis. Groundwater and surface hydrology is intact. No or little evidence of alteration of the system due to groundwater pumping, creek damming, livestock grazing, mining, vehicle use, recreation, or other significant human activity. No or very few exotic species present with no potential for expansion. Swales that are dominated by *Redfieldia flexuosa*, *Oryzopsis hymenoides*, and *Psoralidium tenuifolium* (Great Sand Dunes) and are a good indication of functioning swales. Dynamic process of shifting dunes are in place.

B- rated condition: A natural source of sand exists and is renewed and removed on a yearly basis. Groundwater and surface hydrology is largely intact although this may be slightly altered by localized water development, livestock grazing, vehicle use, recreation, or other human activities. Alteration is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. Surface disturbance from ORV’s, other recreation uses, or livestock grazing may be present but are restricted to less than 3% of the occurrence.

C-rated condition: Natural hydrologic regime altered by ground water pumping or stream diversions/damming. Vehicle use or grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction. Exotic species may be present and impacting the native species composition. Significant resources re required to restor occurrence to a higher quality.

D –rated condition: Natural hydrologic regime or disturbance to site not restorable. System remains fundamentally compromised despite potential restoration of some processes. Exotic species may be dominant. Soil compaction and continued disturbance is extensive throughout the occurrence. A site where the hydrology has been severely altered and the impact from ORV’s effects most or all of occurrence such that restoration is unlikely to occur.

Justification for A-rated criteria: Sand dune and swale complexes are dependent on the ability to have a mosaic of non-vegetated shifting sands and sparsely vegetated sand dunes or swales. These complexes may be dependent on both surface and groundwater. The surface water carries sand back to the source, while the groundwater maintains moist sand needed for the vegetation. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (30,000 acres)

B –rated size: Large (20,000 to 30,000 acres)

C –rated size: Moderate (10,000 to 20,000 ac)

D –rated size: Small (<10,000 ac)

Justification for A-rated criteria: Sand dune and swale complexes are composed of a mosaic of sparsely vegetated and non-vegetated sand dunes. The San Luis valley sand dune system appears to have a combination of large patch and matrix-forming attributes. For example large patches are usually more specific in their ecological tolerances than matrix, while matrix communities are more resilient and resistant to large scale disturbances than large patch communities (Anderson 1999). The sand dune complex fits large patch for its ecological tolerance and fits matrix for its ability to be resilient and resistant to large-scale disturbances, e.g., shifting dunes. A 30,000 acre occurrence in the San Luis Valley is predicted to be large enough to support A-ranked occurrences of the endemic insects. In addition it would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance as well as recover from major sand movement. This size also allows for areas to be adequately buffered from edge effects.

Justification for C/D threshold: C-ranked occurrences maintain a size that will allow for a complex structure with several plant associations and natural ecological processes to occur, and support a minimum viable population of the endemic insects. While D-ranked occurrences are too small to remain viable with natural or unnatural changes to the surrounding landscape and are easily subject to loss of plant associations and their associated plants and animals. Indicator animals include sand dunes tiger beetle (*Cicendela theatina*) and other endemic sand dune beetles (Pineda et al. 1999).

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Evidence of human-caused alteration of surface and groundwater hydrology within a 50 sq. mile radius is minimal. Groundwater pumping is limited to less than 10% of the area. Adjacent systems are unaltered by urban or

agricultural uses (> 90% natural). Connectivity of adjacent systems allows natural ecological processes, e.g., flooding and wind dispersion to occur.

B-rated landscape context: Limited or minor human-caused alteration of hydrology, especially groundwater pumping. Groundwater pumping is limited to 20% of the area. Adjacent systems surrounding occurrence have moderate urban or agricultural alteration (60-90% natural) but retaining much connectivity. Few non-natural barriers present.

C-rated landscape context: Local or moderate human-caused alteration of hydrology. Groundwater pumping is limited to 25% of the area. Adjacent systems surrounding occurrence are fragmented by alteration (20 – 60% natural), with limited connectivity. Some non-natural barriers are present. Significant, but restorable with significant resources.

D-rated landscape context: Major human-caused alteration of hydrology. Groundwater pumping is greater than 25% of the area. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The sand dune complex is especially sensitive to groundwater. Alteration of groundwater from as far away as 50? miles upstream of the sand dunes are believed to have an effect on the groundwater of the sand dunes. A-ranked occurrences exist in a natural hydrologic regime that is necessary to supply blowing sands as well as maintain existing vegetation. The sand dune complex is fully connected with natural intact vegetation and allowing for species migration and is fully buffered by a natural landscape.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species and altered hydrology. While D-ranked occurrences have no buffering, and are subject to significantly altered hydrology and invasive species. Natural hydrologic processes are severely altered potentially causing a shift in species composition and altering the entire complex.

Definition: AUTHORSHIP: Renée Rondeau

Date: June 22, 2000 (edited February 24, 2001)

LITERATURE CITED:

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SOUTHERN ROCKY MOUNTAINS ECOREGION
**NORTH PARK ACTIVE SAND DUNE ECOLOGICAL SYSTEM—LARGE
PATCH**

Pascopyrum smithii Herbaceous Vegetation
Unvegetated sand dunes

SCALE AND RANGE: LARGE PATCH AND LIMITED

The North Park active sand dune ecological system is a large patch system limited to small areas both within Southern Rocky Mountains ecoregion and adjacent ecoregions. North Park differs from the other SRM ecoregion dune system (Great Sand Dunes) in size, climate, dominant species, and primary ecological process. Freeze-thaw and snow-melt processes form the sedimentary structures that distinguish the North Park dunes from the Great Sand Dunes in the San Luis Valley, Colorado.

The North Park dunes are the only major active area in a predominantly dormant dune field which cover approximately 25 square miles. The relatively high precipitation, short summers and cold climate combine to greatly reduce sand movement, even on the active dunes. Because the dunes are active, the area is in a fragile state of soil and vegetative development and is an example of an ecosystem which is extremely rare in Colorado.

Two primary dune fields comprise this system, both nearly equal in size of approx. 620 acres. The east dune fields have restricted visitation, while the west dune field is heavily recreated by ORV's.

The North Park dunes are sparsely vegetated with *Pascopyrum smithii* the dominant species.

MINIMUM SIZE: 100 acres.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation or urban development greater than ½ mile wide 2) natural community from a different ecological system wider than one mile wide, or 3) major break in topography, soils, geology, etc.

Justification: Primary criteria to be considered are the reactions of invertebrates and seed dispersal of dominant grasses and forbs. The separation distance for intervening natural or semi-natural communities assumes a distinct landscape difference that is not conducive to species migration.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Occurrence size criteria may not be as critical for patch communities as it is for matrix-forming communities (Anderson 1999). Factors such as the landscape context current condition, and historical continuity may contribute more to the diversity of an occurrence than does

occurrence size, although the species-area relationship still holds up for patch type communities. See additional notes under “Size”.

CONDITION SPECIFICATIONS:

A –rated condition: There is a natural source of sand that is renewed and removed on a yearly basis. No or little evidence of alteration of the system due to livestock grazing, mining, vehicle use, recreation, etc. No or very few exotic species present with no potential for expansion. Swales that are dominated by *Pascopyrum smithii* are good indications of functioning swales. Dynamic process of shifting dunes are in place.

B- rated condition: There is a natural source of sand that is renewed and removed on a yearly basis although this may be slightly altered by localized development, livestock grazing, vehicle use, or recreation etc. Alteration is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. The site has the above characteristics, but surface disturbance over a small to moderate percentage of sand dunes has occurred due to ORV's, other recreation uses, or livestock grazing.

C-rated condition: Vehicle use or grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction.

D –rated condition: Disturbance to site not restorable. System remains fundamentally compromised despite restoration of some processes. Exotic species may be dominant. Soil compaction and continued disturbance is extensive throughout the occurrence. A site where the hydrology has been severely altered and the impact from ORV's effects most or all of occurrence such that restoration is unlikely to occur.

Justification for A-rated criteria: Sand dune and swale complexes are dependent on the ability to have a mosaic of non-vegetated shifting sands and sparsely vegetated sand dunes or swales. A-ranked occurrences have processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 600 acres)

B –rated size: Large (200 to 600 acres)

C –rated size: Moderate (100 - 200 ac)

D –rated size: Small (<100 ac)

Justification for A-rated criteria: Sand dune and swale complexes are composed of a mosaic of sparsely vegetated and non-vegetated sand dunes. It would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain

natural geomorphic disturbance as well as recover from major sand movement. They are also adequately buffered from edge effects.

Justification for C/D threshold: C-ranked occurrences maintain a size that will allow for a complex structure allowing for several plant associations to occur, natural ecological processes to occur, and a minimum viable population of the insects. While D-ranked occurrences are too small to remain viable with natural or unnatural changes to the surrounding landscape and are easily subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Adjacent systems are unaltered by urban or agricultural uses (> 90% natural). Connectivity of adjacent systems allows natural ecological processes, e.g., flooding and wind dispersion to occur.

B-rated landscape context: Adjacent systems surrounding occurrence have moderate urban or agricultural alteration (60-90% natural) but retaining much connectivity. Few non-natural barriers present.

C-rated landscape context: Adjacent systems surrounding occurrence are fragmented by alteration (20 – 60% natural), with limited connectivity. Some non-natural barriers are present. Significant, but easily restorable.

D-rated landscape context: Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The sand dune complex is fully connected with natural intact vegetation and allowing for species migration and is fully buffered by a natural landscape.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. While D-ranked occurrences have no buffering, and are subject to altered composition and invasive species.

Definition: AUTHORSHIP: Renée Rondeau

Date: February 26, 2001

LITERATURE CITED:

Anderson, M. G. 1999. Viability and spatial assessment of ecological communities in the northern Appalachian ecoregion. Dissertation at University of New Hampshire.

SOUTHERN ROCKY MOUNTAINS ECOREGION
STABILIZED SAND DUNE ECOLOGICAL SYSTEM—LARGE PATCH

Chrysothamnus nauseosus / *Muhlenbergia pungens*-*Oryzopsis hymenoides* Shrubland
Stipa comata - *Oryzopsis hymenoides* Herbaceous Vegetation
Sarcobatus vermiculatus Dune Shrub Herbaceous Vegetation
Pinus ponderosa / *Oryzopsis hymenoides* Sparse Vegetation

SCALE AND RANGE: LARGE PATCH AND LIMITED

The stabilized sand dune ecological system is a large patch system primarily associated with the Great Sand Dunes area in the San Luis Valley. This eolian depositional system covers about 800 km². The system is considered to extend from the Rio Grande northeastward to the Sangre de Cristo Mountains (Fryberger et al. 1990). This extensive vegetated sand sheet exists in a band between the alkaline greasewood flats-ephemeral wet meadow complex and the active sand dune and swale ecological system. At an elevational range of approximately 7,600 to 7,800 feet it is characterized by mostly flat bedded sand deposits with scattered groups of parabolic dunes, many of which have trailing “arms” of sand anchored by grassy or brush vegetation. Southwesterly prevailing winds deposit and shift the sands of this system. *Chrysothamnus nauseosus* is often the dominant shrub although *Sarcobatus vermiculatus* may be co-dominant. *Oryzopsis hymenoides*, *Stipa comata*, *Bouteloua gracilis* and *Muhlenbergia pungens* dominate the herbaceous layer.

Ecological processes that are important in the maintenance of this system are most likely a combination of grazing (antelope, elk, bison), fire, and wind. The natural/historic frequency and intensity of fires is unknown, although it is approx. 30 years for the adjacent pinyon-juniper woodland (Crane 1982). Fires reduce the cover and density of rabbitbrush and increase the density and cover of grasses (pers. observation). The historic amount and timing of grazing is also unknown. Over a portion of this system, bison have been replaced by cattle, although a large bison herd is maintained by The Nature Conservancy’s Medano-Zapata Ranch.

High density, viable populations of Sage sparrow are good indicators of a healthy and functioning occurrence of the stabilized sand dune ecological system.

Threats to this system include groundwater withdrawal, especially large-scale projects that might impact the integrity of the dunes, recreation use especially off-road vehicles that might cause the dunes to become active, fire suppression and improper livestock grazing. Oil and gas exploration and development are also considered a threat to the intactness of this system.

MINIMUM SIZE: 10,000 acres.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than one mile wide, or urban

development. 2) natural community from a different ecological system wider than one mile wide, or 3) major break in topography, soils, geology, or other relevant environmental factor.

Justification: Primary criteria to be considered in establishing separation distances are the reactions of endemic small mammals, e.g., plains pocket mouse (*Perognathus flavescens relictus*) and silky pocket mouse (*P. flavus sanluisi*), seed dispersal by dominant grasses and forbs, and the dispersal behavior and requirements of the Sand Dunes tiger beetle (*Cicindela theatina*). The separation distance for intervening natural or semi-natural communities assumes a distinct landscape difference that is not conducive to species migration and possibly acts as a fire barrier, e.g., wet meadows.

RANK PROCEDURE: 1) size, 2) condition, 3) landscape context. Size and condition receive equal weighting while landscape is of lesser importance.

CONDITION SPECIFICATIONS:

A –rated condition: A natural source of sand exists that is renewed or redistributed on a regular or yearly basis. No mining, limited vehicle use, recreation, or other human alterations that impact the system. Intact hydrology especially the groundwater system. No or very few exotic species present with no potential for expansion. Bison grazing is preferred to cattle grazing although cattle grazing that maintains *Oryzopsis hymenoides* and *Stipa comata* grasslands can still be ranked “A”. Native grasses are dominant, non-native species occupy less than 3% canopy cover. Invasive species with major potential to alter structure and composition are absent.

B- rated condition: A natural source of sand exists that is renewed and removed on a yearly basis although this may be slightly altered by localized water development, livestock grazing, vehicle use, or recreation. Alteration is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. The site has the above characteristics, but surface disturbance over a small to moderate percentage of sand dunes has occurred due to ORV's, other recreation uses, or improper livestock grazing. Often the cover of *Chrysothamnus nauseosus* is higher, while the native bunch grass cover is lower due to 1) improper grazing and 2) suppression of fires. Native grasses dominant, non-native species are present but in small amounts (< 5% total canopy cover). Invasive exotics with major potential to alter structure and composition occupy less than 1% of occurrence.

C-rated condition: Vehicle use or grazing disturbance is extensive and significant enough to have notable impact on species composition and soil compaction. Hydrology is altered over a small portion or minimally across the occurrence. Exotic species may be scattered or patchily distributed, but can still be controlled with a significant amount of resources and effort. Vehicle use results in little to no vegetation cover on areas that are extensively used. If occurrence is poorly managed for livestock the density and cover of native bunch grasses is often patchy and scanty while *Chrysothamnus nauseosus* is dominant. If management improves the occurrence is likely to improve within 10 years.

Non-native species are present and may dominate small patches, although native species still dominate the occurrence.

D –rated condition: A site where the impact from ORV's or improper grazing effects most or all of occurrence such that restoration is unlikely to occur. Hydrology significantly impacted but may not show the full impacts. Disturbance to site not restorable in less than 25 years. System remains fundamentally compromised despite restoration of some processes. Exotic species may be dominant. Soil compaction and continued disturbance is extensive throughout the occurrence. Non-native species are dominant, native species have less than 20% relative cover.

Justification for A-rated criteria: Stabilized sand dune systems are dependent on the ability to have a mosaic of shrublands and grasslands. These complexes are also dependent on grazing, fires, and wind. A-ranked occurrences have ecological processes, species composition, and the physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive and/or irreversible degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 30,000 acres)

B –rated size: Large (20,000 to 30,000 acres)

C –rated size: Moderate (10,000 to 20,000 ac)

D –rated size: Small (<10,000 ac)

Justification for A-rated criteria: Stabilized sand dune systems are composed of a mosaic of shrublands and grasslands. The San Luis valley sand sheet appears to have a combination of large patch and matrix-forming attributes. For example large patches are usually more specific in their ecological tolerances than matrix, while matrix communities are more resilient and resistant to large scale disturbances than large patch communities (Anderson 1999). The stabilized dune system fits large patch characteristics for its ecological tolerance and fits matrix for its ability to be resilient and resistant to large scale disturbances, e.g., fire. Therefore an occurrence larger than 10,000 ac would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic disturbance as well as to recover from a large fire. This size is also adequately buffered from edge effects.

Justification for C/D threshold: C-ranked occurrences have a size that will allow for a complex structure allowing for several plant associations to occur and natural ecological processes to occur. While D-ranked occurrences are too small to remain viable with natural or unnatural changes to the surrounding landscape and are easily subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Adjacent systems are unaltered by urban or agricultural uses (> 90% natural). No anthropogenic barriers present. Connectivity of adjacent systems allows natural ecological processes, e.g., fire and wind dispersion to occur.

B-rated landscape context: Limited or minor human-caused alteration of surrounding landscape. Adjacent systems surrounding occurrence have moderate urban or agricultural alteration (60-90% natural) but retaining much connectivity. Few non-natural barriers present.

C-rated landscape context: Local or moderate human-caused alteration of landscape. Adjacent systems surrounding occurrence are fragmented by alteration (20 – 60% natural), with limited connectivity. Some non-natural barriers are present. Significant, but easily restorable.

D-rated landscape context: Major human-caused alteration of landscape. Adjacent systems surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered.

Justification for A-rated criteria: The stabilized sand dune system exists in a natural landscape setting that is necessary to supply blowing sands as well as maintain existing vegetation. The system is fully connected with natural intact vegetation allowing for species migration and is fully buffered by a natural landscape.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species. While D-ranked occurrences have no buffering, and are subject to altered hydrology and invasive species.

AUTHORSHIP: Renée Rondeau

Date: June 22, 2000 (edited February 24, 2001)

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SOUTHERN ROCKY MOUNTAINS ECOREGION
LOWER MONTANE RIPARIAN WOODLAND ECOLOGICAL SYSTEM

Acer negundo / *Cornus sericea* Forest
Acer negundo - *Populus angustifolia* / *Cornus sericea* Forest
Populus angustifolia - *Populus deltoides* - *Salix amygdaloides* Forest
Populus angustifolia / *Alnus incana* Forest
Populus angustifolia / *Betula occidentalis* Forest
Populus angustifolia / *Cornus sericea* Woodland
Populus angustifolia / *Crataegus rivularis* Woodland
Populus angustifolia / *Prunus virginiana* Woodland
Populus angustifolia / *Rhus trilobata* Forest
Populus angustifolia / *Salix exigua* Woodland
Populus angustifolia / *Salix irrorata* Woodland
Populus angustifolia / *Salix ligulifolia* (*monticola*, *drummondiana*, *lucida*) Woodland
Populus angustifolia / *Salix drummondiana* - *Acer glabrum* Woodland
Populus angustifolia / *Salix* - *Shepherdia argentea* Woodland
Populus angustifolia / *Symphoricarpos*
Populus angustifolia-*Juniperus scopulorum* Woodland
Populus angustifolia-*Picea pungens* / *Alnus incana albus* Woodland
Populus angustifolia Sand Dune Forest Woodland
Populus angustifolia-*Pseudotsuga menziesii* Woodland
Populus balsamifera var. *candicans* [current accepted names Weber=*P. balsamifera*,
Kartez=*P. balsamifera* ssp. *balsamifera*]
Pseudotsuga menziesii / *Betula occidentalis* Woodland
Pseudotsuga menziesii / *Cornus sericea* Woodland
Juniperus scopulorum / *Cornus sericea* Woodland
Juniperus scopulorum Woodland [Provisional]

SCALE AND RANGE: LINEAR AND WIDESPREAD

Lower montane riparian woodland ecological system is a linear system confined to specific environments occurring on floodplains or terraces of rivers and streams. This ecological system is also found in other ecoregions from Idaho to New Mexico. Although the montane/subalpine riparian shrubland ecological system occupies less than 1% of the Southern Rocky Mountains ecoregion it is scattered throughout the region within a broad elevation range from approximately 6,000 to 9,000 feet. This system often occurs as a mosaic of multiple communities that are tree dominated with a diverse shrub component. The variety of plant associations connected to this system reflect elevation, stream gradient, floodplain width, and flooding events. The dominant trees may include *Acer negundo*, *Populus angustifolia*, *P. balsamifera*, *Pseudotsuga menziesii*, *Picea pungens*, or *Juniperus scopulorum*. Dominant shrubs include *Acer glabrum*, *Alnus incana*, *Betula occidentalis*, *Cornus sericea*, *Crataegus rivularis*, *Prunus virginiana*, *Salix monticola*, *S. drummondiana*, *S. exigua*, *S. lucida*, *Shepherdia argentea*, or *Symphoricarpos* spp.. Generally the upland vegetation surrounding this riparian system range from grasslands to forests.

The primary abiotic ecological process necessary to maintain this ecological system is hydrology and more specifically surface flow. Annual and episodic flooding is extremely important for maintaining a diversity of age classes of *Populus angustifolia* as well as a mosaic of plant associations within any given floodplain. (cite Richter et al.). Alteration of the flooding regime due to water impoundment, diversions, etc. may produce changes to plant composition as well as community composition (Richter 1999?). In addition, upstream activities that effect water quality, e.g., mining, may be important to the vertebrates and invertebrate species that use this system.

MINIMUM SIZE: 1 mile by 100 feet.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation or very degraded example of same community greater than ¼ mile long, major highways, urban development, large bodies of water, 2) different natural community (system) longer than than 1 mile along a river corridor, or ¼ mile in other situations, 3) major break in topography, soils, geology, etc., especially one resulting in a hydrologic break.

Justification: Primary criteria to be considered is the reaction to natural flooding. The separation distance for intervening natural or semi-natural communities assumes dynamic movements due to natural flooding regimes. Natural breaks include changes in the stream gradient and other features of the geomorphic setting (e.g. waterfalls). Unnatural breaks are bridges, roads, channelized sections, and heavily degraded reaches that alter the natural hydrologic flow, scour and deposition dynamics of the stream/river.

RANK PROCEDURE: 1) condition, 2) landscape context 3) size. Slightly higher weight should be given to landscape context and condition, as riparian woodlands in montane settings can be naturally very small.

CONDITION SPECIFICATIONS:

A –rated condition: Natural hydrologic regime intact, including an unaltered floodplain. No or little evidence of alteration due to drainage, flood control, irrigation canals, livestock grazing, digging, burning, mining, or vehicle use. No or very few exotic species present with no potential for expansion. Species composition is primarily of native species with a diverse physiognomic structure. Stream banks are not overly steepened, channel not overly widened, nor unvegetated by excessive grazing.

B- rated condition: Natural hydrologic regime intact or slightly altered by local drainage, flood control, irrigation canals, livestock grazing, digging, vehicle use, mining, or roads. Alteration is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. Although species composition is primarily of native species, the physiognomic structure is less diverse than above. Stream banks may show some local deleterious effects from excessive grazing or recreational use.

C-rated condition: Natural hydrologic regime altered by upstream dams, local drainage, diking, filling, digging, or dredging. Alteration is extensive but potentially restorable over several decades. Vehicle use or grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction, causing excessive erosion. Exotic species (e.g., *Taraxacum officianalis*, *Poa pratensis*, *Agrostis stolonifera*) may be widespread but potentially manageable with restoration of most natural processes. Stream banks have been severely altered by excessive grazing or other human caused reasons, e.g, channeling, road construction, etc.

D –rated condition: Natural hydrologic regime or disturbance to site not restorable. System remains fundamentally compromised despite restoration of some processes. Invasive exotic species, e.g, *Tamarix*, may be dominant over significant portions of area, with little potential for control.

Justification for A-rated criteria: Riparian woodlands are dependent on specific hydrologic regimes, soils, and ability to move both up and down the stream as well as side to side within the floodplain. A-ranked occurrences have natural flooding processes, species composition, and physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 5 linear miles)

B –rated size: Large (3 to 5 linear miles)

C –rated size: Moderate (1 to 3 linear miles)

D –rated size: Small (< 1 linear mile)

Justification for A-rated criteria: Riparian woodlands are often composed of a mosaic of different plant associations, often including small patches of shrublands and herbaceous vegetation. Occurrences of this size have a wide range of plant associations within the complex that show a wide range of variation in hydrology, soil texture, and geomorphology, e.g., point bars. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic and hydrologic disturbance. They are buffered from edge effects and small hydrology alterations.

Justification for C/D threshold: C-ranked occurrences are large enough to sustain some natural or human caused perturbations. While D-ranked occurrences are too small to remain viable with changes to the hydrology. They are also extremely susceptible to invasions by non-natives making them subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: No evidence of human-caused alteration of hydrology, especially upstream of occurrence and within the watershed. Uplands surrounding occurrence and within the watershed are largely unaltered by urban or agricultural uses (> 90% natural), and have few to no recent (< 20 years) clearcuts (<25% of landscape). No unnatural barriers present. Connectivity to habitats allows natural processes and species migration to occur.

B-rated landscape context: Little evidence of human-caused alteration of hydrology, especially upstream of occurrence and within the watershed. Uplands surrounding occurrence and within the watershed are largely unaltered by urban or agricultural uses (60 to 90% natural), but retaining much connectivity, or uplands are heavily managed forest landscape with clearcuts, mining, or numerous roads. Few barriers present. Some natural processes such as flooding, may be slightly compromised. No regional dam upstream.

C-rated landscape context: Uplands surrounding occurrence or upstream watershed are fragmented by urban or agricultural alteration (20 to 60% natural), with limited connectivity. Some barriers are present, and natural processes few. Local or moderate human-caused alteration of hydrology may be present, for example small dams, irrigation ditches, etc.

D-rated landscape context: Major human-caused alteration of hydrology. Uplands surrounding occurrence mostly converted to agricultural or urban uses. Riparian occurrence may be reduced to narrow strip with much edge effect. Connectivity and natural processes are nonexistent. Large dams and numerous diversions are within watershed.

Justification for A-rated criteria: These are occurrences with nearly intact watersheds and natural flooding processes in place. Riparian areas are fully connected with uplands, and fully buffer upland influences.

Justification for C/D threshold: C-ranked occurrences provide some limited buffering from upland influences. D-ranked occurrences provide no buffering, and are subject to siltation, pollutions, invasive species, etc. Large dams disrupt the natural flooding process as well as regulating the annual flows.

AUTHORSHIP: Renée Rondeau

Date: June 27, 2000 (edited February 28, 2001)

**SOUTHERN ROCKY MOUNTAINS ECOREGION
FOOTHILLS RIPARIAN WOODLAND AND SHRUBLAND ECOLOGICAL
SYSTEM**

Alnus incana -*Salix irrorata* Shrubland
Crataegus rivularis Shrubland
Forestiera pubescens Shrubland
Populus deltoides - (*Salix amygdaloides*) / *Salix exigua* Woodland
Populus deltoides / *Symphoricarpos occidentalis* Woodland
Populus deltoides ssp. *wislizeni* / *Rhus trilobata* Woodland
Populus fremontii / *Salix exigua* Forest
Prunus virginiana Shrubland
Rhus trilobata - *Salix exigua* Shrubland
Salix amygdaloides Woodland
Salix exigua / Barren Shrubland
Salix exigua / Mesic Graminoids Shrubland
Salix exigua Shrubland [Provisional]
Salix irrorata Shrubland

SCALE AND RANGE: LINEAR AND WIDESPREAD

Foothills riparian woodland and shrubland ecological system is a linear system confined to specific environments occurring on floodplains or terraces of rivers and streams. This system occupies less than 0.5% of the Southern Rocky Mountains ecoregion and is primarily found at the lowest elevations between 5,000 and 7,000 feet. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Riparian areas of the Southern Rocky Mountains are extremely diverse and often several linear ecological systems may be within close proximity to each other, e.g., wet meadows, montane riparian woodlands and foothills riparian woodland and shrubland ecological systems may be closely associated. Primary driving factors elevation, stream gradient, and floodplain width. Foothills riparian woodland and shrubland system is usually found on low to moderate gradient streams with narrow to broad floodplains. Dominant species of this system include *Alnus incana*, *Crataegus rivularis*, *Forestiera pubescens*, *Populus deltoides*, *P. fremontii*, *Prunus virginiana*, *Rhus trilobata*, *Salix amygdaloides*, *S. exigua*, and *S. irrorata*. The surrounding upland systems range from grasslands, shrublands to woodlands.

Primary threats to this system include cessation of flooding, water diversions, clearing of riparian vegetation, excessive livestock grazing, and channelization.

MINIMUM SIZE: 0.5 mile by 30 feet.

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation or very degraded example of same community greater than ¼ mile long, major highways, urban development, large bodies of water, 2) different natural riparian system longer than 1 mile, 3) major break in topography, soils,

geology, etc., especially one resulting in a hydrologic break. Natural breaks include changes in the stream gradient and other features of the geomorphic setting (e.g. waterfalls). Unnatural breaks are bridges, roads, channelized sections, and heavily degraded reaches that alter the natural hydrologic flow, scour and deposition dynamics of the stream/river.

Justification: Primary criteria to be considered is the reaction to natural flooding. The separation distance for intervening natural or semi-natural communities assumes dynamic movements due to natural flooding regimes.

RANK PROCEDURE: 1) condition, 2) landscape context 3) size. Condition and landscape context get slightly higher weighting than size, as these riparian shrublands and woodlands can naturally be quite small.

CONDITION SPECIFICATIONS:

A –rated condition: Natural hydrologic regime intact, including an unaltered floodplain. No or little evidence of alteration due to drainage, flood control, irrigation canals, livestock grazing, digging, burning, vehicle use, etc. If non-native species present than less than 3% canopy cover; in addition there is a small chance for expansion. Species composition is primarily of native species with a diverse physiognomic structure. Stream banks are not overly steepened nor unvegetated by excessive grazing or other human caused actions.

B- rated condition: Natural hydrologic regime intact or slightly altered by local drainage, flood control, irrigation canals, livestock grazing, digging, vehicle use, roads, etc. Alteration is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. Although species composition is primarily of native species, the physiognomic structure is less diverse than above. Stream banks may show some local deleterious effects from excessive grazing or other human caused action.

C-rated condition: Natural hydrologic regime altered by upstream dams, local drainage, diking, filling, digging, or dredging. Alteration is extensive but potentially restorable over several decades. Vehicle use or grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition and soil compaction, causing excessive erosion. Exotic species (e.g., *Taraxacum officianalis*, *Poa pratensis*, *Agrostis stolonifera*, *Bromus inermis*) may be widespread but potentially manageable with restoration of most natural processes. Stream banks may be severely altered by excessive grazing or other human caused reasons, e.g. channeling, road construction, etc.

D –rated condition: Natural hydrologic regime or disturbance to site not restorable. System remains fundamentally compromised despite restoration of some processes. Invasive exotic species, e.g. *Tamarix*, may be dominant over significant portions of area, with little potential for control.

Justification for A-rated criteria: Riparian woodlands and shrublands are dependent on specific hydrologic regimes, soils, and ability to move both up and down the stream as well as side to side within the floodplain. A-ranked occurrences have natural flooding processes, species composition, and physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 1.5 linear miles)

B –rated size: Large (1 to 1.5 linear miles)

C –rated size: Moderate (.5 to 1 linear miles)

D –rated size: Small (< .5 linear mile)

Justification for A-rated criteria: Foothills riparian woodland and shrublands are often composed of a mosaic of different plant associations, often including small patches of herbaceous vegetation. Occurrences of this size have a wide range of plant associations within the complex that show a wide range of variation in hydrology, soil texture, and geomorphology, e.g., point bars. Occurrences of this size would likely contain sufficient internal variability to capture characteristic biophysical gradients and retain natural geomorphic and hydrologic disturbance. They are buffered from edge effects and small hydrology alterations.

Justification for C/D threshold: C-ranked occurrences are large enough to sustain some natural or human caused perturbations. While D-ranked occurrences are too small to remain viable with changes to the hydrology. They are also extremely susceptible to invasions by non-natives making them subject to loss of plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: No evidence of human-caused alteration of hydrology, especially upstream of occurrence and within the watershed. Water quality is excellent and supports expected aquatic invertebrates. Uplands surrounding occurrence and within the watershed are largely unaltered by urban or agricultural uses (>90% natural), and have few to no recent (<20 years) clearcuts (<25% of landscape). No unnatural barriers present. Connectivity to habitats allows natural processes and species migration to occur.

B-rated landscape context: Little evidence of human-caused alteration of hydrology, especially upstream of occurrence and within the watershed. Uplands surrounding occurrence and within the watershed are largely unaltered by urban or agricultural uses (60 to 90% natural), but retaining much connectivity, or uplands are not heavily managed forest landscape with clearcuts, or numerous roads. Few barriers present. Some natural processes such as flooding, may be slightly compromised. No regional dam upstream.

C-rated landscape context: Uplands surrounding occurrence or upstream watershed are fragmented by urban or agricultural alteration (20 to 60% natural), with limited connectivity. Some barriers are present, and natural processes few. Local or moderate human-caused alteration of hydrology may be present, for example small dams, irrigation ditches, and mines.

D-rated landscape context: Major human-caused alteration of hydrology. Uplands surrounding occurrence mostly converted to agricultural or urban uses. Riparian occurrence may be reduced to narrow strip with much edge effect. Connectivity and natural processes are nonexistent. Large dams and numerous diversions are within watershed. Mining may be extensive.

Justification for A-rated criteria: These are occurrences with nearly intact watersheds and natural flooding processes in place. Riparian areas are fully connected with uplands, and fully buffered from upland influences.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from upland influences. D-ranked occurrences have little or no buffering, and are subject to significant impacts such as siltation, pollution, and invasive species. Large dams disrupt the natural flooding process as well as regulating the annual flows.

AUTHORSHIP: Renée Rondeau

Date: July 19, 2000 (edited February 27, 2001)

SOUTHERN ROCKY MOUNTAINS ECOREGION
GREASEWOOD FLATS-EPHEMERAL WETLAND COMPLEX

Chrysothamnus nauseosus / *Sporobolus airoides* Shrubland
Distichlis spicata Herbaceous Vegetation
Distichlis spicata - *Scirpus nevadensis* Herbaceous Vegetation
Eleocharis palustris Herbaceous Vegetation
Puccinellia nuttalliana Herbaceous Vegetation
Salicornia rubra Herbaceous Vegetation
Sarcobatus vermiculatus / *Bouteloua gracilis* Shrubland
Sarcobatus vermiculatus / *Distichlis spicata* Shrubland
Sarcobatus vermiculatus / *Juncus balticus* Sparse Vegetation
Sarcobatus vermiculatus / *Sporobolus airoides* Sparse Vegetation
Sarcobatus vermiculatus Dune Shrubland
Sarcobatus vermiculatus Shrubland
Sporobolus airoides - *Distichlis spicata* Herbaceous Vegetation
Sporobolus airoides Herbaceous Vegetation

SCALE AND RANGE: LARGE PATCH AND LIMITED

Greasewood flats-ephemeral wet meadow complex are large patch systems confined to specific environments defined by hydrologic regime, soil salinity and texture. By definition, this system occurs as a mosaic of multiple communities. Surrounded by grasslands, stabilized sand dunes or wet meadow systems. Within the Southern Rocky Mountains ecoregion, this system is limited to the San Luis Valley.

MINIMUM SIZE: 10,00 acres.

SEPERATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than ¼ mile wide, major highways, canals, or irrigation ditches, urban development, or large bodies of water, 2) a natural community from a different ecological group wider than ¼ mile.

Justification: Primary criteria to be considered are the hydrologic system, soil texture and salinity, and surrounding landscape. The separation distance for intervening natural or semi-natural communities assumes a different hydrologic regime, soil texture and salinity.

RANK PROCEDURE: 1) condition, 2) size, 3) landscape context. Equal weighting should be given to all ranking factors.

CONDITION SPECIFICATIONS:

A –rated condition: Natural hydrologic regime intact. No or little evidence of alteration due to drainage, flood control, irrigation canals, livestock grazing, digging, burming, vehicle use, etc. No or very few exotic species present with no potential for expansion. Native species that increase under anthropogenic influences are not abnormally

predominant. Note: One should be careful when evaluating hydrology, because the hydrologic regime for this system can potentially be affected by off-site factors many miles away.

B- rated condition: Natural hydrologic regime intact or slightly altered (within 60-140% of historic means for timing and magnitude) by local drainage, flood control, irrigation canals, livestock grazing, digging, vehicle use, etc. Alteration is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. Native species that increase under anthropogenic influences may form dense stands over <10% of the occurrence, but do not appear to be expanding.

C-rated condition: Natural hydrologic regime altered by local drainage, diking, filling, digging, or dredging. Alteration is extensive but potentially restorable over several decades. Vehicle use or grazing disturbance, if present, is extensive and significant enough to have notable impact on species composition. Exotic species (especially *Cardaria* spp.) may be widespread but potentially manageable with restoration of most natural processes. Native increasers may dominate the occurrence.

D –rated condition: Natural hydrologic regime or disturbance to site not restorable. System remains fundamentally compromised despite restoration of some processes. Invasive exotic species, especially *Cardaria* spp., may be dominant over significant portions of area, with little potential for control.

Justification for A-rated criteria: Greasewood flats-ephemeral wet meadow complexes are dependent of specific hydrologic regimes, soils, and salinity. A natural hydrologic regime and limited anthropogenic influences insures that A-ranked occurrences have natural processes, species composition, and physical environment intact.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (30,000 acres)

B –rated size: Large (20,000 to 30,000 acres)

C –rated size: Moderate (10,000 to 20,000 ac)

D –rated size: Small (<10,000 ac)

Justification for A-rated criteria: Greasewood-ephemeral wet meadow complexes are composed of mosaics of different associations included in this group. Occurrences of this size have a wide range of plant associations within the complex that show a wide range of variation in hydrology, salinity, and soil texture. They are large enough that most of the occurrence is buffered from edge effects and small hydrology alterations.

Justification for C/D threshold: C-ranked occurrences are large enough to sustain some natural or human caused perturbations as well as provide an area large enough to contain

a mosaic of plant associations. While D-ranked occurrences are too small to remain viable with changes to the hydrology, and contain insufficient area to maintain a diversity of plant associations. They are also extremely susceptible to invasions by non-natives making them subject to loss of greasewood-ephemeral wet meadow plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: No evidence of human-caused alteration of hydrology. No invasive *Cardaria* present on adjacent lands. Wet meadows and grasslands within 1 mile of the occurrence are unaltered by urban or agricultural uses (> 90% natural). No barriers to water or species movement are present, either within an occurrence or between nearby occurrences.. Connectivity of vegetation allows natural ecological processes (e.g., flooding and species migration) to occur. Timing and depth of high and low groundwater has been little affected by groundwater pumping, and remains from 90-110% of historic patterns.

B-rated landscape context: Limited or minor human-caused alteration of hydrology, especially groundwater pumping and canals (mean timing and magnitude are within 60%-140% of the estimated historic means). No or very little, and easily controlled, invasive *Cardaria* present on adjacent wet meadows. Grasslands and wet meadows within ½ mile of the occurrence with moderate urban or agricultural alteration (60-90% natural) but retaining much connectivity among patches of natural and semi-natural vegetation. Few barriers present to movement of material and species across the landscape. Timing and depth of high and low groundwater has been little affected by groundwater pumping, and remains from 75-90% of historic patterns.

C-rated landscape context: Local or moderate human-caused alteration of hydrology. Invasive *Cardaria* may be abundant on adjacent wet meadows surrounding occurrence, altering species composition. Adjacent wet meadows and grasslands surrounding occurrence are fragmented by alteration (20 – 60% natural), with limited connectivity among remaining patches of natural and semi-natural vegetation. Some barriers are present that restrict movement of materials and organisms across system boundaries. C-ranked landscapes are restorable over years or decades. Timing and depth of high and low groundwater has been affected by groundwater pumping, and remains from below 75% of historic patterns.

D-rated landscape context: Major human-caused alteration of hydrology. Adjacent wet meadows and grasslands surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity is severely hampered. Groundwater pumping is greater than 20% of the area. D-ranked landscapes are missing fundamental system components that render restoration unfeasible.

Justification for A-rated criteria: These are occurrences with nearly intact hydrologic regime at the landscape scale, and they are fully connected with natural intact uplands. Both of the features assure that the historic structure, composition, and function of the

system is maintained. The natural landscape surrounding the occurrence fully buffers the occurrence from anthropogenic influences.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from invasive species and changes to upland landscapes. Restoration is conceivable. While D-ranked occurrences have no buffering, and are subject to altered hydrology and invasive species. Natural hydrologic processes are severely altered causing a shift in species composition and altering the entire complex. Restoration is probably not possible.

AUTHORSHIP: Renée Rondeau and John Sanderson

Date: June 21, 2000

**SOUTHERN ROCKY MOUNTAINS ECOREGION
MONTANE WET MEADOW—SMALL PATCH**

Calamagrostis canadensis Herbaceous Vegetation
Carex aquatilis - *Carex utriculata* Herbaceous Vegetation
Carex aquatilis Herbaceous Vegetation
Carex lanuginosa Herbaceous Vegetation
Carex lasiocarpa Herbaceous Vegetation
Carex limosa Herbaceous Vegetation
Carex praeegracilis Herbaceous Vegetation
Carex utriculata Herbaceous Vegetation
Carex saxatilis Herbaceous Vegetation
Carex simulata Herbaceous Vegetation
Eleocharis palustris Herbaceous Vegetation
Eleocharis rostellata Herbaceous vegetation
Juncus balticus Herbaceous Vegetation
Spartina gracilis Herbaceous Vegetation
Triglochin maritimum Herbaceous Vegetation

SCALE AND RANGE: SMALL PATCH AND WIDESPREAD

Montane wet meadow ecological system is a small patch system in the western U.S. montane ecoregions. Within the Southern Rocky Mountains ecoregion, this system is widely distributed both in elevation and latitude and confined to specific environments defined primarily by hydrology. Water levels in this system are often at or near the ground surface for much (or all) of the growing season, but also may fluctuate considerable through the year. Surface inundation may occur, but it typically does not last for long. Physical disturbance during inundation (e.g., during flood events) may be significant for the structure and composition of these systems. Wet meadows occur on mineral soils that have typical hydric soil characteristics, including relatively high organic content and redoximorphic features. This system usually occurs as a mosaic of several plant associations. The surrounding landscape often contains other wetland systems, e.g., riparian shrublands, or a variety of upland systems from grasslands to forest. Although this system usually occurs in small patches, the large intermountain valleys (San Luis Valley, South Park, and North Park) have some large examples of montane wet meadows.

MINIMUM SIZE: 1 acre

SEPERATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than ¼ mile wide, major highways, urban development, or large bodies of water, 2) natural community from a different ecological system wider than ½ mile wide, 3) major break in topography, soils, geology, etc., especially one resulting in a hydrologic break.

Justification: Primary criteria to be considered are the hydrologic system and the surrounding landscape. The separation distance for intervening natural or semi-natural communities assumes a different hydrologic regime that would inhibit movement of wetland associated species. They are often isolated hydrologically from other wetlands, and easily impacted by surrounding land use.

RANK PROCEDURE: 1) condition, 2) landscape context, 3) size. Condition and landscape context are the primary ranking factors, with size secondary because even small examples of this system can have high biological significance.

CONDITION SPECIFICATIONS:

A –rated condition: Natural hydrologic regime intact. No or little evidence of wetland alteration due to increased or decreased drainage, clearing, livestock grazing, or anthropogenic nutrient inputs. No or very few exotic species present with no potential for expansion. Native species that increase with disturbance or changes in hydrology/nutrients (e.g., nitrogen and phosphorus) are absent or low in abundance.

B- rated condition: Natural hydrologic regime nearly intact. Alteration from local drainage, clearing, livestock grazing, or nutrient inputs is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. Native species that increase with disturbance or changes in hydrology/nutrients are absent, low in abundance, or restricted to high-nutrient microsites that represent less than 5% of the total wetland area.

C-rated condition: Natural hydrologic regime altered by local drainage. Alteration from local drainage, clearing, or livestock grazing is extensive, but potentially restorable over several decades. Exotic species may be widespread but potentially manageable with restoration of most natural processes. Native species that increase with disturbance or changes in hydrology/nutrients may be prominent.

D –rated condition: Natural hydrologic regime or disturbance regimes not restorable. System remains fundamentally compromised despite restoration of some processes. Exotic species may be dominant. Native species that increase with disturbance or changes in hydrology/nutrients are prominent to dominant.

Justification for A-rated criteria: Montane wet meadows in the Southern Rocky Mountains depend on seasonally to permanently saturated soils, and occasional flooding disturbance, so alteration of the hydrologic regime invariably compromises the natural communities. Other anthropogenic influences (grazing, nutrient inputs) can significantly alter community composition by shifting competitive interactions. Non-native species (e.g., *Poa pratensis*), when in sufficient number, can displace native species. A-ranked occurrences have hydrologic processes intact, which supports native species composition, nutrient status of the wetland, and other natural conditions of the wetland.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 75 acres)

B –rated size: Large (20 to 75 acres)

C –rated size: Moderate (1 to 20 ac)

D –rated size: Small (< 1 ac)

Justification for A-rated criteria: Wet meadows are usually composed of mosaics of different plant associations included within this system. Occurrences of this size would maximize the diversity of species and plant associations. They would also likely contain sufficient internal variability to capture the full range of characteristic biophysical gradients, retain natural geomorphic features, and allow for natural disturbances (e.g., flood). The core of occurrences of this size is buffered from edge effects and small hydrology alterations along their periphery.

Justification for C/D threshold: C-ranked occurrences are large enough to sustain some natural or human caused perturbations. While D-ranked occurrences are too small to remain viable with changes to the hydrology. They are also extremely susceptible to invasions by non-natives making them subject to loss of wet meadow plant associations and their associated plants and animals.

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Uplands within 1 mile of the occurrence are largely unaltered (>90% natural) by urban or agricultural uses such as clearcuts, crop cultivation, land development, or heavy livestock grazing. There are no unnatural barriers present between adjacent lands and the occurrence, allowing free flow of organisms and materials across the wetland/upland boundary. Connectivity of habitats allows natural processes and species migration to occur.

B-rated landscape context: Uplands with ¼ mile of the occurrence with moderate urban or agricultural alteration (60 to 90% natural), but with no major barriers to water or species movement within the occurrence. There are few unnatural barriers present between this occurrence and nearby occurrences that would inhibit species movement among occurrences. Some natural processes such as flooding and fire may have altered frequencies or intensities.

C-rated landscape context: Uplands surrounding occurrence are fragmented by urban or agricultural alteration (20 to 60% natural), with limited connectivity between this occurrence and the next nearest occurrence. Some barriers are present, and natural processes few. Activities (development, clearcuts, heavy grazing, etc.) in surrounding uplands alters the hydrologic regime. Restoration of the hydrologic regime and species composition resembling the historic composition is feasible.

D-rated landscape context: Uplands surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity and natural processes are almost nonexistent. Restoration is not feasible within reason.

Justification for A-rated criteria: These are occurrences with nearly intact watersheds and processes. Wetlands are fully connected with other occurrences of this system, and with natural intact uplands. The wetlands are fully buffered from unnatural upland influences. Having these structures and processes in place means adjacent landscapes fully support the natural functioning of the occurrence.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from upland influences, they are connected (although minimally) with other natural systems in the surrounding landscape, and the hydrologic regime and nutrient status have not been completely altered by upland influences. For C-ranked occurrences, restoring drainage patterns and compatible management activities in surrounding landscapes could improve the rank. D-ranked occurrences have no buffering, and are subject to altered hydrology and invasive species. Natural hydrologic processes are severely altered causing a shift in species composition and altering the entire complex. For D-ranked occurrences, there is no possibility of changing the structure or the management on adjacent lands.

AUTHORSHIP: Renée Rondeau and John Sanderson

Date: June 27, 2000 (edited February 24, 2001)

**SOUTHERN ROCKY MOUNTAINS ECOREGION
FRESHWATER MARSH—SMALL PATCH**

Eleocharis palustris Herbaceous Vegetation
Eleocharis rostellata Herbaceous Vegetation
Glyceria borealis Herbaceous Vegetation
Myriophyllum sibiricum Herbaceous Vegetation
Nuphar lutea ssp. *polysepala* Herbaceous Vegetation
Polygonum amphibium Herbaceous Vegetation [Provisional]
Potamogeton foliosus Herbaceous Vegetation
Potamogeton natans Herbaceous Vegetation
Ranunculus aquatilis - *Callitriche palustris* Herbaceous Vegetation
Scirpus americanus - *Eleocharis* spp. Herbaceous Vegetation
Scirpus maritimus Herbaceous Vegetation
Scirpus pungens Herbaceous Vegetation
Scirpus tabernaemontani - *Scirpus acutus* Herbaceous Vegetation
Sparganium angustifolium Herbaceous Vegetation
Sparganium eurycarpum Herbaceous Vegetation
Typha angustifolia-*Typha latifolia* Herbaceous Vegetation

SCALE AND RANGE: SMALL PATCH AND WIDESPREAD

Freshwater marsh ecological system is a small patch system confined to specific environments defined primarily by hydrology. Marshes are frequently or continually inundated, with water depths up to 2 m. Water levels may be stable, or may fluctuate 1 m or more over the course of the growing season. Natural marshes may occur in depressions in the landscape (ponds, kettle ponds), as fringes around lakes, and along slow-flowing streams and rivers (such riparian marshes, are also referred to as sloughs). Marshes have distinctive soils that are typically mineral soils but can also accumulate organic material. Soils have characteristics that result from long periods of anaerobic conditions (e.g., gleyed soils, high organic content, redoximorphic features). Marshes are characterized by herbaceous vegetation adapted to saturated soil conditions. Vegetation is typically emergent (rising out of the water) such as *Typha* spp. and *Scirpus* spp., or submergent/floating such as *Potamogeton* spp. and *Lemna* spp.. Most freshwater marshes are usually composed of mosaics of several plant associations and may be dominated by *Eleocharis* spp., *Glyceria borealis*, *Myriophyllum sibiricum*, *Nuphar lutea*, *Polygonum amphibium*, *Potamogeton* spp., *Ranunculus aquatilis*, *Scirpus* spp., *Sparganium* spp. or *Typha*. Within the Southern Rocky Mountains ecoregion this system is widely scattered. It can occur at nearly any elevation and is usually limited to small areas. This system is also found in many other ecoregions.

Primary threats to this system include changes in water quality and quantity, diversions, mining, logging, and invasive species.

MINIMUM SIZE: 2 acres

SEPARATION DISTANCES: 1) substantial barriers to natural processes or species movement, including cultural vegetation greater than ¼ mile wide, major highways, urban development, or large bodies of water, 2) natural community from a different ecological system wider than ½ mile wide, 3) major break in topography, soils, geology, etc., especially one resulting in a hydrologic break.

Justification: Primary criteria to be considered are the hydrologic system and the surrounding landscape. The separation distance for intervening natural or semi-natural communities assumes a different hydrologic regime that would inhibit movement of organisms or materials among occurrences. They are often isolated hydrologically from other wetlands, and easily impacted by surrounding land use.

RANK PROCEDURE: 1) condition, 2) landscape context, 3) size. Condition and landscape context are the primary ranking factors, with size secondary because even small examples of this system can have high value.

CONDITION SPECIFICATIONS:

A –rated condition: Natural hydrologic regime intact. No or little evidence of marsh or wetland complex alteration due to increased or decreased drainage, clearing, livestock grazing, anthropogenic nutrient input, mining, or other human impacts. No or very few exotic species present with no potential for expansion. Native species that increase with disturbance to changes in hydrology or nutrients are absent or low in abundance.

B- rated condition: Natural hydrologic regime nearly intact. Alteration from local drainage, clearing, mining, or livestock grazing is easily restorable by ceasing such activities. Few exotic species with little potential for expansion if restoration occurs. Native species that increase with disturbance to changes in hydrology or nutrients are absent, low in abundance, or restricted to high-nutrient microsites.

C-rated condition: Natural hydrologic regime altered by local drainage. Alteration from local drainage, clearing, mining, or livestock grazing, is extensive, but potentially restorable over several decades. Exotic species may be widespread but potentially manageable with restoration of most natural processes. Native species that increase with disturbance to changes in hydrology or nutrients may be very prominent.

D –rated condition: Natural hydrologic regime or disturbance to site not restorable without significant resources. System remains fundamentally compromised despite restoration of some processes. Exotic species may be dominant. Native species that increase with disturbance to changes in hydrology or nutrients are prominent to dominant.

Justification for A-rated criteria: Freshwater marshes in the Southern Rocky Mountains ecoregion depend on perennial water regime, permanently saturated soils, and occasional flooding disturbance. A-ranked occurrences have these processes intact, with no history of alteration to the hydrology or surface structure, thus fully supporting the historic structure, composition, and function of the occurrence.

Justification for C/D threshold: C-ranked occurrences have potential for restoration over several decades. D-ranked occurrences have little or no potential for restoration because of extensive degradation.

SIZE SPECIFICATIONS:

A – rated size: Very large (> 50 acres)

B –rated size: Large (20 to 50 acres)

C –rated size: Moderate (2 to 20 ac)

D –rated size: Small (< 2 ac)

Justification for A-rated criteria: Marshes are usually composed of mosaics of different plant associations included within this system. Occurrences of this size would likely contain maximum diversity of species and plant associations. Very large occurrences would also contain sufficient internal variability to capture characteristic biophysical gradients, retain natural geomorphic surfaces, and allow for natural disturbance regimes such as flooding and drawdown. The core of an A-ranked occurrence is buffered from edge effects and small hydrology alterations along its edges.

Justification for C/D threshold: C-ranked occurrences are large enough to contain moderate diversity, and to sustain some natural or human caused perturbations. D-ranked occurrences are noticeably lacking in diversity, and are too small to remain viable with changes to the hydrology. They are also extremely susceptible to invasions by non-natives making them subject to loss of wet meadow plant associations and their associated plants and animals. These small occurrences are also not able to withstand extreme nutrient discharges or sediment loads from upstream or the uplands

LANDSCAPE CONTEXT SPECIFICATIONS:

A-rated landscape context: Uplands within one mile of the occurrence are largely unaltered by urban or agricultural uses (>90% natural), and include few to no recent clearcuts, roads, mines, developments, or excessively grazed pastures. No hydrological alterations are in place that pump groundwater or divert surface flows away from the marsh. There are no unnatural barriers present either within or surrounding the occurrence that would inhibit movement of organisms and materials across systems boundaries. Connectivity of habitats allows natural processes and species migration to occur.

B-rated landscape context: Uplands within ¼ mile of occurrence with moderate urban or agricultural alteration (60 to 90% natural), but retaining much connectivity, or uplands are heavily managed. Few unnatural barriers present between wetlands and uplands. Some hydrological alteration may occur within the local watershed, but is at some distance (>1 mile) from the marsh and has only minor influence on the natural water levels in the marsh. Other natural processes such as flooding, drawdown, and fire have been altered but not significantly so from their historic frequency and intensity.

C-rated landscape context: Uplands surrounding occurrence are fragmented by urban or agricultural alteration (20 to 60% natural), with limited connectivity among patches of natural or semi-natural vegetation. Some barriers are present, and natural processes have been eliminated or have had their frequency and intensity greatly altered. Restoration is feasible.

D-rated landscape context: Uplands surrounding occurrence are mostly converted to agricultural or urban uses. Connectivity and natural processes are almost nonexistent. Restoration is not feasible within reason.

Justification for A-rated criteria: These are occurrences with nearly intact watersheds and processes so that a natural hydrologic regime supports historic system structure, composition, and function. Wetlands are fully connected with natural intact uplands, and their core is fully buffered from upland influences.

Justification for C/D threshold: C-ranked occurrences have some limited buffering from upland influences. D-ranked occurrences have no buffering, and are subject to altered hydrology and invasive species. Natural hydrologic processes are severely altered causing a shift in species composition and altering the entire complex.

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