Appendix

D

MEDICINE BOW NATIONAL FOREST

Revised Land and Resource Management Plan

Final Environmental Impact Statement

Appendix D
Biological Diversity Report

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Appendix D

Introduction

This report has been prepared in support of the revision of the 1985 Medicine Bow Land and Resource Management Plan (1985 Plan). This report is not intended to be a full discussion or description of the biological diversity found on the Forest. It is intended to provide background and informational context for the environmental consequences discussed in the Environmental Impact Statement and for the programmatic decisions made and presented as the Revised Land and Resource Management Plan.

Biological diversity refers to "the full variety of life in an area, including the ecosystem, plant and animal communities, species and genes, and the processes through which individual organisms interact with one another and with the environment" (USDA Forest Service 1992). Conservation of biological diversity has become a concern of many. The Forest Service is charged with providing for the diversity of plant and animal species (36 CFR §219.26).

This report is presented in two parts:

- Part 1: The Ecosystem Assessment includes the hierarchy of nested ecosystems, how they relate to the Medicine Bow National Forest ecosystem, a description of composition, structure, function and disturbance processes that shape those ecosystems, and finally, information about the historic range of variation within those ecosystems;
- Part 2: The Single Species Assessment includes the list of animal, fish and plant species that have population viability concerns and the threats that place them in this category of concern.

The Ecosystem Assessment focuses on understanding dominant disturbance processes and evaluating how proposed management interacts with current conditions in light of those processes. If ecosystem processes and functions are managed so vegetation patterns approximate the historic range of variability (HRV), then the outcome of management will be more predictable and dominant ecosystem elements are likely to be retained (Everett, Townsley et al. 2000).

The Single-Species Assessment considers those species where there is a known viability concern. This assessment focuses on the species of viability concern and the factors limiting species distribution and abundance in relation to threats posed by current ecological conditions or the outcome of proposed management.

The Environmental Consequences Analysis for the Ecosystem Components sets the foundation for Single Species Analysis. Through this process, we are able to draw conclusions on how well we are conserving biological diversity and maintaining viable species of native and selected non-native populations.

The Ecosystem Assessment:

1. Identifies ecosystem elements whose current condition differs significantly from most common conditions based on Historic Range of Variability (HRV).
2. Provides an ecosystem context for the Single Species Analysis through the discussion of habitat elements and their occurrence across the landscape.
3. Quantifies and describes the occurrence and distribution of ecosystem elements such as cover types and habitat structure stages for the existing condition and the conditions that would result from the implementation of the alternatives.
4. Compares the Forestwide occurrence and distribution of ecological elements with the pattern at an ecoregional scale and to conditions that existed historically.
5. Determines how each Management Area contributes to the maintenance of biological diversity and how combinations of Management Area allocations contribute to biological diversity.
6. Determines changes in the occurrence and distribution of ecosystem elements and describes the environmental consequences of these changes.
7. Provides background necessary to evaluate habitat conditions for wildlife.

Ecosystem components of **composition** (cover type), **structure** (habitat structure stages and landscape arrangement of patches) and **function** (growth and disturbance processes) provide a basis for describing ecosystem diversity.

The Single Species Assessment here is a list of species and threats, but Appendix I contains a full analysis. These species have been identified as having a need for a more rigorous examination of viability. The expected viability of each species is based on a combination of:

- The species' characteristics (abundance, distribution, trend in population, trend in habitat, dispersal ability);
- The consequences of environmental conditions and threats outside the control of the Forest Service.
- The species' sensitivity to Forest Service management and activities on the Forest; and
- Management direction in the Plan.

Our two-part approach evolved from developments in conservation biology and from policy and direction contained in many federal laws and regulations, particularly the National Forest Management Act and the Endangered Species Act. The goals of the Endangered Species Act require a species-specific focus to prevent extinction of endangered taxa. In contrast, NFMA calls for the maintenance of viable populations of all native vertebrate species. The Ecosystem Analysis responds to limitations of the species-by-species approach and deficits in the knowledge of species requirements. Combining knowledge regarding ecosystems and species to develop conservation management reflects some of the philosophy of coarse-filter/fine filter methods employed designing systems of preserves (Hunter 1990; Hunter 1991; Noss 1991). However, our approach places greater emphasis on evaluating ecological processes in the context of multiple use management and broadens the analysis reflecting developments in ecosystem management (Grumbine 1990a; Salwasser 1991; Everett, Hessburg et al. 1994; USDA Forest Service and USDI Bureau of Land Management 1994; USDA Forest Service 2001b). A recent administrative review of forest plan appeals have supported this approach (Tenny, 2001).

Context for Assessment

Nature of Forest Plans

Chapter 1 of land and resource management plans (Forest plans) is a statement of the goals, objectives, and strategies that will be pursued through the implementation of resource management programs over the life of the plan. Goals are broad statements that describe overall conditions the Forest will strive to achieve. They should relate directly to descriptions of the desired ecosystem conditions for the planning area. Objectives are more specific than goals, focusing on such things as water quality and quantity, forest and rangeland health, and recreation opportunities. Finally, strategies provide measurable steps that will be taken to move toward the plan goals and objectives.

These statements paint the broad picture of how Forest ecosystems will appear and how they will function in a few years or decades as the result of management. They are very important to understanding the ecosystem management principles underlying the plan alternatives. Most plan alternatives are designed to achieve several multiple-use objectives to varying degrees. A plan will provide more than just standards and guidelines to direct particular actions such as timber harvest or fuel management. It will also set objectives for habitat restoration and maintenance, provide the means to protect watershed integrity, establish a framework to regulate recreation use, and provide for monitoring and evaluation. The sum of all these forms of direction, and the outcomes to be realized through achievement of the plan's desired conditions must be kept in mind when evaluating impacts to species viability. The 1982 NFMA planning regulations require that "diversity of plant and animal communities" be provided in a manner "consistent with the overall multiple-use objectives of the planning area" (36CFR §219.26). Optimal results for one species or one program area are not likely and should not be expected.

Site-specific analysis and mitigation is provided during project development that builds upon the goals, objectives, and other measures provided in the plan to protect species viability. Some of this mitigation consists of standards and guidelines taken from the Forest plan and applied to the project. Some is newly developed during project analysis based on improved information applicable to the site. When evaluating the extent to which plans provide for species viability, it is important to assume that all relevant plan direction will be applied using site-specific knowledge.

Sustainability

Sustainability of ecosystems and the species they support is based on:

- Composition, structure, pattern and distribution of vegetation communities;
- Ecosystem processes (growth, nutrient cycling);
- Natural ecosystem disturbance processes such as fire, wind, insects and disease;
- Human ecosystem disturbance processes:
    1. Timber harvesting and the silvicultural systems used to manage for timber production and fir suppression activities;
    2. Introduction of non-native animals, plants and fish;
    3. Recreation use during snow-on and snow-off seasons and roads that provide access for that use;
    4. Changes due to introduction of domestic livestock and changes due to grazing;

5. Changes due to other human actions (hunting, trapping, mining, water manipulation);
6. A combination of human disturbance processes and/or changes such as climate.

- Species viability (population stability) for threatened, endangered, and R2 sensitive species.

Species Viability

There are some important factors to consider when assessing the risks to species viability at the plan scale:

> The mere presence of certain land management activities such as timber harvest or oil and gas exploration is insufficient to evaluate risk – information on location, extent, and timing that relates directly to the imposition of a threat to one or more species must be provided and evaluated;
>
> Certain activities traditionally viewed as benign or neutral, e.g., dispersed recreation, should not be assumed to have no effects on species;
>
> The level of activity, as measured by output of board-feet or acres of fuel reduction is insufficient to evaluate risk – large programs that are guided by appropriate direction and mitigation may pose less risk than small programs that are poorly designed or regulated;
>
> Risks must be calculated based on the net effect of the activities and all applicable management direction;
>
> Cumulative effects must be evaluated within the context of the historic range of variation – effects due to natural trends or processes must be compared to the effects of management within the planning horizon;
>
> The location, timing, and degree of dispersal or concentration of activities may affect the degree to which they present risks to viability;
>
> The evaluation of risk must consider the relationship between conditions that will exist and actions that will be taken on NFS land, and the cumulative effects of all land ownerships and of actions outside of National Forests or by actors other than the Forest Service;
>
> The evaluation must focus on the likelihood that appropriate conditions for species are to be provided on NFS lands, but should take into account the relative distribution of a species, and the risks to that species, across all land ownerships (e.g., a Forest should not be held accountable for the risk to lichen populations presented by air pollution if that risk factor is the result of off-Forest power plants). Forests should disclose such off-site risks when evaluating the overall risk to species viability.

Hierarchy of Ecological Units

Forest Service Manual 2060.3 states that forests must:

> Use an ecological type classification to coordinate and integrate resource inventories and to stratify land and resource production capability and make predictions and interpretations for management, and

> Identify ecological Units in inventory and use them in monitoring and evaluation, planning and to make predictions and interpretations for resource management on National Forest System Lands.

A national review of biological diversity concluded that the public lands in federal ownership encompass a large part of the natural variety in the United States (Langner and Flather 1994). The National Forest System (26% of federal lands) provides aquatic and terrestrial habitat to support more than 3,000 species of wildlife and fish (Flather and Hoekstra 1989).

Central to biological diversity and ecosystem management is the study of landscape spatial and temporal patterns. The hierarchical structure of ecological systems allows characterization of ecosystems and the identification of patterns and processes of interest at different scales. Ecosystem composition, structure, and function determine diversity patterns across a range of spatial and time scales. The ecological hierarchy of interest is determined by the purpose of the project. To determine sustainability of an ecosystem, patterns of natural or historically sustained variability must be defined at all relevant scales (Bourgeron and Jensen 1993).

Complex landscape patterns, along with the many processes that form them, have been grouped within a hierarchical framework. This framework consists of multi-scaled systems that can be viewed as constraints in which a higher level of organization provides, to some extent, the environment from which the lower levels evolve. Every level is a discrete functional entity. The hierarchy concept allows us to define the components of an ecosystem or set of ecosystems, and the linkages between different scales of ecological organization. The following table presents the National Hierarchy of Ecological Units (Ecomap 1993).

Table D-1 National Hierarchy of Ecological Units

Planning and Analysis Scale	Ecological Units	Purpose, Objectives, and General Use	General Size, Range
Ecoregions Global Continental Regional	Domain Division Province	Broad applicability for modeling and sampling RPA assessment. International planning	1,000,000s to 10,000s of square miles
Subregions	Sections Subsections	RPA planning multi-forest, statewide, and multi-agency analysis and assessment.	1,000s to 10s of square miles
Landscape	Landtype Association	Forest or area-wide planning, and watershed analysis.	1,000s to 100s of acres
Land Unit	Landtype Landtype Phase	Project and management area planning and analysis.	100s to less than 10 acres

The following table summarizes the criteria used to differentiate the ecological units used in this report to describe the Forest (Ecomap 1993).

Table D-2 Principal Map Unit Design Criteria of Ecological Units

Ecological Unit	Principal Map Unit Design Criteria*
Domain	Broad climatic zones or groups (e.g. dry, humid, tropical)
Division	Regional climatic types (Trewartha 1968) Vegetational affinities (e.g. prairie or forest) Soil order
Province	Dominant potential natural vegetation (Kuchler 1964) Highland or mountains with complex vertical climate-vegetation-soil zonation
Section	Geomorphic province, geologic age, stratigraphy, lithology Regional climatic data Phases or soil orders, suborders, or great groups Potential natural vegetation (PNV)** Potential natural communities (PNC)**
Subsection	Geomorphic process, surficial geology, lithology Phases of soil orders, suborders, or great groups Subregional climatic data PNC-formation or series
Landtype Association	Geomorphic process, geologic formation, surficial geology and elevation Phases of soil subgroups, families or series Local climate PNC-series, subseries, plant associations
Landtype	Landform and topography (elevation, aspect, slope gradient, and position) Rock type, geomorphic process Phases of soil subgroups, families, or series PNC-plant associations
Landtype Phase	Phases of soil families or series Landform and slope position PNC-plant associations or phases

**The criteria listed are broad categories of environmental and landscape components. The actual classes of components chosen for designing map units depend on the objectives for the map.*

***Potential Natural Community-Vegetation that would develop if all successional sequences were completed under present site conditions.*

Source: National Hierarchy of Ecological Units (ECOMAP 1993)

Historic Range of Variability

The historic range of variability serves to identify those ecological conditions that would provide high likelihood of supporting the viability over time, of native and desired non-native vertebrates and vascular plants "well distributed" within their ranges in the plan area. High likelihood is achieved when habitats are of sufficient quality, distribution and abundance to allow species populations to be well-distributed and interactive (within the bounds of the life history of the species and the capability of the landscape) across the plan area.   The concept of well distributed includes the species' existing and historical distribution, the existing, historical and potential distribution of its habitat, and the recognition that habitat and population distribution is likely to be dynamic over time.

The historic range of variability serves to place conditions and management actions in a temporal context. It also helps illustrate ecosystem dynamics and processes (especially disturbance processes) and, to some degree, provides information on the conditions that can be maintained (Morgan, Aplet et al. 1994).

Dillon *et al.* (Dillon, Knight et al. 2003) determined the historic range of variability of four major landscape types (high elevation forest, low elevation forest, aspen forest and non-forest vegetation) based upon the spatial and temporal variation in composition, structure and function experienced in an ecosystem from the late 1600s to middle 1800s when the influences of European-Americans were minimal.

Plant and animal communities are transitory assemblages of species that are responsive to climate change and disturbance. The current patterns of vegetation are the result of the survival of relict vegetation from earlier climatic and geologic periods, vegetation distribution in response to climate or geologic change and vegetation distribution that has been modified by Euro-American influences after settlement of the area. The Rocky Mountain area has varied between forest and woodland scrub vegetation with the boundaries of each vegetation type changing with climate and glaciation. (Flora of North America Committee 1993).

The remainder of this Appendix sets the current physical, biological and social stage for the Medicine Bow National Forest planning area giving consideration to the historic range of variability. It is somewhat of an encyclopedic reference for the Biological Diversity and Wildlife sections in the FEIS – Chapter 3 – Affected Area and Environmental Consequences and Appendix I – Biological Assessment and Biological Evaluation.

Part 1 – Ecosystem Assessment

Overview of Provinces and Sections

The levels of hierarchical scale used to define the management situation for the Forest are identified to the Section level. This document will only describe, in very general terms, information pertaining to the Domain and Division spatial scales. Additional detail will be provided to describe the Province and Sections in which the Forest resides.

The Medicine Bow National Forest lies within the NHEU **Dry Domain** (300), **Temperate Steppe Mountains Division** (M330); primarily within the **Steppe - Open Woodland - Coniferous Forest - Alpine Meadow Province** (M334) [Bailey 1994, Bailey 1997]. There are 1,071,377 acres within the M334 province (98.8% of MBNF).

The following table displays the acres of the MBNF within each NHEU Section and the representation of the MBNF within the NHEU Section:

Table D-3 Relation of MBNF to National Hierarchy of Ecological Units

Domain	Division	Province	Section	Section Acres	MBNF NFS Acres % Section
300 Dry	M330 Temperate Steppe Mountains	M332 Steppe – Coniferous forest - Tundra	M332F	704,049	1,129 <1%
		M334 Steppe – Open woodland - coniferous forest – alpine meadow	M334H	5,916,083	61,844 1%
			M334I	13,431,935	1,009,533 7.5%
	M340 Temperate Desert	M341 Semidesert	M341F	8,927,922	12,109 <1%

Source: GIS (ARC/Info), Colorado Gap Analysis Project (Schrupp, W.A. Reiners et al. 2000) and the Wyoming Gap Analysis Project (Merriam, Merrill et al. 1996) landcover layers and National Hierarchy of Ecological Units layer (Powell, Faulkner et al. 1993), (Bailey 1998).

Domains

Domains are sub-continental areas of broad climate similarity. The Forest resides within the Dry Domain. The first map that follows shows the spatial relationship of the Forest and the Dry Domain. This domain is characterized by a relatively dry climate where annual water losses (through evaporation at the earth's surface) exceed annual water gains from precipitation (Bailey 1980).

Divisions

Domains are further partitioned into Divisions. Divisions are determined by delineating areas of differing vegetation, broad soil categories, and regional climates. The Forest resides within the Temperate Steppe Division. The Division is characterized by a semi-arid continental climatic regime (Bailey 1980).

Provinces

Divisions are further subdivided into Provinces. Provinces are determined by broad vegetation regions, which are primarily controlled by length and timing of dry seasons and the duration of cold temperatures. Provinces are also characterized by similar soil orders and by similar potential natural communities as mapped by Kuchler (Kuchler 1964).

The majority (99%) of the Forest resides within the Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow Province (M334). See the second map that follows.

The following is the map unit description for Province M334 (Bailey, Avers et al. 1994).

<u>M334 Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow Province</u>

Middle and Southern Rocky Mountains 102,300 sq. mi. (265,000 sq. km)

Land-surface Form - The Rocky Mountains are rugged, glaciated mountains as high as 14,000 feet (4,300 m). Local relief is between 3,000 feet (900 m) and 12,000 feet (2,100 m). Several sections have intermontane depressions of "parks" with floors less than 6,000 feet (1,800 m) in altitude. Many high-elevation plateaus, composed of dissected, horizontally layered rocks, are in Wyoming and Utah.

Climate - The climate is a temperate semi-arid steppe regime in which precipitation falls in winter despite considerable variation with altitude. Total precipitation is moderate but is greater than on the plains to the west and the east. In the highest mountains, a considerable part of the annual precipitation is snow; however, permanent snowfields and glaciers cover relatively small areas. Bases of these mountains receive only 10 to 20 inches (260 to 510 mm) of rainfall. With elevation, precipitation increases to 40 inches (1,020 mm), and temperatures decrease.

Climate is influenced by the prevailing west winds and the general north-south orientation of the mountain ranges. East slopes are much drier than west slopes. Within this region, the individual mountain ranges have similar east-west slope differences. Average annual temperatures are mainly 35 to 45 degrees Fahrenheit (2 to 7 degrees Celsius), but reach 50 degrees Fahrenheit (10 degrees Celsius) in lower valleys.

Vegetation - Well-marked vegetational zones are a striking feature. Their distribution is controlled mostly by a combination of altitude, latitude, direction of prevailing winds, and slope exposure. Generally, the various zones are at higher altitudes in the southern part of the province, rather than in the northern area. They also extend downslope on east-facing and north-facing slopes and in narrow ravines and valleys subject to cold air drainage. The uppermost zone, the alpine, is characterized by alpine tundra and the absence of trees. Just below is the subalpine zone, dominated in most places by Engelmann spruce and subalpine fir. The montane zone, immediately below the subalpine, is characterized by the dominance of ponderosa pine and Douglas-fir. Frequently there is alternation in the occurrence of these two trees. Ponderosa pine is on the lower, drier, more exposed slopes; Douglas-fir is dominant on the higher, more moist, and more sheltered ones.

After a fire in the subalpine zone and in the upper part of the montane zone, the original forest trees are usually replaced by aspen or lodgepole pine.

Grass, often mixed with sagebrush, regularly covers the ground under open ponderosa pine forests and in some treeless areas. These treeless openings are usually small, and they often alternate, according to slope exposure, with ponderosa pine forest. At the lower edge of the montane zone, they may be continuous with the adjacent grass and sagebrush belt.

Below the montane belt is the foothill (woodland) zone. Dry rocky slopes in this zone often have a growth of shrubs in which mountain mahogany and several kinds of scrub oak are conspicuous. Along the border of the Colorado Plateau Province, the ponderosa pine and pinyon/juniper associations frequently alternate extensively according to exposure of the slopes.

Unforested parks are a conspicuous feature of this province. Many are dominated by grasses, but some are covered largely by sagebrush and other shrubs, such as antelope bitterbrush.

Soils - In the Rocky Mountains, soil orders occur in zones corresponding to the vegetation zones. These range from Mollisols and Alfisols in the montane zone to Aridisols in the foothill zone. In addition, because of steep slopes and recent glaciation, there are areas of Inceptisols.

Map D-1 Relation of ecological units (Domain)

Map D-2 (Provinces)

Fauna - Common large mammals include elk, deer, bighorn sheep, mountain lion, moose, bobcat, beaver, and black bear. Grizzly bear and moose are found in the northern portions. Small mammals include mice, squirrels, martens, chipmunks, mountain cottontails, and bushytail woodrats. Several species of hawks and owls inhabit most of the province. Hundreds of bird species are year-round or seasonal residents. Some of the more common birds are the mountain bluebird, chestnut-backed chickadee, red-breasted nuthatch, ruby-crowned kinglet, pygmy nuthatch, gray jay, Steller's jay, and Clark's nutcracker. Rosy finches are found in the high snowfields. Blue and ruffed grouse are the most common upland game birds.

Sections

Provinces are further subdivided into Sections. Sections are broad areas of similar geologic origin, geomorphic process, stratigraphy, drainage networks, topography, and regional climate. Sections are typically inferred by relating geologic maps to potential natural vegetation "series" groupings mapped by Kuchler (Kuchler 1964). The Forest resides within two Sections: M331H (North-central Highlands and Rocky Mountain) and M331I (Northern Parks and Ranges). The third map shows the spatial relationship of the Forest and the two sections mentioned above.

The following are the map unit descriptions for the two sections (McNabb and Avers 1994).

Section M334H - North-Central Highlands and Rocky Mountain

Geomorphology - This area includes steeply sloping to precipitous flat-topped mountains dissected by narrow stream valleys with steep gradients. High plateaus have steep-walled canyons. There are gently rolling mountain parks, mountain ridges, and foothills. Elevation ranges from 5,600 to 12,000 feet (1,706 to 3,657 m). This section is within three geomorphic physical divisions: Fenneman and Johnson's Wyoming Basin (northern part of the Section), Southern Rocky Mountains (central part of the Section), and the Colorado Plateaus (southern part of the Section).

Lithology and Stratigraphy - The northern one-third of the Section is predominantly Cretaceous sandstones, siltstones, shales, and coal, with porphyritic intrusives. This part of the Section includes the White River uplift, the northeastern part of which is Tertiary basalt. Much of the remaining two-thirds is structurally complex and includes Lower Paleozoic carbonates and shales and Upper Paleozoic conglomerates, sandstones, siltstones, shales, and evaporites. In the central part of the Section, Precambrian granite and biotite gneiss are found. In the extreme south are volcanic rocks; including ash flow tuffs, andesitic lavas, breccias, and conglomerates. The lower elevations in the southern two-thirds of the Section are Cretaceous and Tertiary sandstones, siltstones, shales, and local coals. The rock types in this area make it highly susceptible to slope failure. The southern part of the Section also includes local glacial drift and morainal deposits.

Map D-3 (Sections)

Soil Taxa - There are mesic, frigid, and cyric temperature regimes. Soils include Mollisols, Alifsols, Inceptisols, and Entisols, including Boralfs, Ochrepts, Orthids, and Orthents.

Potential Natural Vegetation - Kuchler mapped vegetation as western spruce/fir forest, pine/Douglas-fir forest, pinyon/juniper woodland, mountain mahogany-scrub oak, and sagebrush steppe. Above timberline, alpine tundra predominates. At higher elevations, types include Engelmann spruce, subalpine fir, Douglas-fir, ponderosa pine/Douglas-fir, aspen, and meadows of grass and sedge. At lower elevations there are pinyon pine, shrubs, grass, and shrub-grass vegetation.

Fauna - Elk, mule deer, black bear, and mountain lion are common large mammals of this Section. Rocky Mountain bighorn sheep have been reintroduced to many areas where they occurred historically. Common smaller mammals include marmot, beaver, snowshoe hare, pika, and pine marten. Typical forest-dwelling birds include Clark's nutcracker, grey jay, northern flicker, and Steller's jay. White-tailed ptarmigan inhabit portions in the higher elevations. Mountain bluebirds are common summer nesters. Herpetofauna include chorus frogs, leopard frogs, and western garter snakes. Native cutthroat trout have been displaced in much of their former range by brook, rainbow, and brown trout.

Climate - Precipitation ranges from 7 to 45 inches (170 to 1,140 mm). Temperature averages 32 to 45 degrees Fahrenheit (0 to 7 degrees Celsius). The growing season lasts 70 to 140 days.

Surface Water Characteristics - In the mountains, water from streams and lakes is abundant, and ground water is plentiful. Snowfields exist on upper slopes and crests. Major rivers in this Section include the Yampa, White, Colorado, Eagle, Arkansas, Taylor, Gunnison, Crystal, Roaring Fork, and Frying Pan.

Disturbance Regimes - Fire, insects, and disease are the principal sources of natural disturbance.

Land Use - More than 50% of the mountain area is federally owned; the remainder is in farms, ranches, and other private holdings. About 50% of the park area is federally owned and is leased to ranchers for livestock grazing (cattle and sheep); the remainder is privately owned ranches. There are some irrigated pastures adjacent to the rivers and streams in the park area. Recreation, mining, and timber harvest are land uses in this section.

Section M334I - Northern Parks and Ranges

Geomorphology - Steeply sloping to precipitous mountains are dissected by many narrow stream valleys with steep gradients. This area has gently rolling mountain parks and valleys, with some mountain ridges. Rugged hills and lower mountains are found in narrow bands along the eastern slopes of the Rocky Mountains. These hills are strongly dissected and in many places are crossed by large streams flowing eastward from the mountains. Elevation ranges from 5,575 to 14,410 feet (1,700 to 4,400 m). This section is within Fenneman and Johnson's Southern Rocky Mountain geomorphic physical division.

Lithology and Stratigraphy - Most of the Section is Precambrian granite and biotic, felsic, and hornblendic gneiss. North, south, and middle parks have local Pennsylvanian through Cretaceous sandstones, siltstones and shales. Between middle and south parks are local Tertiary porphyritic intrusives.

Soil Taxa - This Section has mesic, frigid, and cryic temperature regimes. Soils include Mollisols, Alfisols, Inceptisols, and Entisols including Boralfs, Borolls, Ochrepts, Orthids, Orthents, and Ustolls.

Potential Natural Vegetation - Kuchler mapped vegetation as alpine meadows and barren, fescue-mountain muhly prairie, sagebrush steppe, pinyon/juniper woodland, and Great Basin sagebrush.

Fauna - Common large mammals of this Section are elk, mule deer, black bear, and mountain lion. Rocky Mountain bighorn sheep and isolated mountain goat populations are found over portions of the Section. Smaller mammals include beaver, marmot, pika, pine marten, and bobcat. Common forest-dwelling birds are Stellar's jay, Clark's nutcracker, and grey jay. Wild turkeys are not numerous but are present. At higher elevations, white-tailed ptarmigan are present. Mountain bluebirds and broadtailed hummingbirds are summer residents. Herpetofauna present are western garter snakes and leopard frogs. Prairie rattlesnakes live at lower elevations in the eastern part of the Section. Native cutthroat trout have been displaced, to a large extent, by introduced brook, rainbow, and brown trout.

Climate - Precipitation ranges from 5 to 50 inches (120 to 1,120 mm). Temperature averages 32 to 50 degrees Fahrenheit (0 to 10 degrees Celsius). The growing season ranges from less than 70 to 160 days.

Surface Water Characteristics - In the mountains, water from streams and lakes is abundant, and ground water is plentiful. Snowfields occur on upper slopes and crests. In the parks, perennial streams originate from snowmelt; by August, these streams are often short of water. Large reservoirs store water for domestic, power, and irrigation uses outside the mountain park area. Major streams cross the foothills area, but elsewhere water is scarce. The Arkansas, North Platte, Laramie, Fraser, Yampa, White, Crystal, Roaring Fork, Frying Pan, and Colorado are major rivers in this Section.

Disturbance Regimes - Fire, insects, and disease are the predominate sources of natural disturbance.

Land Use - About 50% of the mountain area is federally owned; the remainder is farms, ranches, and other private holdings. About 50% of the park area is federally owned; the rest is private ranches. Less than 20% of the foothills area is federally owned, and about 80% is farms and ranches. Irrigation occurs along some rivers and streams in park areas and in some small mountain valleys. Grazing use is heavy, occurring on open mountain woodlands and grasslands in almost all of the park areas and in the woodlands and grasslands of the foothills. Recreation, mining, and timber harvest are present and past uses.

Province - Composition, Age, Disturbance and Land Use Data

The Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow Province covers approximately 65,851,200 acres.

The USDA Forest Service mapped the forested land as a part of the Resources Planning Act (RPA) 1992 assessment update (Powell, Faulkner et al. 1993). Applying this information to the Province, the broad cover types and acreages are as shown in the following table.

Table D-4 Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow Province Cover Types, Acres, and Percent of Total

Cover Type	Acres	Percent of Total
Douglas-fir	3,702,200	5.6
Ponderosa Pine	5,269,300	8.0
Lodgepole Pine	9,781,700	14.9
Spruce/fir	8,776,500	13.3
Oak brush (chaparral)	1,601,700	2.4
Pinyon/juniper	8,115,900	12.3
Hardwoods (predominately aspen)	5,045,400	7.7
Nonforested	23,316,900	35.4
Water	241,600	.4
Total	65,851,200	100.0

Source: (Powell, Faulkner et al. 1993)

Much of the Province is non-forested. The major forested cover type is lodgepole pine. Spruce/fir and pinyon/juniper are also important cover types. Forested cover types comprise roughly 65% of the land area.

Age of Forested Cover Types

Data is not specifically available for the Province, but there is information available for the Rocky Mountain Region (Colorado, most of Wyoming and small portions of South Dakota, Nebraska and Kansas). According to the Biological Diversity Assessment done for this Region, the majority of the forests are older forests in excess of 100 years (USDA Forest Service 1992).

Insects and Disease

According to the Biological Diversity Assessment done for this Region (USDA Forest Service 1992), the risk of insect epidemics in the Region as a whole is moderate to high because of the large amount of older trees. Insect epidemics are currently occurring in two places in the Region: the Uncompahgre Plateau and Routt Divide in Colorado and the Laramie Peak area in Wyoming. Insect and disease outbreaks have occurred in the past in the Wind River mountains in Wyoming, the Black Hills in South Dakota (outside the Province), in central Colorado, and along the Front Range. In areas suffering from drought conditions, trees are stressed and more susceptible to attack, and outbreaks can be expected in the near future.

Timber Resource

Of the cover types listed above, Douglas-fir, ponderosa pine, lodgepole pine, and spruce/fir currently have the highest value for wood products. The total of these cover types is shown in the following table.

Not all of these forested lands are available for timber management. Timber management, as used here, means cutting and thinning of trees for the production of wood fiber. According to Forest Service Land and Resource Management Plans, Bureau of Land Management programs, state programs, and activities on private land, approximately 6,133,600 acres are available. This represents 22% (6.1 million acres divided by 27.5 million acres) of the forested lands (cover types currently valued for wood products) and 9%

(6.1 million acres divided by 65.8 million acres) of the total Province acres.

Table D-5 Acres, and Percent of Total of Selected Cover Types from the Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow Province.

Cover Type	Acres	Percent of Total
Douglas-fir	3,702,200	13
Ponderosa pine	5,269,300	19
Lodgepole pine	9,781,700	36
Spruce/fir	8,776,500	32
Total	27,529,700	100

Source: (Powell, Faulkner et al. 1993).

Not all lands identified as available for timber management are treated in any given year or even in a decade. It is estimated that 2% - 5% of these lands could be affected by some kind of timber harvest in any one decade. Assuming the 5% level, it would take 200 years to alter the entire 6.1 million acres or 22% of the forested lands. The other 78% would change through natural disturbance processes and succession.

These forest cover types provide habitat for many species of wildlife associated with older forests. While it cannot be said that all of these acres is suitable and occupied, there is potentially a significant amount of habitat associated with older forests present. The likelihood of all of this older forest being altered through timber harvest is low. However, there are localized exceptions where the combination of timber harvest and fires has greatly reduced the abundance of older forest habitats.

Of the major forested cover types in the Province, ponderosa pine has probably been altered the most by human activities such as logging, residential and recreational development, and fire suppression. Preliminary work on the range of natural variability for Rocky Mountain ecosystems indicated that older ponderosa pine forests were not widespread or abundant. These ponderosa pine forests were also a more open, not the dense, multi-layered forest more often described for old-growth forests.

Livestock Grazing

At this time, information is not available on how much of the Province supports domestic livestock grazing. For the Rocky Mountain Region of the Forest Service, approximately 40% of the National Forest System land base supports livestock grazing (USDA Forest Service 1992). However, this includes the National Grasslands, which are not within the Province proper. Thus, the 40% figure may overestimate the land base supporting livestock.

Rare Species

Nationwide, the threatened and endangered species list contains 944 species: 433 animals and 511 plants (U.S. Fish and Wildlife Service 1995) Langner, et al. (Langner and Flather 1994) compiled a summary of threatened and endangered species for the entire United States by county. Endangered species are not evenly distributed across the country. There are distinct areas where there is a high number of threatened and endangered species relative to the size of the land area. Florida, Southern Appalachia, and the arid southwest are prominent regions that support an especially high number of threatened and endangered species. The Province, relative to the rest of the United States, is low to moderate in terms of threatened and endangered species occurrence.

Air Quality

Air quality data has not been generated specifically for the Province. However, this Province can be broadly characterized by references that describe conditions for the Western United States.

Water

Aquatic resources are best assessed by watersheds. Provinces and Sections are composed of portions of many different watersheds that are not connected hydrologically. Rather than consider water by Province, Section and Forest, the evaluation will be done for the Upper Yampa, North Platte, and Upper Colorado River basins.

Forty-eight percent of the watersheds are in the Yampa basin, 30% in the North Platte, and 22% in the Upper Colorado basin. In all cases, water quality impairment in the basins is due to metals present in the streams. The entire region around the Forest has had historical surface and subsurface mining (precious metals and coal). Thus, the impairment due to metals could be left over from that era. The status of the streams given by the state of Wyoming is Water Quality Limited. This classification means that designated uses are not measurably impaired due to water quality, but assessment information indicates the potential for impairment of the designated uses in the near future. The severity rating for all listed streams is low, and fisheries are present in each stream.

Sections - Composition, Age, Disturbance and Land Use Data

Cover Types

The following table displays information on cover type within NHEU Sections that contain the majority (99%) of the Medicine Bow National Forest NFS lands.

Table D-6 Cover Types, Acres and Percent of Total by NHEU Section

Cover Type M341F	Acres M334H	% M334H	Acres M334I	% M334I
Non Forest Types				
Rock	349,503	5.9%	430,020	3.2%
Forb	139,034	2.3%	685,508	5.1%
Grass	96,360	1.6%	1,749,639	13.0%
Nonforested	50,158	1.6%	539,969	4.0%
Shrub	2,052,976	34.7%	1,961,091	14.6%
Water	9,865	0.2%	51,741	0.4%
Total Non-forest	**2,967,896**	**45.6%**	**5,417,968**	**40.3%**
Forest Types				
Aspen	1,375872	23.3%	832,735	6.2%
Cottonwood	6,517	0.1%	91,533	0.7%
Douglas-fir	49,401	0.8%	443,708	3.3%
Gambel Oak Tree	43	0.0%	0	0.0%
Limber pine	0	0.0%	89,423	0.7%
Lodgepole pine	69,942	1.2%	2,444,082	18.2%
Ponderosa pine	13,161	0.2%	1,796,261	13.4%
Juniper	375,377	2.8%	375,377	2.8%
Blue Spruce	0	0.0%	7,421	0.1%
Spruce/fir	838,416	14.2%	1,865,308	13.9%

Cover Type M341F	Acres M334H	% M334H	Acres M334I	% M334I
Other Tree	102,186	1.7%	67,942	0.5%
Total Forest	**3,218,188**	**54.4%**	**8,013,966**	**59.7%**
Total All Cover Types	**5,916,083**	**100.0%**	**13,431,935**	**100.0%**

Source: GIS (ARC/Info), Colorado Gap Analysis Project (Schrupp, W.A. Reiners et al. 2000) and the Wyoming Gap Analysis Project (Merrill, T.W. Kohley et al. 1996) landcover layers and National Hierarchy of Ecological Units layer (Powell, Faulkner et al. 1993), (Bailey 1998).

As the data shows, the forested area ranges from 54.4% of M334H to 59.7% of M334I. Aspen, Lodgepole pine, Spruce/Fir and Ponderosa pine are the major forested cover types. Shrub and grass are the major non-forest cover types.

Using the vegetation/land cover data (based on LANDSAT satellite data) from the Colorado GAP Analysis Project (Schrupp, W.A. Reiners et al. 2000) and the Wyoming GAP Analysis Project (Merrill, T.W. Kohley et al. 1996), information was summarized for the two-section area. This information is presented in the following table.

Table D-7 Cover Types, Acres, and Percent of Total for Sections M334H and M334I

Cover Type	Acres	Percent of Total	Cover Type % in Province Represented in Section
Douglas-fir	482,000	2.5%	13.0%
Ponderosa pine	1,927,100	10.0%	36.6%
Lodgepole pine	2,980,000	15.4%	30.5%
Spruce/fir	2,583,000	13.4%	29.4%
Oak brush (chaparral)	995,800	5.1%	62.6%
Pinyon/juniper	1,137,900	5.9%	14.0%
Hardwoods (predominately aspen)	2,311,700	11.9%	45.8%
Nonforested	6,888,500	35.6%	29.5%
Water	41,700	.2%	17.3%
Total	19,347,700	100.0%	29.4%

Source: GIS (ARC/Info),landcover layers from Colorado Gap Analysis Project (Schrupp, W.A. Reiners et al. 2000) and Wyoming GAP Analysis Projects (Merrill, T.W. Kohley et al. 1996) and National Hierachy of Ecological Units layer.

As the data shows, about two-thirds of the two-section area is forested. The major forested cover type is lodgepole pine. Spruce/fir, aspen, and ponderosa pine also cover a large percentage of the total acreage. Of special note, 63% of the oak brush and 46% of the aspen, in the Province is found within these two sections. Accordingly, areas covered by oak brush and aspen in the two Sections are very important in their contribution towards this cover type at the Province level.

Age of Forested Cover Types

At this time, age data is not available for the two sections in which the Forest lies. It is assumed that age classes, by the dominant cover type, are similar to those for the Province.

Insects and Disease

The risk of insect epidemics in the Region as a whole is moderate to high because of the large percentage of older trees. The northern portion of section M334H (Laramie Peak area) experienced an epidemic outbreak of mountain pine beetle (*Dendroctonus ponderosae*) in ponderosa pine in the early 1990's. In 1997, there was a large blowdown due to high winds along the Continental divide running from northern Colorado into southern Wyoming.

Timber Resource

Of the cover types listed above, Douglas-fir, ponderosa pine, lodgepole pine, and spruce/fir currently have the highest value for wood products. The total of these cover types is shown in the following table.

Table D-8 Selected Cover Types, Acres, and Percent of Total for Sections M334H and M3341

Cover Type	Acres	Percent of Total
Douglas-fir	482,000	6
Ponderosa pine	1,927,100	24
Lodgepole pine	2,980,000	37
Spruce/fir	2,583,000	32
Total	7,972,100	99 (rounding)

Source: Colorado GAP Analysis Project (Schrupp, W.A. Reiners et al. 2000) and Wyoming GAP Analysis Project (Merrill, T.W. Kohley et al. 1996).

Not all of these forested lands are available for timber management. Timber management, as used here, means cutting and thinning of trees for the production of wood fiber. It is estimated that about 1,300,000 acres are available for timber management in the two-section area. This represents about 16 percent (1.30 million acres divided by 7.97 million acres) of the forested lands (cover types currently valued for wood products) and 7% (1.30 million acres divided by 20.00 million acres) of the total acres in the two sections.

Of the 1.30 million acres available, it is estimated that 1% - 5% of these lands could be affected by some kind of timber harvest in any one decade. Assuming the 5% level, it would take 200 years to alter the entire 1.30 million acres or 16% of the forested lands. The other 84% would change through natural disturbance processes and succession.

These forest cover types provide habitat for many species of wildlife associated with older forests. While it cannot be said that this entire habitat is suitable and occupied, there is a large amount of habitat associated with older forests present. The likelihood of this entire older forest component being altered through timber harvest is low. However, there are localized exceptions where the combination of timber harvest and fires has greatly reduced the abundance of older forest habitats.

Livestock Grazing

At this time, information is not available on how much of the two-section area supports domestic livestock grazing.

Rare Species

The two-section area includes several National Forests. The Arapaho-Roosevelt National Forests, the Medicine Bow-Routt National Forests, and the White River National Forest are all included in the two sections M334H and M334I. The Single Species Assessment found later in this appendix provides a list of rare species for the MBNF. Rare species for the Arapaho-Roosevelt National Forests are discussed in (USDA Forest Service Arapaho-Roosevelt National Forests and Pawnee National Grassland 1997) Rare species for the White River National Forest are discussed in USDA 2002 (USDA FS White River National Forest 2002)

Medicine Bow National Forest

Location and Area

A recent report, The State of the Southern Rockies Ecoregion (Shinneman, McClellan et al. 2000) examined the ecological health and integrity of the Southern Rockies Ecoregion (SRE) and includes the area of the Medicine Bow National Forest. The boundaries of the SRE are based on the Ecoregional Land Classification System developed by the U.S. Forest Service (Bailey 1995). In addition, the San Luis Valley/Upper Rio Grande Basin and the Gunnison Basin were included in the study area, because these major valleys share close ecological ties with the Southern Rockies, such as animal migration, and are nearly enclosed by the ecoregion. The SRE stretches roughly 500 miles from southern Wyoming to northern New Mexico, and extends 250 miles from east to west at its widest point. The SRE covers roughly 63,654 square miles (40,721,141 acres). The information from this report provides information about existing conditions and human induced changes in ecosystems of the Southern Rockies Ecoregion and the social and environmental context of the ecosystems of the MBNF. The State of the Southern Rockies Ecoregion report (Shinneman, McClellan et al. 2000) provided information on composition, structure and function of ecosystems within the SRE for this assessment.

In addition, some of the assessment will be based on the two sections in which the major portions of the Forest resides, M334H - North-central Highlands and Rocky Mountains, and M334I - Northern Parks and Ranges. This two-section area includes portions of Colorado and Wyoming.

Terrestrial Forested Communities - Covertypes

Von Ahlefelt and Speas (Von Ahlefeldt and Speas 1996) identified that at least 1,162 vascular plant species occur on the MBNF. McLaughlin (McLaughlin 1989) has identified thirteen geographic elements of local floras west of the Rocky Mountains including the area that encompasses the MBNF. The composition of the flora of the MBNF has major influence from the flora of the Rocky Mountains and the Colorado Plateau, with minor influence from the Great Basin, Columbia Plateau, Sierra Nevada and Southern Rocky Mountain – Mogollon Plateau.

The following table displays the composition of the flora of the MBNF in terms of these 13 elements.

Table D-8. Geographic Elements of the Flora of the MBNF

Geographical Element	Percent of MBNF Flora
Sonoran	<10%
Colorado Plateau	40-50%
Great Basin	10-20%
Sierra Nevada	0-20%
Rocky Mountain	50-60%

Geographical Element	Percent of MBNF Flora
Chihuahuan	<10%
Apachian	<10%
Southern Rocky Mountain – Mogollon	0-30%
Penisular	<10%
California	<10%
Vancouverian	<10%
Columbia Platueau	10-30%
Mohave	<10%

Source: McLaughlin (McLaughlin 1989).

The following table displays the cover types found on the MBNF and by mountain range in order of decreasing abundance.

Table D-9. Spatial extent of cover types of the Medicine Bow National Forest.

Forest Cover Types	MBNF Acres	Percent of MBNF	Laramie Peak	Sherman (Pole Mtn)	Sierra Madre	Snowy Range
Lodgepole pine	472,577	43.6%	58,061	6,097	134,169	274,250
Spruce/fir	191,695	17.7%	2,556	21	73,237	115,881
Ponderosa pine	95,949	8.8%	85,566	9,037	30	1,317
Aspen	83,686	7.7%	2,535	3,772	58,782	18,596
Limber pine	11,633	1.1%	9,681	411	36	1,504
Douglas-fir	10,297	0.9%	1,609	712	2,964	7,396
Cottonwood	408	>0.1%	115	0	286	7
Juniper	243	>0.1%	70	0	0	173
Gambel oak (tree)	43	>0.1%	0	0	43	0
Total Forest Cover Types	866,532	79.9%	160,194	20,051	267,163	419,125
Non-Forest Cover Types	**Acres**	**Percent of MBNF**	**Laramie**	**Sherman (Pole Mtn)**	**Sierra Madre**	**Snowy Range**
Shrub	132,863	12.2%	12,111	10,285	58,040	52,426
Grass	71,278	6.6%	5,571	23,906	8,643	33,158
Rock (non-vegetated)	9,702	0.9%	2,580	961	1,948	4,214
Wet and water	2,315	0.2%	0	12	658	1,645
Krummholz	1,896	0.2%	0	0	0	1,896
Urban and Right-of-Way	28	>0.1%	0	0	1	27
Total Non-forest Cover Types	218,082	20.1%	20,262	35,164	69,289	93,366
Total	**1,084,614**	**100.0%**				

Source: MBNF RMRIS Database 2002, MBNF GIS, (USDA Forest Service 1998b).

Forest Cover Types

Current forests are island remnants of late Pleistocene forests that were more widespread 20,000-10,000 years ago (Knight and Reiners 2000). Forest cover types occur on 79.9% of the MBNF. Lodgepole pine is the most common forest cover type.

Based on the figures presented in the previous table (Spatial extent of cover types of the Medicine Bow National Forest), the MBNF is approximately 80% forested while the two sections are 54% and 60%, respectively. Non-forested areas cover approximately 20% of the MBNF compared to 46% and 40% of the two sections.

Dillon *et al.* (Dillon, Knight et al. 2003) indicate that high elevation forests at the time of settlement consisted of lodgepole pine, Engelmann spruce and subalpine fir. These forest types occurred in amounts and distribution similar to where they currently occur. Natural disturbances may have caused shifts in distribution along elevational and moisture gradients. Human disturbances have resulted in the occurrence of greater amount of early successional stages. Where lodgepole is successional to Spruce-fir types, this would be seen as a shift in cover type distribution (Dillon, Knight et al. 2003). Dillon *et al.* (Dillon, Knight et al. 2003) indicate that the aspen variables they considered are probably similar to HRV for the MBNF.

Based upon the amount of conifer harvest and the amount of the forest burned over at the time of settlement (Thybony, Rosenberg et al. 1985), aspen would currently have had opportunity to occupy any sites it was capable of occupying. Based upon average life span of 125 years and a potential life span of 160 years for aspen reported by Mehl (Mehl 1992), there seems to have been insufficient time available for conifer replacement of aspen stands established later than the 1870s. Aspen rarely regenerates from seed, however aspen clones can occupy a site in a stable condition for thousands of years (Bartos 2000), (Mitton and Grant 1996).

Dillon *et al.* (Dillon, Knight et al. 2003) describe the historic low elevation forests as consisting of woodlands and savannas composed of ponderosa pine, limber pine and/or Douglas-fir. They state that when trees grow densely enough to be considered forests, the stands are small and located in ravines or on north slopes. Ponderosa pine has been limited to the Laramie Range and is found in areas that receive relatively high summer precipitation. Douglas-fir was possibly more wide-spread than it is currently. Limber pine distribution is responsive to competitive pressure from other species and it occurs mixed with ponderosa pine and Douglas-fir similar to current distribution patterns. Edaphic, topographic, seed distribution by birds and white pine blister rust are also important (Antolin M.F and A.W. Schoettle 2001), (Jacobi and H. J. S. Kearns 2003).

Ponderosa pine may have expanded its distribution range into areas where fire suppression has been successful and in those areas it may occur at much higher densities than historically. Lodgepole pine occurs at elevations too high for other low elevation forest species. On these sites, lodgepole may be the potential natural vegetation (climax).

Aspen stands are older than was typical of the past and increased amounts of fir have invaded the stands. Montane riparian areas have less aspen as aspen has been crowded out by conifers (Cerovski, Gorges et al. 2001). Understory herbaceous vegetation is reduced because of the increase in canopy cover (Dillon, Knight et al. 2003).

Description of Major Forest Cover Types of the MBNF

Engelmann spruce/subalpine fir

Engelmann spruce and subalpine fir are the dominant overstory species in this type. The mixture of these two species and presence of other overstory species varies. Both Engelmann spruce and subalpine fir can reproduce in their own shade. Consequently, this type is considered climax (the potential natural vegetation) for 59% of the Forest. These forests often form multi-aged stands. In addition, the ability to grow in their shade produces trees with live branches reaching a great distance down the truck (Alexander and O. Engelby 1983). Engelmann spruce has a life span of 350 to 400 years with trees as old as 600 years common. Sub-alpine fir is a shorter-lived species, so that older stands in the spruce/fir cover type are mostly composed of spruce (Mehl 1992).

Lodgepole pine

Lodgepole pine is the dominant overstory tree in this type. Forests of this type may also contain other overstory species but always in a minority. Lodgepole pine has difficulty reproducing in shade and so this type is a seral stage in succession on most of the acres where it occurs. Thus, given a long enough period of time, it is often replaced by the climax types, Engelmann spruce/supalpine fir. Lodgepole forests are generally even-aged, with live branches confined to the upper trunk (Alexander and O. Engelby 1983). Lodgepole pine can be up to 400 years old but is more commonly found up to 250 years old (Mehl 1992).

Aspen

Aspen makes up the majority of overstory trees in this forest type. Conifer species are often present in varying degrees in both the overstory and understory. In the Rocky Mountain Region, aspen generally do not reproduce by seed but rather by clonal suckering (root sprouts). Aspen often do not reproduce easily in their own shade and tend to be short lived. However some clones are capable of producing several age classes on the same site (uneven-aged or multi-aged). These seral forests are often replaced by conifer forests however there are also aspen clones that appear to naturally exist in a climax state with conifers. There are some aspen stands/clones on the Forest that are climax. However, most of this forest type generally requires some disturbance in order to be maintained. Historically, fire was the disturbance event responsible for aspen regeneration. Aspen forests also have an abundance of grasses and forbs in their understory (Sheppard and Engelby 1983; Alexander, Hoffman et al. 1986). Aspen trees are rarely found that are older than 160 years, however aspen clones are known to be thousands of years old (Mehl 1992; Mitton and Grant 1996; Bartos 2000).

Rocky Mountain Juniper

Rocky Mountain juniper is found in small patches in the southern portion of the Laramie Peak Range and on the west side of the Snowy Range on dry, rocky ridges at lower elevations (Alexander, Hoffman et al. 1986). It is a common component of the foothills or woodland coniferous zone. Sparse understories are a characteristic of Rocky Mountain juniper stands. The seeds are primarily spread by birds. It is shade tolerant when young and intolerant as a mature tree. Rocky Mountain juniper lives to be 300-700 years old and some specimens are over 3,000 years old. It is easily killed by fire. It is a climax species where it is the dominant cover. It is also a component in stands with other cover types (Noble No date).

Gambel Oak

Gambel oak is a small deciduous tree or shrub. It occurs most commonly as a shrub on the Medicine Bow National Forest. It occurs mostly on the southwestern edge of the Sierra Madre Range. It grows on warm dry sites and regenerates after fires (Alexander, Hoffman et al. 1986). It is located below the general forest zone and above the sagebrush zone.

Cottonwood

Cottonwood grows in low elevation riparian areas. It is often the only tree present but can occur with blue spruce and willows. Is generally intolerant but can occur in two storied stands where streambank disturbances have favored establishment of new seedlings (Jones 1992; Jones and Ogle 2000).

Ponderosa Pine

Ponderosa pine extends in a north-south direction along the east slope of the front range of the Rocky Mountains. It extends southward from the Medicine Bow National Forest through Colorado to northern New Mexico (Alexander, Hoffman et al. 1986). Ponderosa pine generally occurs as a single species but can have other species occur occasionally in stands where ponderosa pine is dominant. It can also occur as a minor component in other cover types. Ponderosa pine stands occur between 6,500 and 9,000 feet in elevation as a mosaic of variations in tree size and stand density. There are occurrences of ponderosa pine on all mountain ranges of the MBNF. The greatest abundance of ponderosa pine occurs in the Laramie Range. Ponderosa pine is rated as shade-intolerant (Baker 1994) but can grow at low densities that allow for reproduction of ponderosa pine below mature trees. Thick bark on older, large trees makes them resistant to fire. Ponderosa pine foliage can have very low moisture content during hot weather and droughts. Where tree crowns are not separated from the understory vegetation, fire can burn into the tree crowns and cause extensive mortality in stands. Dillon *et al*. (Dillon, Knight et al. 2003) discuss that ponderosa pine in this area is subject to several different fire regimes and can exhibit dense multi-story structure within the historical range of variability. Ponderosa pine can be up to 450 years old but more commonly occurs up to 300 years old (Mehl 1992).

Limber Pine

Limber pine is known as a tree of high cold windy ridges growing on sites where other trees can't grow. It occurs most commonly above 9,000 feet in elevation but can occur in low elevation canyons and buttes (Wier 1998b). The seeds are large and lack wings, being primarily distributed by wildlife. Limber pine can grow to be as old 700 years and some specimens are noted as being over 1,000 years old. Limber pine is an effective pioneer and colonizes disturbed sites. It may be seral to aspen or other climax conifers on some sites. It is very slow growing and only reaches a height of 50 feet.

Douglas-fir

The Douglas-fir type is dominated by Douglas-fir in the overstory. Other tree species may be present in smaller percentages. Douglas-fir is mostly found at low elevations on the western edge of the Snowy Range and on shaded slopes on north aspects in the Sherman Peak Range (Pole Mountain) (Alexander, Hoffman et al. 1986). Douglas-fir seedlings can tolerate shade, but the species prefers full sunlight. This type is usually seral, but can be climax under the right environmental conditions. Thick bark on older trees makes them more resistant to fire than most of the species it is associated with on the Medicine Bow National Forest. The forest can be multi-aged or even-aged (Hermann and Lavender 1990). Douglas fir can be up to 400 years old with occasional trees as old as 600 years old (Mehl 1992).

Potential Natural Vegetation - Forested Cover Types

Potential Natural Vegetation (PNV) refers to the vegetation that would develop if all successional sequences were completed under present site conditions. Kuchler (Kuchler 1964) developed the first maps of PNV. PNV, along with NHEU and SRE ecoregions and historic range of variability, provide information about the context of the ecosystems of the MBNF and the potential responses of these ecosystems to natural and human disturbances.

An analysis of PNV for the MBNF was completed using the concepts of Kuchler (Kuchler 1964), and Alexander (Alexander 1988) and data contained in the MBNF RMRIS database. The PNV was determined using plant association, soil and existing vegetation information. The abundance of the following cover types was analyzed.

Table D-10 Cover Types Analyzed for PNV

Cover Type	Cover Type	Cover Type
Aspen	Limber Pine	Lodgepole Pine
Ponderosa Pine	Rangeland, Rangeland Scattered Pine, Riparian	Spruce/Fir
Spruce/Fir Krummholz	Rock	Juniper
Cottonwood	Water	Douglas-fir

The abundance of PNV cover types for the MBNF is displayed in the following table in order of decreasing abundance:

Table D-11 PNV Cover Types, Acres and Percent of Total for MBNF

Cover Type	Acres	Percent of Total
Spruce/Fir	640,637	59%
Rangeland, Scattered Pine, Riparian	153,942	14%
Lodgepole pine	107,116	10%
Ponderosa pine	46,650	4%
Limber Pine	43,433	4%
Aspen	40,349	4%
Spruce-fir-Krummholz	26,002	2%
Douglas-fir	24,497	2%
Water	1,214	<1%
Cottonwood	397	<1%
Juniper	282	<1%
Rock	95	<1%
Total	**1,084,612***	**100.0%**

Source: MBNF RMRIS Database 2002, MBNF GIS, (USDA Forest Service 1998). GIS and product accuracy may vary based upon data sources.*

The difference between PNV and existing abundance of cover types is indicative of the changes that would occur if all successional sequences were completed under present site conditions. With time, and without disturbance, the abundance of aspen ponderosa pine and lodgepole pine cover types would be expected to decrease while the abundance of spruce/fir and limber pine cover types would increase. Most other cover types would remain relatively stable. This should not be confused with HRV, which includes natural disturbance processes. This is just a trendline of how cover types would progress without disturbance.

Terrestrial Non-Forested Communities – Covertypes

Information on the spatial extent of non-forest cover types was presented in the previous table (Spatial extent of cover types of the Medicine Bow National Forest). Non-forest cover types occur on 20.1% of the MBNF. The shrub cover type is the most common non-forest cover type.

The MBNF has a very small amount of gambel oak cover type and has a lower representation of the cover type than NHEU Sections M334H and M334I. The total shrub cover for the MBNF is also much less than for the NHEU Sections M334H and M334I (see previous table Cover Types, Acres, and Percent of Total for Sections M334H and M334I for details). Since National Forest boundaries were drawn to encompass the forested areas (Thybony, Rosenberg et al. 1985), the major cover types on the MBNF are forest cover types.

Dillon *et al.* (Dillon, Knight et al. 2003) describe the historic non-forest vegetation as grasslands, shrublands and forblands, which are found in a distribution similar to that found historically. In some instances, changing climatic or edaphic conditions may now allow tree seedling establishment on areas that were historically occupied by meadows. Dillon et al. (Dillon, Knight et al. 2003) noted that oak woodlands that occur on the west side of the Sierra Madre may now be more subject to juniper invasion because of fire suppression. The occurrence of alpine shrub lands (tundra) is responsive to the severe alpine environment.

At a statewide level, sagebrush has expanded because of fire suppression (Cerovski, Gorges et al. 2001). In some areas, sagebrush has been purposely removed and replaced by grasses in order to increase forage.

Successional stage pathways from Stahelin (Stahelin 1943) discussed in Knight (Knight 1994) indicate that severe fires at high elevations in spruce/fir forests may lead to subalpine grasslands that persist for centuries.

Description of Major Non-Forest Cover Types of the MBNF

Grass/forb

Grasses and forbs of various types are the dominant species along with various numbers of shrub and tree species. This type is generally limited to the alpine tundra and native meadows found in the higher mountains on the Forest.

Shrubs

Shrubs dominating these areas include Gambel oak, sagebrush, and willow. They may be climax or seral, depending on environmental factors. Gambel oak and sagebrush are found at lower elevations on drier sites. Many of these types require some disturbance in order to reproduce. In the past, fire has served as the disturbance agent.

Non-vegetated

Areas in which vegetation does not exist or is very sparse are classed as non-vegetated. Talus, rock outcroppings, and snowfields are included. These areas are usually not capable of producing vegetative cover under current climatic conditions.

In response to temperature and climate changes over the last century, the distribution of the alpine zone vegetation may be changing. The EPA (Environmental Protection Agency 1998) indicates that over the last century, the average temperature in Laramie, Wyoming, has increased 1.5°F, and precipitation has decreased by up to 20% in many parts of the state.

Aquatic and Riparian Communities

There are approximately 1,600 miles of perennial stream channel on NFS lands within the MBNF boundary. Water originating on the Forest contributes to flow in both the Platte and Green River (Colorado River) basins. The majority of the Forest is in the Platte River drainage (84%). Rob Roy (640 acres) and Hog Park (520 acres) are the two largest reservoirs on the Forest. Lake Owen, Turpin Reservoir, and Sand Lake are each approximately 100 acres in size. Many of these large reservoirs are part of a trans-basin diversion of water for the city of Cheyenne. There are also hundreds of smaller lakes, reservoirs, and ponds distributed across the Forest; the northern half of the Snowy Range has the largest concentration.

There are approximately 1,600 miles of perennial stream channels on NFS lands within the Medicine Bow National Forest boundary. Water originating on the Forest contributes to flows in both the Platte and Green River (Colorado River) basins (see Appendix I Biological Evaluation for more information on water contributions to these river systems and on diversions from these river systems). The majority of the Forest is in the Platte River drainage (84%). Rob Roy (640 acres) and Hog Park (520 acres) are the two largest reservoirs on the Forest. Lake Owen, Turpin Reservoir, and Sand Lake are each approximately 100 acres in size. Hundreds of smaller lakes, reservoirs, and ponds occur on the Forest; the northern half of the Snowy Range has the largest concentration.

Creation of dams (large and small) has altered the type and distribution of riparian habitat. For example, a reservoir may replace what was an area or shallow pool or marsh. Flow in the outlet stream will be more even, with less spring flooding and with flow persisting later in the summer.

Water diversions from some streams in the Forest and less beaver activity have reduced baseflows, lowered water tables, and changed the abundance and distribution of riparian vegetation. Most of these impacts occur in the foothills areas of the Forest (Eaglin 2001).

Dahl (Dahl 1990) reports that there was a 38% loss of wetlands in Wyoming between 1780 and 1980. The total amount of wetlands in Wyoming circa 1780 was less than 5%. Frayer *et al*. (Frayer, Peters et al. 1989) estimated that 87% of the wetland losses from the mid-1950's to the mid-1970's were due to agricultural conversion which would have little influence on the Medicine Bow National Forest (Frayer, Peters et al. 1989). Conifer encroachment in wet grassland mountain meadows can replace these wetland areas with forests (Dillon, Knight et al. 2003), (Jakubos and W.H. Romme 1993), (Bunting and E.F. Peters 1994).

The current amount and distribution of riparian cover types is similar to the amount and distribution that occurred historically. Riparian cover types have been altered by natural disturbances and land uses in the past (Von Ahlefeldt and Speas 1996).

Changes to riparian areas include:

- Lowered water tables and changed vegetation due to removal of beavers;

- Alteration of riparian vegetation resulting from historical tie drives;
- Removal of large trees during the tie drives created relatively young, even-aged stands of trees (restoration of riparian ecosystems is dependent upon the growth of large trees in the riparian zone and their eventual recruitment into the streams as coarse woody debris);
- Alteration of riparian vegetation and stream channels from past and present grazing, especially on the west side of the Sierra Madre Mountains and in the Laramie Mountains;
- Changes to aquatic and riparian areas caused by management activities such as road construction, timber harvesting, and grazing in specific watersheds;
- Alteration of aquatic communities in Haggerty Creek and Bear Creek from point source pollution (Haggerty Creek has been identified by the WY Dept. of Environmental Quality as the most severely affected creek from point source pollution in the state);
- Alteration of natural flow regimes and riparian vegetation due to water diversions and sediment spills which change habitat characteristics (diversion of water from natural stream courses on the Forest has lowered water tables and altered riparian vegetation (primarily in the foothills areas of the Forest);
- Alteration of high-elevation riparian communities due to past timber harvesting around kettleholes in the northern Snowy Range;
- Proliferation of exotic noxious weeds in many lower elevation riparian areas. (See Fish and Aquatics section of AMS for details.)

Description of Major Riparian/Wetland Cover Types of the MBNF

Riparian/wetland

Riparian ecosystems cross through and occur within a number of cover types. There is great variability in the size and complexity of riparian zones because of the many possible combinations of stream gradient, elevation, soil, aspect, topography, water quantity and quality, type of stream bottom, and plant communities (Jones and Ogle 2000). Major aquatic ecosystems on the Forest include high mountain lakes, kettle ponds, reservoirs, high elevation streams and major foothills streams and rivers such as the North Platte River. There is additional information on riparian vegetation in the Aquatics section of Chapter 3.

The following table summarizes relative abundance of riparian and wetland vegetation types by mountain range.

Table D-12 Riparian and Wetland Acres for MBNF by Mountain Range

Vegetation Type	Acres of riparian areas and wetlands				Total Acres & % of Vegetation Type
	Sierra Madre	Snowy Range	Sherman Mountains	Laramie Peak	
Deciduous Forest	2,155	1,806	355	486	4,802 7%
Coniferous Forest	6,612	13,533	510	4,306	24,961 36%
Shrubland	8,439	18,515	2,487	2,233	31,664 46%

Vegetation Type	Acres of riparian areas and wetlands Sierra Madre	Snowy Range	Sherman Mountains	Laramie Peak	Total Acres & % of Vegetation Type
Grass and Forb	937	1,701	1,191	431	4,260 6%
Other	839	2,381	34	3	3,257
Total Acres % of land in riparian/wetland	18,892 5.6%	37,936 7.4%	4,577 8.3%	7,449 4.2%	68,944

Source: (Von Ahlefeldt and Speas 1996).

Shrub, Grass, Coniferous Forest and Deciduous Forest Riparian

Shrublands and coniferous forests make up more than 80% of the riparian areas on the Forest. In contrast, less than 10% of the riparian areas are deciduous forests and grass/forb dominated. Riparian and wetland areas average 6.4% (70,000 acres) of NFS lands and range from 4 to 8% by mountain range.

Fens

Fens occur on the MBNF but occupy a very small percentage of the overall riparian/wetland acreage, fens are an important element of biological diversity, and often support globally rare plant and invertebrate species and unique species assemblages (Heidel and S. Laursen 2003), (Proctor 2003), (Reider 1983), (USDA Forest Service 2002). (See discussion of sensitive plant species and fens in Appendix I for more information.)

Fens are wetlands with water-saturated substrates and an accumulation of about 30 cm or more of peat (organic soil material). Peatlands, which include fens, bogs, and muskegs, are widely distributed across boreal regions. Fens within Region 2 are normally ground water driven, have pH above 5.5, and are dominated by grasses, sedges, or willows. Because of their water-holding capability, fens provide very stable habitats. For example, many of the fens of Region 2 are over 10,000 years old, with organic soil accumulation rates ranging from about 4 to 16 inches per thousand years. Because the rate of accumulation is so slow, these ecosystems are essentially irreplaceable (USDA 2002). Mitigation for loss of fens is problematic, as there are no known methods to create new functional fens (USDI Fish and Wildlife Service 1998).

In 2002 and 2003, an intensive remote sensing/GIS effort sought to locate, map, field verify and record high quality peatlands and their flora for select portions of the Medicine Bow Forest including parts of the Snowy Range (North Fork Allotment, Libby Flats and Elk Creek drainage), Sheep Mountain and the Sierra Madre Range (Huston Park) (Heidel and S. Laursen 2003), (Proctor 2003). This effort mapped and inventoried 6 fen/peatland sites on the Snowy Range (3 sites), Sheep Mountain (1 site) and Sherman (Pole) Mountain (1 site). Additional fens have been identified as part of project botanical surveys on the Sierra Madre range (Proctor 2003).

Forested Communities - Age Classes and Habitat Structural Stages

Forested Age Classes

Depending on forest management objectives, active timber harvest and burning can influence the age structure of the forest if management is extensive and changes a significant proportion of stands over a planning cycle.

This section examines the potential changes in age structure of the forest as a consequence of alternative management directions. This section focuses on the most abundant forest cover types. (Habitat structure stages are used to describe the ecological function of stands -- see following section for more details. Age classes are roughly equivalent to habitat structure stages with more precision at younger ages and with more divergence at older ages. Age as a descriptor of old growth is discussed in the following section on old growth.)

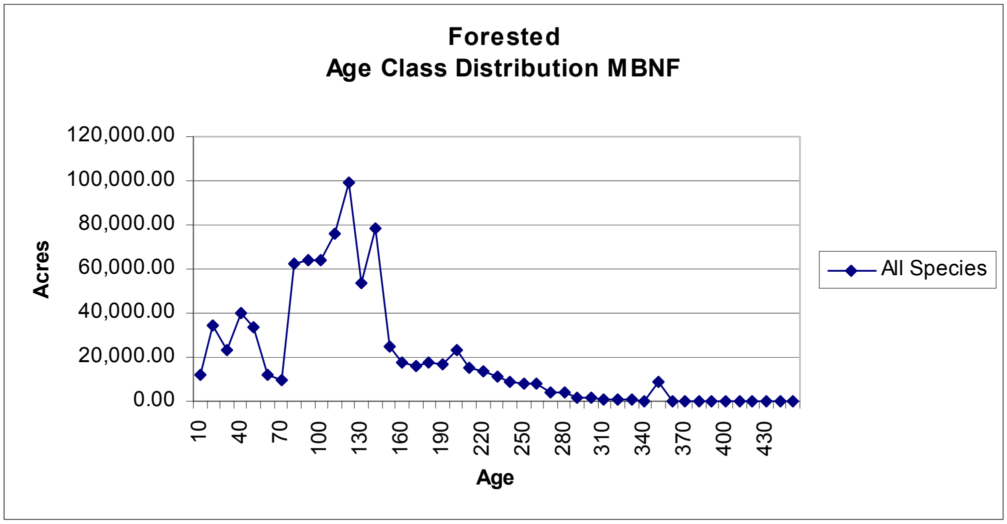
An age class is a distinct aggregation of trees originating from a single natural event or regeneration activity, or grouping of trees, e.g. 10-year age class, as used in inventory or management (Adams, J.D. Hodges et al. 1994). For classification purposes, forested stands change age classes every 10 years, irregardless of the size of the trees or the function of the stand (HSS). Not all forest cover types have the same potential for longevity.

Studies of high-elevation forests of Yellowstone National Park and elsewhere suggest that the proportion of young, middle-aged, and old forests has varied considerably during the last several centuries (Dillon, Knight et al. 2003). This shifting pattern over time is a consequence of the frequency and extent of large disturbance processes in relation to the rate of forest succession. Stand replacing wildfire and tree mortality from insects and disease in subalpine forests of the central Rocky Mountains tend to occur infrequently (return intervals often exceeding 100 or more years). Individual events, however, can kill overstory trees over large areas (many square miles). Under these conditions, the proportion of the forest in young age classes at any one time has varied depending on the time since a large disturbance event.

About 25-50% of the MBNF was harvested and burned in the late 1800s and early 1900s, creating the large number of 100-125 year-old stands that exist today. There is little information about stand age available from the late 1800s when harvesting and burning took place. The HRV report discusses stand age for the historical period (Dillon, Knight et al. 2003). A full range of age class structures from even-aged lodgepole pine to older uneven-aged spruce-fir stands existed in the past. At the stand level, that range is probably within the historic range of variability (Dillon, Knight et al. 2003). Middle-aged forests 50-150 years post regeneration appear to be more common than was the norm under historic disturbance regimes although the current condition would have been observed infrequently on the MBNF (Dillon, Knight et al. 2003).

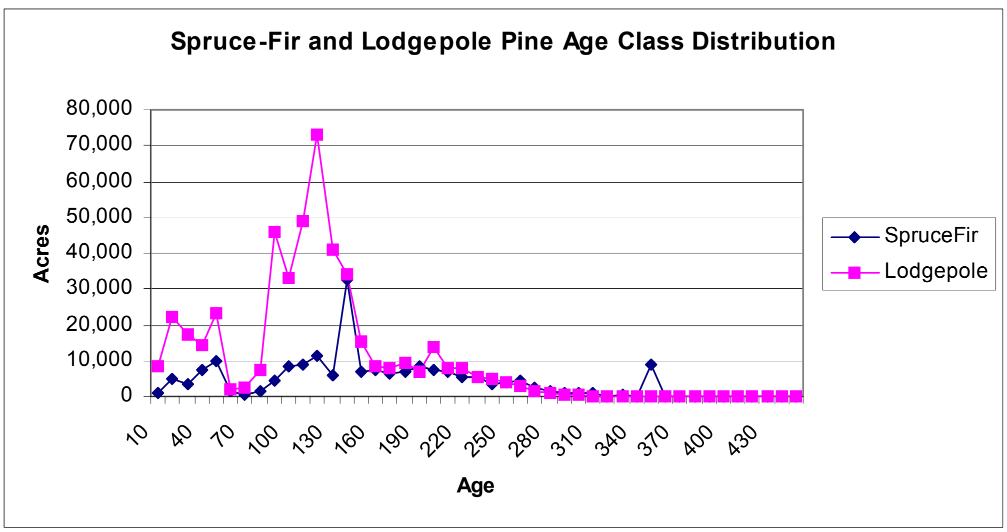
The following figures display the existing 10-year age class distribution of the MBNF for all species and for spruce/fir, lodgepole pine, ponderosa pine and aspen.

Figure D-1. Existing 10-year age classes for all forest species MBNF.



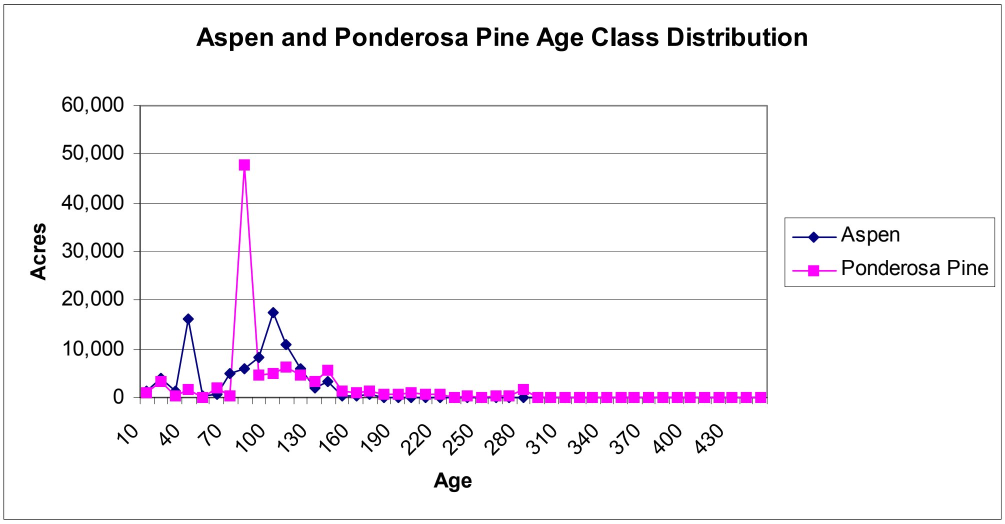
Source: MBNF RIS database

Figure D-2. Existing 10-year age classes for Spruce-Fir and Lodgepole pine.



Source: MBNF RIS database

Figure D-3. Existing 10-year age classes for Aspen and Ponderosa Pine.



Source: MBNF RIS database

The following table displays a summary of acres by age class and percent of the MBNF. The 50-year age classes are specifically displayed to allow comparison with Dillon *et al.* (Dillon, Knight et al. 2003).

Table D-13. Summary of age classes for all species as a percent of total forest cover.

0- 50 year age class	60-100 years age class	110-150 year age class	160 –200 year age class	> 200 year age classes
17%	24%	38%	11%	10%

Source: RIS database. Total Acres of forested NFS = 866,512

Table D-14. Summary of age classes as a percent of total forest cover by major cover type.

Cover Type	0- 50 year age class	60 - 100 year age class	110-150 year age class	160 - 200 year age class	Greater than 200 year age classes
Spruce-Fir	14%	8%	35%	19%	24%
Lodgepole Pine	18%	19%	45%	10%	8%
Ponderosa Pine	7%	62%	22%	5%	4%
Aspen	28%	44%	27%	1%	<1%

Source: RIS database. Total Acres of four cover types = 843,888. % is % of cover type.

Age classes between the 80-140 years are the most abundant. It also displays dramatic shifts between 50 and 80 years and between 140 and 150 years. This pattern appears to be coincident with the following three eras: 1-pre-tie hacking and fire, 2-tie hacking plus fire, and 3-Great Depression and World War II.

Forested Habitat Structural Stages

Forested ecosystem elements are modified through the interplay of succession and disturbance. Succession is an orderly process of biotic community development that involves changes in species, structure, and community processes with time. It is reasonably directional and, therefore, predictable (Schwarz, Thor et al. 1976). Forest stands develop recognizable stand structures over time that can be described in terms of the horizontal and vertical distribution of components including height, diameter, crown layers and stems of trees, shrubs, herbaceous understory, snags and down woody pieces (Thomas, Miller et al. 1979).

Different arrangements of these components provide different habitats for wildlife (DeVos and Mosby 1971; Edgerton and Thomas 1978). Hoover and Wills (Hoover 1987) identified combinations of these components as habitat structural stages (HSS). Characteristics for old growth, HSS 5 are further described by Mehl (Mehl 1992). These definitions were incorporated into the RMRIS database (USDA Forest Service 1998b). These definitions are based upon even-aged stands. There are no provisions for multiple canopy layers or numerous age classes within the same stand of trees (Hoover 1987). Habitat structure stages are used in the following discussion to represent the function of forest stands as forest structural elements.

Habitat structural stage definitions are incorporated into the RMRIS database and provide useful information on forest structure (USDA Forest Service 1998). The following table displays the description of the different habitat structure stages.

Table D-15 Habitat Structure Stage Descriptions.

Habitat Structure Stage	Code	DBH Range for Most Trees	Crown Cover %
Non vegetated	0	N/A	0
Grass Forb	1	Any	0 –10
Shrub – Seedling	2	< 1.5 inches	11 -100
Sapling – Pole	3a	> 1.5 inches	11 - 40
Sapling – Pole	3b	> 1.5 inches	41 - 70
Sapling – Pole	3c	> 1.5 inches	71-100
Mature	4a	> 9 inches	11 - 40
Mature	4b	> 9 inches	41 - 70
Mature	4c	> 9 inches	71 - 100
Old Growth Lodgepole Spruce/Fir Ponderosa Pine Aspen	5	 10 tpa >10 inches 10 tpa > 16 inches 10 tpa > 16 inches 20 tpa > 14 inches >50%	 > 1 canopy layer >1 canopy layer > 1 canopy layer > 1 canopy layer >50% cover

Source: R2 RMRIS data dictionary, Source: R2 RMRIS data dictionary,(Mehl 1992) N/A – not applicable

An understanding of the variation in structural patterns that would have occurred on the forest over time under native disturbance regimes is difficult to create because there is little available data on stand structure prior to timber harvest in the 1800's. For a landscape such as the subalpine forest of the MBNF, where there is a lack of fire history information, a proxy landscape and reference period can be used to evaluate current ecological conditions. The ecosystems of Yellowstone National Park (YNP) can serve as a proxy landscape because of the similarities in environmental conditions and climate, and because the park represents a large area relative to the extent of dominant disturbance processes. Because little timber harvest has occurred in YNP, recent conditions may serve as a reference period comparable to the pre-historic and historic past of the MBNF. (See Appendix B –Biological Diversity Analysis for detailed information.) For most of the Rocky Mountain region, the several hundred years prior to the arrival of European settlers in the mid to late nineteenth century provides such a benchmark period (Romme 2002).

Table D-16. Estimated landscape structure for subalpine forest of the MBNF for "Ordinary", "Extreme" and "Long Fire-free" Conditions.

Structural Stage on the Medicine Bow National Forest	% of the subalpine landscape during "ordinary" climatic conditions *	Maximum / minimum % of the landscape for several decades after "extreme" fire events **	Maximum / minimum % of the landscape towards the ends of very long fire-free periods ***
Grass/Forb+	5 - 15%	50% maximum	3% minimum
HSS 1 Est for CES-HSS	5 - 10%	--	5% minimum
Shrub/Seedling+	5 - 15%	50% maximum	3% minimum
HSS 2 Est. for CES-HSS	1 - 10%	--	3% minimum
Sapling/Pole (<40% crown cover)+	5 – 45%	50% maximum	3% minimum
HSS 3a Est. for CES-HSS	1 - 10%	--	5% minimum
Sapling/Pole (40-70% crown cover)+	15 - 45 %	50% maximum	5% minimum
HSS 3b Est. for CES-HSS	5 - 15%	--	5% minimum
Sapling/Pole (>40% crown cover)+	15 - 45 %	50% maximum	5% minimum
HSS 3c Est. for CES-HSS	15 - 25%	--	8% minimum
Trees >9" DBH (<40% crown cover) +	N/A ****	N/A ****	N/A ****
HSS 4a Est. for CES-HSS	5 - 15%	--	5% minimum
Trees >9" DBH (40-70% crown cover)+	15 - 50 %	15% minimum	50% maximum
HSS 4b Est. for CES-HSS	20 - 30%	--	22% minimum
Trees >9" DBH (>40% crown cover)+	15 - 50 %	15% minimum	50% maximum
HSS 4c Est. for CES-HSS	15 - 25%	--	22% minimum
Old Growth+	15 – 30 %	15% minimum	40% maximum
HSS 5 Est. for CES-HSS	30 - 40%	< 30-40%	50-60%

+Estimates are for a 250,000 acre subalpine landscape of lodgepole pine and spruce-fir.

**"Ordinary" climatic conditions are those that prevail most of the time (Romme 2002).*

*** "Extreme" fire events are exemplified by the 1988 fires in YNP or by the extensive fires that occurred in YNP in the early 1700s and 1860s) (Romme 2002).*

**** Very long fire-free periods have occurred naturally in high-elevation Rocky Mountain forest systems. "Fire-free" refers only to the absence of* large *fires. Fires still are ignited every year,* *but never grow to large size, probably because of wet weather conditions (Romme 2002). MBNF figures are based on weighted averages from representation of Lodgepole, Spruce-fir and aspen cover types for potential natural vegetation and habitat structure stage residence times.(See appendix B –Biological Diversity Analysis and Appendix D-Biological Diversity Report for details.)*

***** This type probably is controlled by edaphic conditions rather than disturbance, and occupies a more or less constant proportion of the landscape over time for YNP but may be more widespread on the MBNF.*

CES-HSS – Continuous, even supply of HSSs based on stand development over time from residence times in each HSS (See Appendix B and D for more details). Potentially a measure of central tendency (median) for the fluctuations represented in HRV. Such a pattern may have been rare over time under natural disturbance regimes. Based on concepts in Hall and Thomas (Hall and J.W. Thomas 1979) and (Davis 1966), (Davis and K. N. Johnson 1987).

[+ -] *From Romme (Romme 2002).*

Predictions were modeled after Romme (Romme 2002) and assume similar response to disturbance. See earlier discussion of critical assumptions and discussion of uncertainty in Composition section.

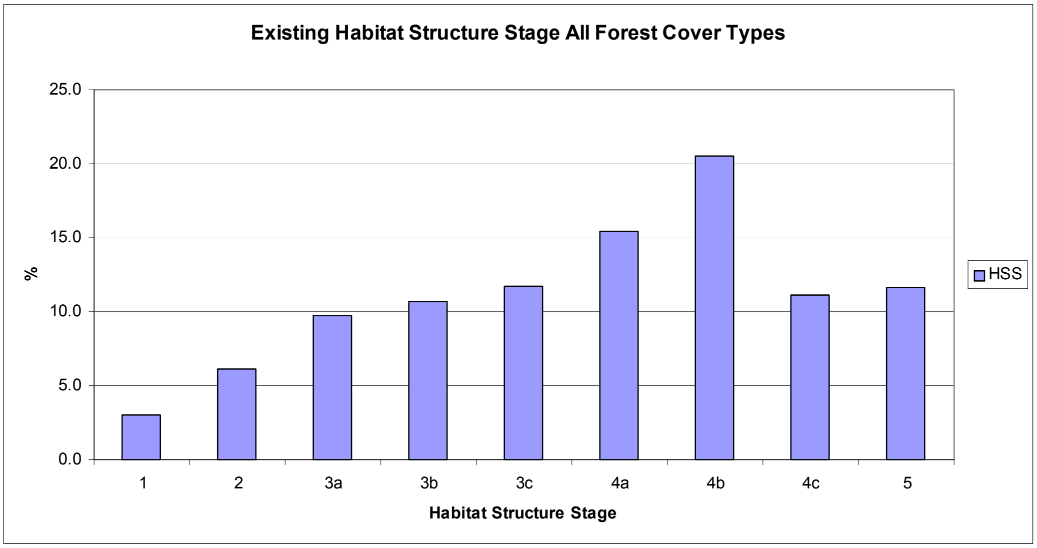
Current stand structure combined with knowledge of silvicultural practices of the last century and historical accounts of what timber products were removed from the forest can also provide assistance in understanding past stand structure. Until about 1950, selective or partial cutting in lodgepole pine or mixed conifer stands was the predominant form of timber harvest on the MBNF. Between the 1860s and the early 1900s, trees of 10-14 inches in diameter were removed for railroad ties. In some areas, this removed most or all of the trees in a stand while in other areas, large or old trees and/or small trees were left standing. The combined effect of tree removal and fires apparently led to the initiation of many new stands (Dillon, Knight et al. 2003). Riparian areas along most tie-driven streams were cleared of all trees as the ties were floated to their destination in floodwaters created when splash-dams were released to carry the trees downstream. After about 1950, clearcutting and timber removal by roads became more common.

In a natural forest, in this region, the number of trees in stands shortly after initiation ranges from less than one hundred mature trees per acre in open stands to over 15,000 trees per acre in dense stands of lodgepole pine. Ten years after the 1988 fires in Yellowstone, tree seedling density ranged from essentially no seedlings to extremely high densities, sometimes, exceeding 40,000 seedlings per acre (100 seedlings per square meter). Seedling and sapling density on the MBNF appears to be within the historic range of variability (Dillon, Knight et al. 2003).

Comparing historic forest conditions with current conditions suggests that current conditions on the MBNF are similar to those expected to commonly occur under natural disturbance patterns. However, a closer look at specific environmental settings suggests some cases where current conditions may reflect a pattern that was more rare in the past. In their analysis of current conditions Dillon *et al.* (Dillon, Knight et al. 2003) suggested that the extent of older forest in environments where few fires are expected (north and leeward slopes and valley bottoms) at high-elevation (>7,800 feet) is less than expected under natural disturbance patterns. Also, in high elevation forests, ecosystem characteristics that depend on periods of forest development longer than 140 years may be lost in some areas where harvest and fire have influenced extensive areas in the past 1.5 centuries (Dillon, Knight et al. 2003).

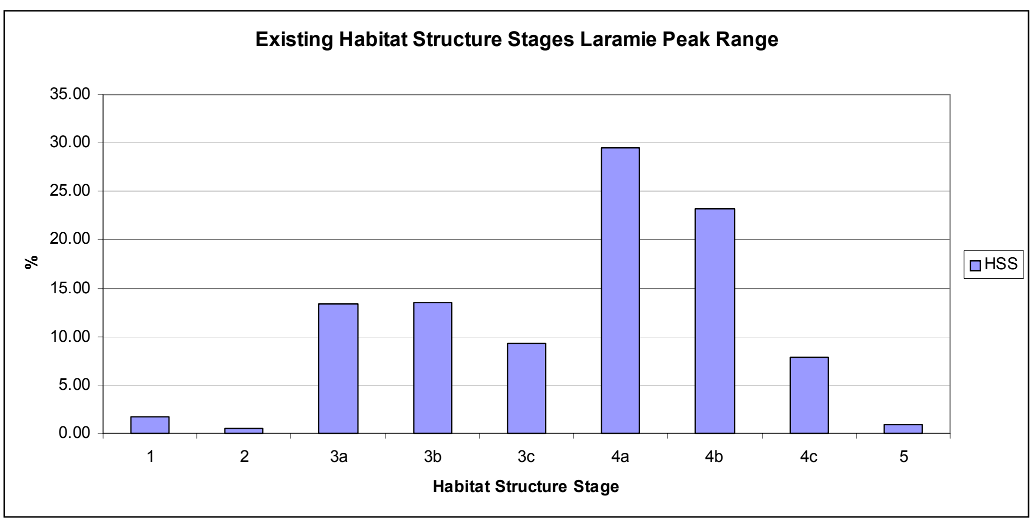
The following figure displays the existing habitat structure stages for the forested portion of the MBNF.

Figure D-4. Existing habitat structure stage distribution (% of Forested Acres) for the MBNF.



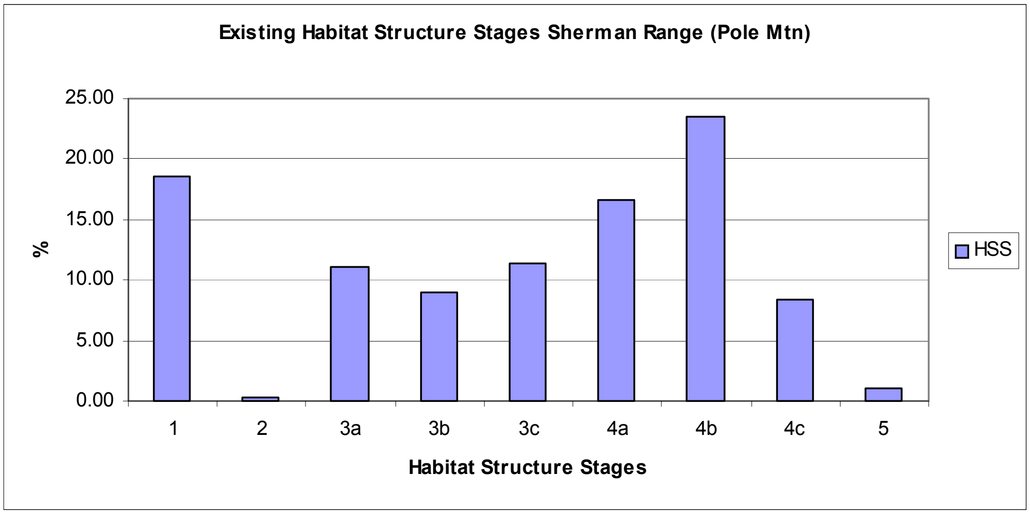
Source: RMRIS. 1-grass-forb, 2-shrub-seedling, 3a-low density sapling-pole, 3b medium density sapling-pole, 3c high density sapling-pole, 4a-low density mature, 4b-medium density mature, 4c high density mature, 5-old growth.

Figure D-5. Existing habitat structure stage distribution (% of Forested Acres) for Laramie Peak Range.



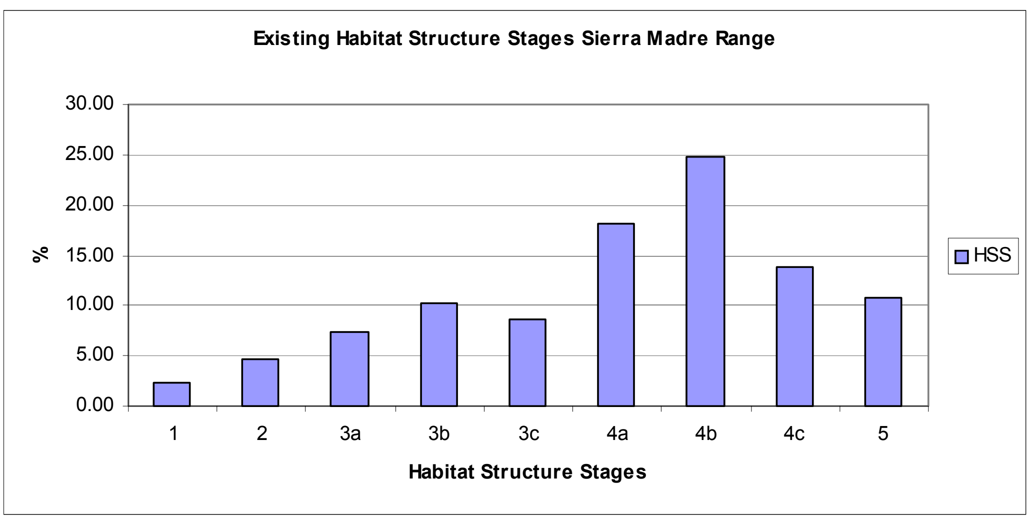
Source: RMRIS. 1-grass-forb, 2-shrub-seedling, 3a-low density sapling-pole, 3b medium density sapling-pole, 3c high density sapling-pole, 4a-low density mature, 4b-medium density mature, 4c high density mature, 5-old growth.

Figure D-6. Existing habitat structure stage distribution (% of Forested) for Sherman Range (Pole Mountain).



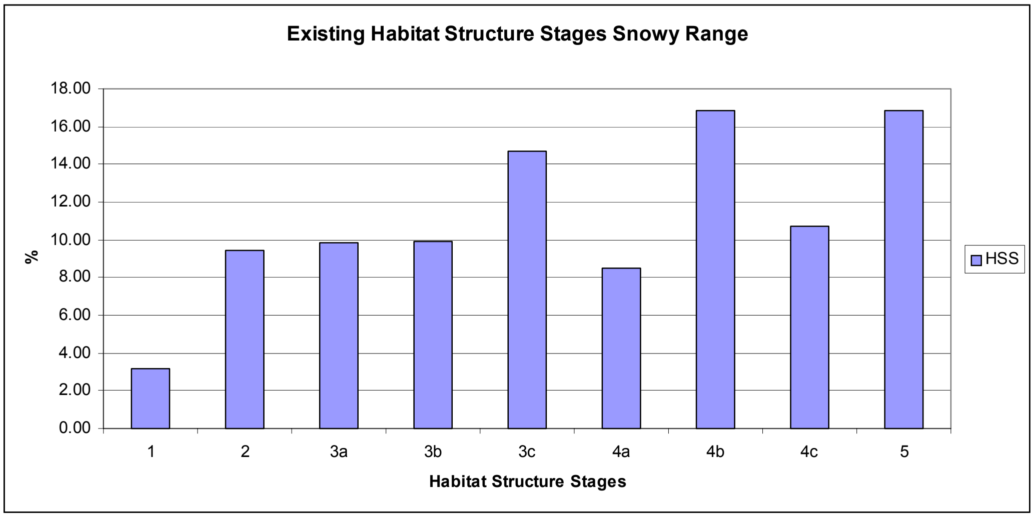
Source: RMRIS. 1-grass-forb, 2-shrub-seedling, 3a-low density sapling-pole, 3b medium density sapling-pole, 3c high density sapling-pole, 4a-low density mature, 4b-medium density mature, 4c high density mature, 5-old growth.

Figure D-7. Existing habitat structure stage distribution (% of Forested) for Sierra Madre Range.



Source: RMRIS. 1-grass-forb, 2-shrub-seedling, 3a-low density sapling-pole, 3b medium density sapling-pole, 3c high density sapling-pole, 4a-low density mature, 4b-medium density mature, 4c high density mature, 5-old growth

Figure D-8. Existing habitat structure stage distribution for Snowy Range.



Source: RMRIS. 1-grass-forb, 2-shrub-seedling, 3a-low density sapling-pole, 3b medium density sapling-pole, 3c high density sapling-pole, 4a-low density mature, 4b-medium density mature, 4c high density mature, 5-old growth.

Across the MBNF, approximately 9% of the forested area is in a grass or seedling stage (HSSs 1 and 2); 32% is in a sapling-pole stage (HSS 3a, 3b, and 3c); 47% is in a mature stage (HSS 4a, 4b, and 4c); and 12% is classified as old growth (HSS 5). There is more complete discussion of the classification of old growth in the following section.

The four mountain ranges exhibit a wide variation in distribution of habitat structure stages. The pattern for each mountain range reflects the different history of natural and human disturbances to forest stands.

Classifying non-forest stands in terms of horizontal and vertical cover is more difficult than classifying forest structure (Thomas, Miller et al. 1979). Non-forested vegetation on the MBNF has been assigned a habitat structure stage based the presence and size of any trees on the site or is classified as early successional stages (grass/forb, shrub/seedling).

The following table displays existing acres of each habitat structural stage for both the forested and non-forested stands of the MBNF.

Table D-17. Habitat structure stages by cover type.

	Acres in Habitat Structure Stage									
Cover Type	**0**	**1**	**2**	**3a**	**3b**	**3c**	**4a**	**4b**	**4c**	**5**
Aspen	0	3,168	1,896	15,809	17,245	8,003	14,822	13,427	5,009	4,307
Cottonwood	0	0	0	84	25	41	122	128	7	0
Douglas-fir	0	131	0	232	359	1,403	2,407	2,678	1,525	1,561
Gambel oak (tree)	0	0	0	0	43	0	0	0	0	0
Limber pine	0	54	270	5,870	759	200	2,896	1,160	177	246
Lodgepole pine	0	13,561	41,645	44,307	64,861	87,408	39,758	86,858	54,329	39,849
Ponderosa pine	0	4,284	446	2,685	2,985	976	43,250	32,197	7,046	2,080
Spruce/fir	0	4,766	8,899	15,260	6,270	3,854	30,579	41,537	28,037	52,493
Juniper	0	0	0	154	0	0	89	0	0	0
Total Forested	**0**	**25,964**	**53,157**	**84,401**	**92,546**	**101,885**	**133,924**	**177,985**	**96,132**	**100,537**
HSS as % of Total Forested	**0**	**3.0%**	**6.1%**	**9.7%**	**10.7%**	**11.8%**	**15.5%**	**20.5%**	**11.1%**	**11.6%**
HSS as % MBNF for Forested		**2.4%**	**4.9%**	**7.8%**	**8.5%**	**9.4%**	**12.3%**	**16.4%**	**8.9%**	**9.3%**
Total Non-forested	**10,593**	**76,551**	**130,537**	**2**	**2**	**72**	**250**	**35**	**36**	**4**
HSS as %MBNF for Non-Forested	**1.0%**	**7.1%**	**12.0%**	**<0.1%**	**<0.1%**	**<0.1%**	**<0.1%**	**<0.1%**	**<0.1%**	**<0.1%**
Total	**10,593**	**102,515**	**183,693**	**84,403**	**92,549**	**101,958**	**134,174**	**178,020**	**96,168**	**100,541**
HSS as % of Total	**1.0%**	**9.4%**	**16.9%**	**7.8%**	**8.5%**	**9.4%**	**12.4%**	**16.4%**	**8.9%**	**9.3%**

Source: MBNF RMRIS database and MBNF GIS

0 –non-vegetated, 1-grass-forb, 2-shrub-seedling, 3a-low density sapling-pole, 3b medium density sapling-pole, 3c high density sapling-pole, 4a-low density mature, 4b-medium density mature, 4c high density mature, 5-old growth.

Although alterations in structure have been more apparent in ponderosa pine than in other forest cover types, the majority of ponderosa pine on the MBNF is classified as mature, low density (HSS 4a). Very recent wildfires and continuing insect activity have reduced the total mature ponderosa pine and reduced the density of some stands from what is currently displayed in the RIS database.

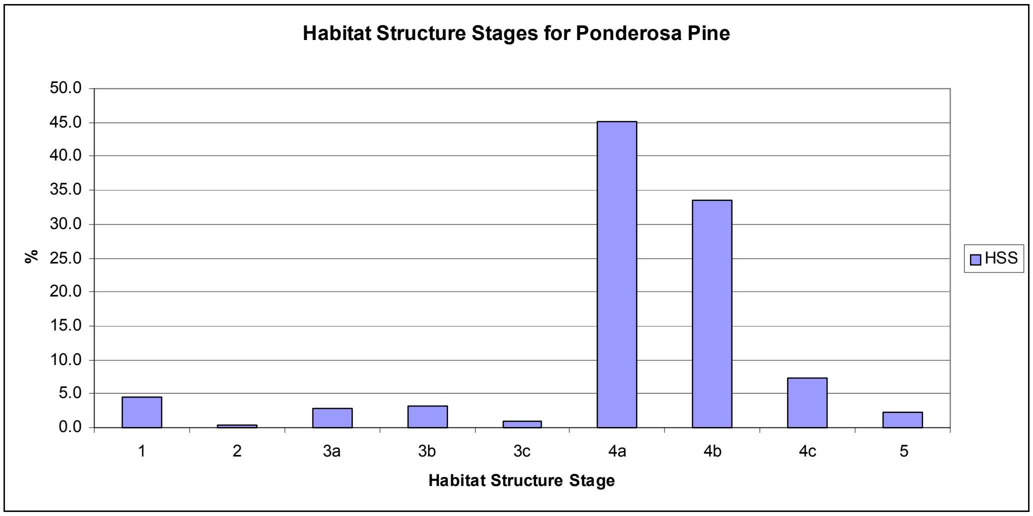
The Laramie Peak Range has 89% of the ponderosa pine that occurs on the MBNF. On the Laramie Peak Range, in ponderosa pine, an extensive mountain pine beetle epidemic occurred between 1988 and 1994. The Cold Spring Ecosystem Management Project (USDA FS Douglas Ranger District 1998) stated that there was extensive tree mortality on 7,500 acres due to that epidemic. The changes from this epidemic are reflected in the RIS data.

Also on the Laramie Peak Range, there are 16,194 acres of ponderosa pine within the perimeter of recent fires. Although the stand structure changes from these fires is not reflected in the RIS database, a sensitivity analysis of possible change verified that HSS distribution patterns remain nearly the same as distribution pattern derived from the RIS database. HSS 1 and HSS 4a would be expected to see slight increases. HSS 3b, HSS 3c, HSS 4b, HSS 4c and HSS 5 would be expected to slight decreases.

Some changes in stand structure may be expected in the Ponderosa pine system due to fire suppression. However Dillon *et al*. (Dillon, Knight et al. 2003) indicate that ponderosa pine in this area is subject to several different fire regimes and stands with dense multi-story structure may have occurred frequently under native fire regimes. Shinneman and Baker (Shinneman and W.L. Baker 1997) indicate that ponderosa pine forest can be subject to non-equilibrium dynamics and exhibit both open canopy structures and dense canopies under different fire regimes. Brown and Shepperd (Brown and W.D. Shepperd 2001) and Brown *et al.* (Brown, Ryan et al. 2000) discuss historic patterns of fire frequency for the Ashenfelder Basin area of the Laramie Peak Range and suggest that longer fire free intervals may have been common in this range than other areas studies within the Rocky Mountain region. The Biological Diversity Report (Appendix D) describes alterations in ponderosa pine communities on the MBNF.

The following figure displays the existing habitat structure stages for ponderosa pine of the MBNF.

Figure D-9. Existing habitat structure stage distribution for ponderosa pine forestwide.



Source: RMRIS. 1-grass-forb, 2-shrub-seedling, 3a-low density sapling-pole, 3b medium density sapling-pole, 3c high density sapling-pole, 4a-low density mature, 4b-medium density mature, 4c high density mature, 5-old growth.

Potential Natural Vegetation – Forested Habitat Structural Stages

The potential flow of habitat structure stages were predicted using the Forest Vegetation Simulator Central Rockies Variant (Dixon 2001), (Wycoff 1986), (Wycoff, Crookston et al. 1982), (Wycoff, Dixon et al. 1990), (Crookston 1985), (Crookston 1990), (Crookston and Stage 1999). The following table displays the information about the flow of habitat structure stages over time.

Table D-18 Flow of HSS over time

Residence Time Years					
Cover Type	**HSS1**	**HSS 2**	**HSS 3a-HSS 3c**	**HSS 4a-HSS 4c**	**HSS 5**
Aspen	10	10	60	40	40
Cottonwood	10	10	60	40	40
Douglas-fir	10	20	30	120	200
Gambel Oak Tree	10	30	90	N/A	70
Limber pine	10	30	60	100	500
Lodgepole pine	10	20	40	20	100
Ponderosa pine	10	10	30	120	150
Spruce / Fir	10	10	30	130	300
Juniper	10	30	60	100	500

Source: FVS modeling.

Non-forested Communities – Habitat Structural Stages

The structure of climax grass and/or forbs lands (in contrast to the grass, forb and/or shrub stages of forestlands) is relatively constant throughout different successional stages (Knight 1994). Most shrubs have average life spans of 30-60 years and develop from grass-forb early successional stages. Different shrub communities provide different types of structure and when intermixed across the landscape provide habitat diversity (Knight 1994).

Dillon *et al.* (Dillon, Knight et al. 2003) noted the following: some meadows, grasslands and shrublands were grazed more heavily in the early 1900s than previously, but current management practices appear to be creating conditions that are similar to those that would have been common under natural disturbance regimes. In some instances, changing climatic or edaphic conditions may now allow tree seedling establishment on areas that were historically occupied by meadows.

Habitat structure stages have not been defined for non-forest communities, however these communities do exhibit structural changes over time (see Vegetation –Rangelands for more information on non-forest vegetation). If there are trees present on sites dominated by non-forest vegetation, then the habitat structure stage assigned in the MBNF RMRIS database reflects the status of the tree structure and cover.

At a statewide level, sagebrush stands have become more uniform as they converge on a larger, denser, older structure (Cerovski, Gorges et al. 2001).

Potential Natural Vegetation - Nonforest Communities - Shrub and Grassland structure.

The following was noted by Dillon *et al.* (Dillon, Knight et al. 2003): Some meadows, grasslands and shrublands were grazed more heavily in the early 1900s than previously, but current management practices appear to be creating conditions that are within HRV. In some instances, changing climatic or edaphic conditions may now allow tree seedling establishment on areas that were historically occupied by meadows. Oak woodlands that occur on the west side of the Sierra Madre may now be more subject to juniper invasion because of fire suppression.

Old Growth Forests

Old growth forests are ecosystems distinguished by relatively complex physiognomy, horizontal heterogeneity, relatively large old trees and related structural attributes (Thomas, Ruggiero et al. 1988; Hayward 1991). Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics which may include tree size, accumulations of large dead woody material, number of tree top layers, species composition and ecosystem function. It can require 80-200 years for forest stands within different cover types to develop the characteristics of old growth (Mehl 1992).

Ecological processes that dominate in late successional and old growth forests can be found in a continuum in forest stands that have an increasing representation of senescence, high structural complexity in tree crowns and boles, high structural complexity in the forest floor, spatial diversity and the presence of complex energy pathways (Franklin and Fites-Kaufmann 1996), (Kaufmann, Moir et al. 1992). These features may develop sooner under certain disturbance patterns. Certain of these features may also develop sooner where there are other late successional forest patches nearby that provide structural input or inoculum (fungi, lichens etc.). Thus, it is not necessary for all characteristics of old growth to be present for an area to provide many of the ecological functions of old growth (Franklin 2002). Old growth is thought to be the preferred habitat for certain species (Buttery and B.C. Gillam 1987).

Since the 1985 Plan was approved, the definition of old growth has evolved. Forests in the Rocky Mountain Region have used generalized descriptions outlined by Mehl (Mehl 1992) to describe and inventory old growth after 1992 (Estill 1992).

Using the descriptions for old growth developed by Mehl (Mehl 1992) for spruce/fir, lodgepole pine, ponderosa pine and similar descriptions developed by Wier (Wier 1998) and Thorin (Thorin 1999) for species/cover types not described by Mehl (cottonwood, gambel oak and limber pine), old growth can be described in terms of the age of the largest trees, a minimum number of trees above a certain diameter (DBH) and canopy characteristics. The following table displays these three criteria of old growth by cover type:

Table D-19. Old growth description by cover types.

Cover Type	Age of Largest Trees	Diameter of largest trees	Crown Cover %
Lodgepole	150	10 tpa > 10 inches	≥ 1 canopy layer
Spruce-fir	200	10 tpa > 16 inches	>1 canopy layer
Ponderosa pine	200	10 tpa > 16 inches	≥ 1 canopy layer
Douglas-fir	200	10 tpa > 18 inches	≥ 1 canopy layer >50% cover
Aspen	100	20 tpa > 14 inches	≥ 1 canopy layer >50% cover
Cottonwood	100*	20 tpa > 14 inches	≥ 1 canopy layer >50% cover
Gambel oak	80*	30 tpa > 4 inches	
Limber pine	200*	10 tpa > 12 inches	
Juniper	200	30 tpa > 12 inches	> 35% canopy cover

*tpa = trees per acre. Sources (Mehl 1992), *(Wier 1998a) and (Thorin 1999).*

The current amount and condition of old growth on the MBNF is difficult to estimate because of changed old growth criteria between 1985 and the present. The MBNF does not have an inventory of old growth forest habitat based on the Mehl (Mehl 1992) descriptions, however the existing data can be used to provide an evaluation of existing old growth and effects to old growth. Baker (Baker 1994) used HSS 4a, HSS 4b, HSS 4c or HSS 5, a scorecard value greater than 37 or a year of origin prior to 1800 to analyze old growth and fragmentation.

There are three sources of information on old growth for the MBNF. They are discussed in detail in the following paragraphs. The information from these sources is stored in the RMRIS database.

1. Habitat structure stage –available for all forested stands;
2. Old growth scorecards – primarily available from project level inventory;
3. Stand age category of the RIS database – available where stand examinations have been completed.

The only old growth information that is available for the entire forested portion of the MBNF is habitat structure stage. Habitat structure stage is calculated from stand examinations (where available) or identified through photo interpretation. Definitions for old growth, HSS 5, have changed over time so it is likely that the acres identified in this category have not been inventoried using the same criteria. There are 100,541 acres of HSS 5, old growth, or 11.6% of the forested acres. HSS 5 data has a moderate level of certainty when predicting amount of old growth that meets the Mehl definition (Mehl 1992). Since several of the characteristics of old growth can be difficult to determine from photo interpretation, a portion of the stands that are classed as HSS 4a, 4b or 4c would be likely to qualify as old growth if inventoried.

Table D-20. Acres and % of Cover Type in HSS 4a-5 for the Four Major Forested Cover Types on the MBNF.

Cover Type	HSS 4a	HSS 4b	HSS 4c	HSS 5	Total
Spruce/Fir	30,579 15.9%	41,537 21.7%	28,037 14.6%	52,493 27.4	152,646 79.6%
Lodgepole Pine	39,758 8.4%	86,858 18.4%	54,329 11.5%	39,849 8.4%	220,794 46.7%
Ponderosa Pine	43,249 45.1%	32,197 33.6%	7,046 7.3	2,080 2.2	84,573 88.1%
Aspen	14,822 17.7%	13,427 16.0%	5,009 6.0%	4,307 5.2%	37,565 44.9%

Source: RIS database.

HSS 5 -old growth is not evenly distributed across the four mountain ranges that make up the forest. The following table displays the amount of HSS 5 on each mountain range.

Table D-21. Acres and % of Cover Type in Habitat Structure Stage 5 by Mountain Range on the MBNF.

Laramie Peak	Sherman (Pole Mtn)	Sierra Madre	Snowy Range
1,498 1.5%	213 0.2%	28,714 28.4%	70,540 16.8%

Source: RIS database.

The following table presents a comparison of habitat structure stages 4-5 for the SRE (Shinneman, McClellan et al. 2000) and habitat structure stages 4-5 for the MBNF for those cover types reported for the SRE.

Table D-22 SRE and MBNF Habitat Structure Stages 4 - 5 by Cover Type

	% in Habitat Structure Stage	
Cover Type	**SRE 4+5**	**MBNF 4+5**
Aspen	33%	45%
Douglas-fir	75%	79%
Lodgepole pine	47%	47%
Ponderosa pine	68%	88%
Spruce/fir	74%	80%
Total For Cover Types Listed	60%	59%

Source: Shinnenman et al. *2000; RMRIS*

Old growth scorecards were developed from old growth descriptions for the Pacific Northwest Region (USDA Forest Service Circa 1984). Old growth scorecards do not match the Mehl (Mehl 1992) definition of old growth precisely. Old growth scorecard inventories have not systematically covered the forested acres but have been primarily associated with project inventories in specific locations. There are 205,315 acres (23.7% of the forested acres) with an old growth score rating greater than or equal to 38. A score of 38 is a threshold based on definitions from the 1985 forest plan and amendments (USDA Forest Service 1989).

Table D-23. Acres and % of Total Forested Area with Scorecard Greater than or Equal to 38 by Mountain Range.

Laramie Peak	Sherman (Pole Mtn)	Sierra Madre	Snowy Range
13,604 6.6%	0 0%	85,398 41%	106,313 51.8%

Source: RIS database.

Old growth scorecard ratings have a moderate level of certainty when predicting amount of old growth that meets the Mehl (Mehl 1992) definition for spruce-fir cover types only. Old growth scorecard ratings have a low or very low level of certainty when predicting amount of old growth that meets the Mehl definition in other cover types (lodgepole pine, ponderosa pine, aspen, limber pine, gambel oak, juniper, cottonwood).

The age of the largest trees is a criteria in the Mehl (Mehl 1992) description of old growth. There is not currently an available method to extract just the age of the largest trees in a stand from the RMRIS database. Stand age in RMRIS is determined from stand inventory data and averages ages of a larger number of trees than would be used for the Mehl (Mehl 1992) definition. Stand inventories have also not systematically covered the forested acres.

The following table displays information on average stand age by cover type from the RMRIS database. In addition to the amount listed on this table, there may be more acres where the age of the largest trees is above the Mehl age but the stand age is less than Mehl. Stand age has a low to moderate certainty level when predicting amount of old growth that meets the Mehl definition (Mehl 1992).

From information on average stand age from stand origin date in the RIS database and from estimated ages from growth modeling where inventories are not complete, the information in the following table is available for cover types.

There are approximately 200,000 (23% of forested) acres that would generally meet the minimum age requirements of the Mehl old growth definition.

Table D-24. Amount of forest that meets or exceeds old growth age minimums.

Cover Type	Age of Largest Trees*	Acres where Average Stand Age is Greater than Mehl Age**	% of Cover Type
Lodgepole	150	98,845	20.9%
Spruce/Fir	200	53,790	28.1%
Ponderosa Pine	200	4,793	5.0%
Douglas-fir	200	1,403	13.6%
Aspen	100	40,947	48.9%
Cottonwood	100*	251	61.5%
Gambel Oak	80*	43	100.0%
Limber Pine	200*	130	1.1%
Juniper	200	0	0%
Total		200,203	23.1%

*From (Mehl 1992), *(Wier 1998a) and (Thorin 1999)** Age of largest trees is always greater than or equal to stand age*

Some of the forested acres discussed above are included in more than one, and sometimes all three of the different methods of estimating old growth. Based on the information from the three approaches to identifying old forest stands, between 10% and 60% of the forested acres on the MBNF represent old-growth forest as described by Mehl (Mehl 1992).

Late successional forest stands have some of the characteristics of old growth and provide many of the functions of old growth. Late successional forests can be considered to be represented by habitat structure stages 4 through 5 and/or older age classes.

Cover types of spruce/fir, lodgepole pine, limber pine, ponderosa pine, Douglas-fir, cottonwood, aspen and gambel oak were evaluated for late successional/old growth potential using all the available data, from the RIS database. The description of how the data were processed to identify those acres that have indicators of late successional forest and/or old growth is shown in the following table.

Table D-25. Description of Available Indicators of Late Successional and/or Old Growth Forest

HSS	Old Growth Score Card	Age from Average of Trees > 5" dbh	Available Indicator Level
4A-4C	Not available or < 38	Not available or < Mehl*	1
5	Not available or <38	Not available < Mehl*	2
4A-5	Not available or < 38	≥Mehl* definition	3
4A-5	≥38	Not Available or < Mehl* definition	4
4A-5	≥38	≥Mehl definition	5
<4A	Not available	Not available	Not Late Successional/Old Growth
<4A	Not available or < 38	≥Mehl* Definition	Not Late Successional/Old Growth
<4A	≥38	Not available or <Mehl* definition	4
<4A	≥38	≥Mehl* definition	5

**From (Mehl 1992); For species not covered by Mehl (Mehl 1992) from (Wier 1998), (Thorin 1999).*

The following table displays the summary of acres of late successional and old growth by available indicator level, for each mountain range.

Table D-26. Acres of Late Successional and Old Growth Forest by Level of Available Indicators

Mountain Range	Total Acres Forest Cover Types	1	2	3	4	5	Total Acres 1-5
Laramie Peak	163,587	66,456	142	4,269	12,584	1,664	85,114
Sherman Mtn	20,051	9,452	82	396	0	0	9,930
Sierra Madre	267,163	80,904	6,677	16,887	68,748	16,651	189,866
Snowy Range	410,229	67,572	8,872	47,298	62,978	42,692	229,411
Grand Total	**866,532**	**225,731**	**15,773**	**68,919**	**144,309**	**61,006**	**515,738**

There are **403,967** acres out of the total of **515,738** (78.3%) that have field verification of habitat structure stage or old growth score card rating greater than 20 (= Mehl (Mehl 1992) definition). The remaining 111,771 acres have only photo interpretation data available for determination of habitat structure stage. There are 575,831 acres over 100 years of age and 110,883 acres over 200 years of age.

The following maps display the location of Late Successional /Old Growth for the MBNF. The maps also illustrate the variety of patch sizes and shapes and the distribution of old-growth forest.

Although the maps indicate that the Snowy Range and Sierra Madre Mountains appear to have the majority of the old growth while the Laramie Mountains have very little, and Sherman (Pole) Mountain appears to have almost none, this is more reflective of inventory status than of old growth status. The maps do not display the cover type of the polygons. The major cover-types are not evenly distributed across the four mountain ranges that make up the forest. The western Sierra Madre Range has a high concentration of aspen and Laramie Peak Range has a high concentration of ponderosa pine. (See previous discussion on composition by mountain range for details.)

Map D-4 Late successional/old growth for Sierra Madre and Snowy Range

Map D-5 Late successional/old growth for Sherman Mountains (Pole Mtn) and Laramie Peak Range

Potential Natural Vegetation - Late Successional/Old Growth

An analysis of a continuous, even supply of habitat structure stages (CES-HSS) including old growth was completed based on old growth as described by Mehl (Mehl 1992). Although old growth could exist across the landscape at higher levels, it would do so for limited periods of time. A continuous even supply of HSS including old growth probably represents a measure of central tendency for the variability included in HRV.

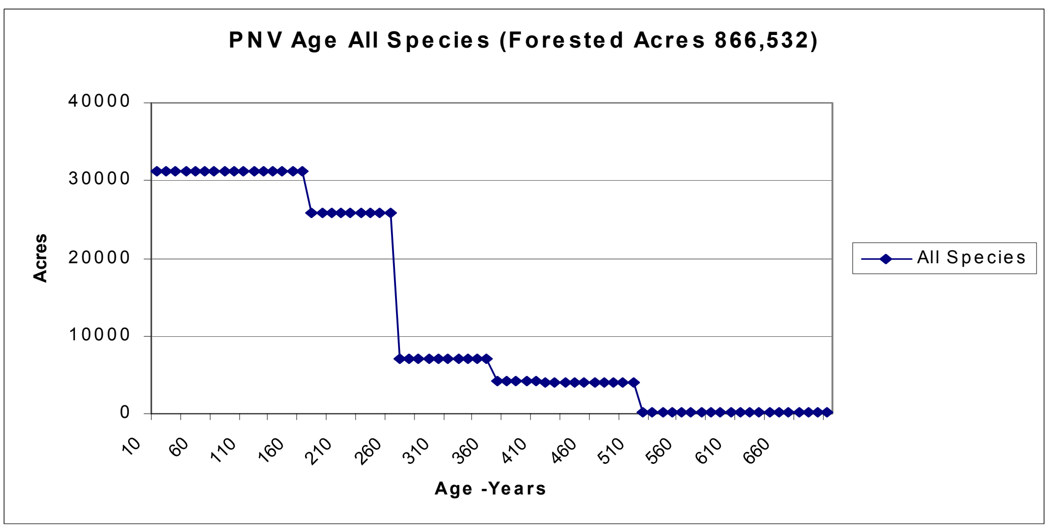
Table D-27 PNV Continuous Even Supply of Old Growth

Cover Type	Age for Old Growth Character	Observed Maximum Age for Cover Type	% of Cover Type Sustainable in Old Growth*	% of Cover type Sustainable in LSOG
Lodgepole pine	150	250	≤ 40	≤ 56
Spruce/fir	200	500	≤ 60	≤ 76
Ponderosa pine	200	350	≤ 43	≤ 77
Aspen	100	160	≤ 25	≤ 50
Total for Listed Types			≤ 43	≤ 62

Source: (Mehl 1992).LSOG – Late successional and old growth.

The PNV age structure of the forest from HSS modeling is displayed in the following figure. These were developed with the same assumptions used for development of PNV covertypes.

Figure D-10 PNV age structure for all species on forest land.



The summary of PNV acres, by age class and percent of the MBNF, is displayed in the following table.

Table D-28 PNV Age Structure of MBNF

0-20	21-100	101-200	200+
62,327	249,308	290,611	264,285
7.2%	28.8%	33.5%	30.5%

Based on total = 866,532 acres

Figure D-11 PNV age structure for Lodgepole pine cover type.

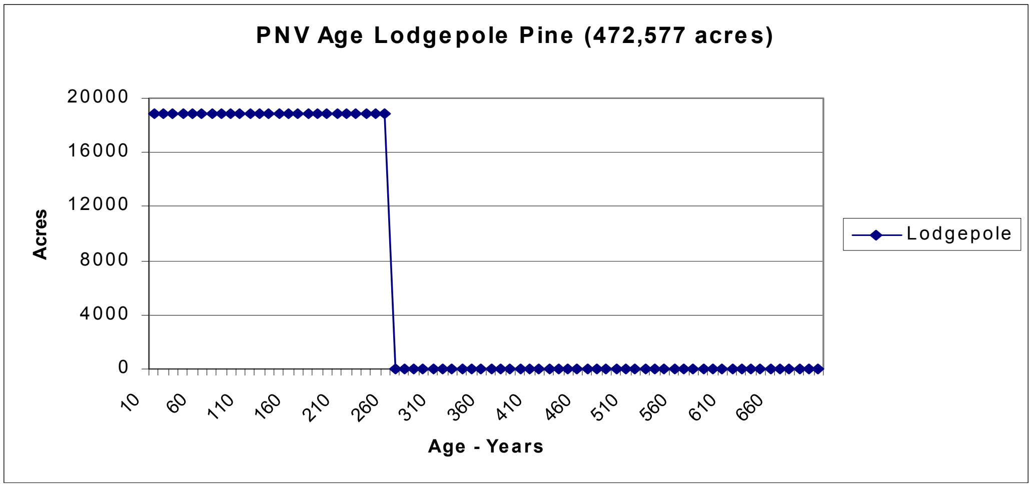


Figure D-12 PNV age structure for Ponderosa pine cover type.

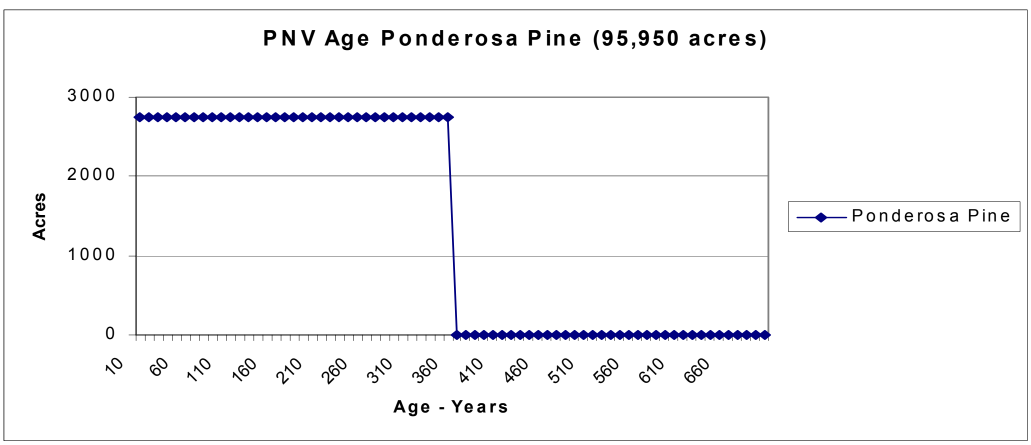
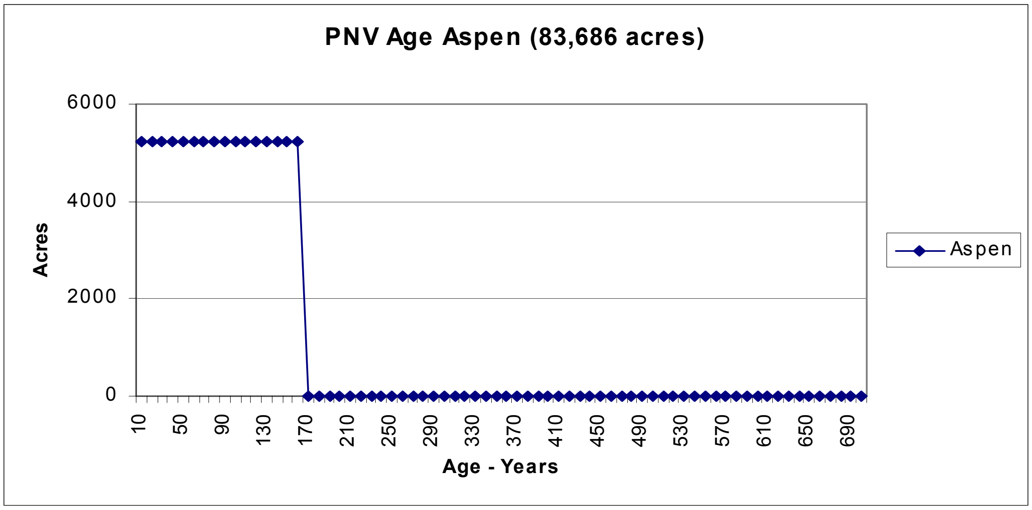


Figure D-13 PNV age structure for Aspen cover type.



Fragmentation

Rocky Mountain forests are naturally patchy – forest is broken into patches of various sizes as a consequence of topography, soil conditions, disturbance from a variety of agents, and environmental history. Patterns of fragmentation stem, in part, from long-term changes in regional flora; current forests are island remnants of late Pleistocene forests that were more widespread 20,000-10,000 years ago (Knight and Reiners 2000). Patterns in Rocky Mountain forests are particularly influenced by large, episodic disturbances, especially fire (Buskirk, W.H. Romme et al. 2000). Forest management activities that occur within these forests can create additional patterns of mature forest interspersed with areas of forest renewal (Smith 2000).

Forest fragmentation is described as a broad-scale process in which forest tracts are progressively subdivided into smaller, geometrically more complex (initially but not necessarily ultimately), and more isolated forest fragments as a result of both natural processes and human land use activities (Harris 1984). Fragmentation is also described as a disruption in the continuity of predominantly natural landscapes (Buskirk, W.H. Romme et al. 2000). Much of the research on fragmentation has focused on changes caused by agriculture or urban development, which are long-term or permanent in nature (Wiens J.A. 1995) Furthermore, this research has concentrated on landscapes where focal habitat patches are isolated in a matrix of disturbed lands. This pattern contrasts with the pattern most often observed as a consequence of management in many Rocky Mountain Forests (Wiens J.A. 1995). In contrast, most habitat alterations from timber harvests, other forest management activities are relatively temporary (Knight and Reiners 2000). Natural disturbance processes can result in short term and/or long term changes (Knight 1994).

Patch size and isolation, road effects and edge/interior are key indicators of fragmentation (Shinneman and W.L. Baker 2000). Several reports provide information on the HRV of patch sizes on the MBNF and the implications of those patch size changes:

- Patch size is decreasing and there is less interior forest (Dillon, Knight et al. 2003).

- Patches are more uniform in size (Dillon, Knight et al. 2003).
- The amount of high-contrast edge is increased in high-elevation forest because of roads and clearcutting (Dillon, Knight et al. 2003).
- Stands have been fragmented by roads, trails, and clearcuts (Cerovski, Gorges et al. 2001).
- Fire suppression has altered the structure and the patchiness of sagebrush and of associated species of plants, insects, and birds (Paige and Ritter 1999).
- The amount of timber harvesting is a significant source of variation in landscape structure across the MBNF (Baker 1994), (Tinker and Baker 2000).

Vegetation Patches

Patch size can be attributed to both human-caused activities such as timber harvesting and road building, or natural disturbances such as fire, insects, and disease. Approximately 130,000 acres have been harvested in the last 50 years on the MBNF. Harvest patches occur in a variety of sizes and shapes including narrow strips, which were cut in the 1950s and 1960s and more recent cuts which attempt to emulate natural disturbance patterns. Most of these harvest areas are smaller than 40 acres in size.

Natural patches on the landscape can occur in many sizes and shapes. Certain vegetation patches are controlled in size and location by related to topographical features such as avalanche paths, steep slopes, soil conditions, rock outcrops, meadows, wetlands, streams, and lakes. Across the forested areas vegetation patch sizes are more generally the result of natural disturbance processes that influence forest structure patterns. Wildfires that burn under extreme conditions result in large patch sizes, sometimes reaching thousands of acres (Romme 1982), (Rothermel, Hartford et al. 1994), (Turner, Romme et al. 1994). Turner *et al.* (Turner, Romme et al. 1997) and Turner *et al.* (Turner, Romme et al. 1994) document large patches of about 9,000 acres (3600 ha) that were created by the Yellowstone Fires of 1988. However, even in these cases, patches tend to support heterogeneous vegetation structure and the resulting forest is not uniform across the disturbance site.

Since the turn of the century, wildfire suppression may have limited the occurrence of these large-scale fires. Recent drought conditions have resulted in several large fires on the Laramie Peak Range.

The type of disturbance can influence the type of edge associated with each patch. Wildfires and regeneration timber harvest generally create high contrast edges. However, where two or more canopy layers exist in a stand, a disturbance event could create a low contrast edge. Low contrast edges are more frequently associated with natural disturbance agents such as insects and disease mortality over long time periods at slow rates (Dodge 2002).

The potential for different forest cover types to occur in various size patches within the ecosystems of the MBNF is shown in the following table.

Table D-29. Potential of wildfire, insects and diseases to create patches of various sizes by major cover types.

Forest Cover Type	Very Small Patches 0.25 - 5 acres	Small Patches 6 - 20 acres	Medium Patches 20 - 100 acres	Large Patches 100 – 1000 acres	Very Large Patches 1000+ acres
Lodgepole	X	X	X	X	X
Spruce - Fir	X	X	X	X	X
Aspen	X	X	X	X	X
Ponderosa Pine	X	X	X	X	
Douglas-fir	X	X	X		
Limber Pine	X	X	X		

Source: (Knight 1994; Schmid and Mata 1996; Veblen, Kitzberger et al. 2000b).

To quantify current patterns of forest patchiness, we analyzed forest pattern on the MBNF. The analysis of existing patch sizes and shapes was conducted using the FRAGSTATS computer model. The FRAGSTATS model was developed to quantify spatial patterns across the landscape (McGarigal and Marks 1995a). Existing spatial patterns including patch size and core size for 42 structural elements (combination of cover type and habitat structure stage) were determined using FRAGSTATS. Edge effects were modeled using similar procedures to those in Baker (Baker 1994), Baker (Baker 2000) and Baker and Knight (Baker and Knight 2000).

For each cover type on the MBNF, similar habitat structure stages (HSS) were grouped into habitat functional types (HFT). These grouping were made such that the any stand within the group would not modify the ecological functions of any of the other stand within the group.

The following HFTs based upon groupings of cover types and HSSs have been defined as ecologically meaningful for the MBNF:

- Grasses, forbs, rushes and sedges were grouped into HFT grass;
- Non-vegetated lands excluding rock were grouped into HFT non-vegetation;
- Rock outcrops and boulder fields as HFT rock;
- All shrub cover types were grouped into HFT shrubs;
- Limber pine and juniper were grouped into HFT for conifer woodlands;
- Cottonwood and gambel oak were grouped into HFT of other hardwoods.

For each major forest cover type (lodgepole, spruce/fir, aspen, ponderosa pine): a series of habitat functional types would be

- HSS 1 and 2 would be grouped into HFT early seral
- HSS 3a would stand as HFT mid-seral low density.
- HSS 3b and 3c would be grouped into HFT midseral medium-high density
- HSS 4a would stand as HFT late seral low density.
- HSS 4b, 4c and 5 would be grouped into HFT late seral medium-high density.

This grouping is similar to that followed by other R2 forests to examine this same question and following process documentation in Hessburg *et al.* (Hessburg, Smith et al. 2000). For the MBNF there were a total of 42 HFTs including one for roads. Each edge created between HFT was given an edge effect value of 0, 30, 60, or 90 meters based upon the similarity of the two HFTs with those of greater dis-similarity receiving greater values.

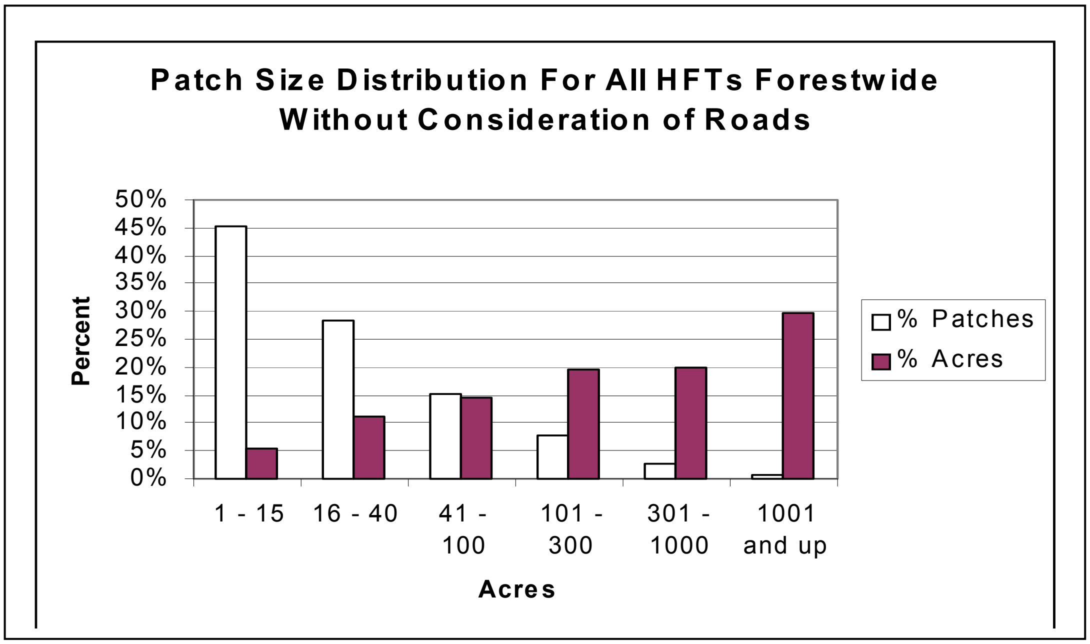
Existing Patch Sizes and Distribution

The existing distribution of patch sizes is displayed in the following two figures. These figures are based on all HFTs Forestwide. Summaries by HFT and by mountain range are found in the following discussion.

The resulting distribution is typical of the Rocky Mountain Region (USDA FS Routt National Forest 1998), (USDA FS White River National Forest 2002). There is a greater percentage of small patches, but they comprise a relatively small amount of acres. Conversely, there are very few large patches, but they comprise the most acres.

The existing distribution of patch sizes for all HFTs forestwide without consideration of roads as fragmenting elements is displayed in the following figure.

Figure D-14. Patch size distribution for all HFTs Forestwide without consideration of roads.



The largest patches (without consideration of roads) by mountain range from FRAGSTATS analysis are 29,356 acres (11,880 ha) of high density late seral spruce-fir on the Snowy Range; 20,811 acres (8,422 ha) of high density late seral spruce-fir on the Sierra Madre, 2,832 acres (1,146 ha) of high density late seral ponderosa pine on Laramie Peak Range and 5,906 acres of grass/forb as the largest patch and 613 acres (248 ha) of high density midseral lodgepole pine as the largest forest patch on Sherman (Pole) Mountain. These largest patches were most likely the result of wildfire (whether human ignited or natural ignition is unknown). The size of the largest patches is consistent with large patch sizes for Yellowstone. Turner *et al.* (1997) and Turner *et al.* (1994) document large patches of about 9,000 acres (3600 ha) that were created by the Yellowstone Fires of 1988.

Roads, trails and developed sites interrupt the continuity of the forest canopy and of the forest floor. For some species, the habitat provided in the forest near the roads is different that provided away from roads. Some wildlife and some ecological functions are more sensitive to the presence of roads while others are not.

The following table displays the existing acres adjacent to roads, trails and developed sites.

Table D-30. Amount of the MBNF within a specified distance of Level 2, 3, 4 and 5 Roads.

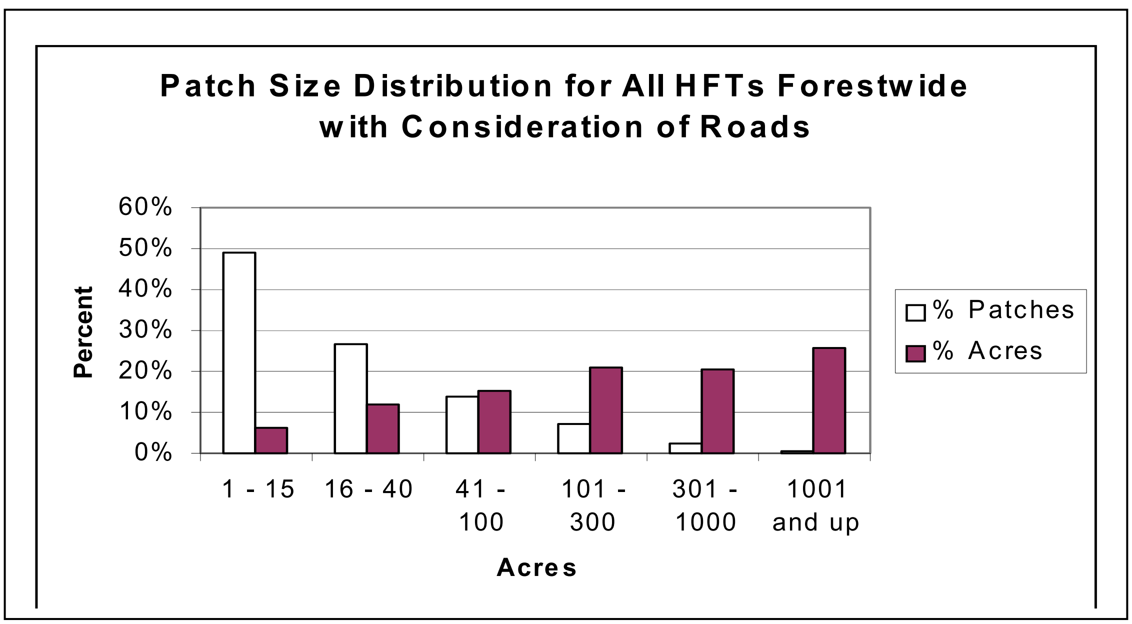
Area	Acres Within 150 feet (50 M)	% Within 150 feet (50 M)	Acres Within 300 feet (100 M)	% Within 300 feet (100 M)	Acres Within 2 Miles (32 KM)	% Within 2 Miles (32 KM)
MBNF	92,739	8.5%	175,863	16.2%	1,061,739	97.9%
Laramie Peak	6,622	3.7%	13,026	7.2%	176,968	98.1%
Sherman Mtns.	8,367	15.1%	15,558	28.0%	55,192	99.3%
Snowy Range	53,585	10.5%	100,994	19.7%	499,866	97.5%
Sierra Madre	24,165	7.2%	46,285	13.8%	329,713	98.0%

Source: MBNF GIS.

Shinneman et al (Shinneman, McClellan et al. 2000)using data supplied by the MBNF indicate the areas immediately adjacent to roads are more likely impacted by road edge-effect, such as changes in microclimate and plant communities, invasion by weedy species, and are more readily accessible habitat by humans. This data also indicates how little of the Sierra Madre and Snowy Range is within large, roadless, interior habitat conditions that some native species require. For instance, for the Sierra Madre and Snowy Range there are only 21 road-interior patches larger than 5,000 acres and the largest is only 48,127 acres.

The existing distribution of patch sizes for all HFTs forestwide with consideration of roads as fragmenting elements is displayed in the following figure.

Figure D-15 Patch size distribution for all HFTs Forestwide with consideration of roads.



The largest patches (with consideration of roads) by mountain range from FRAGSTATS analysis are 26,242 acres (10,620 ha) of high density late seral spruce-fir on the Snowy Range; 20,571 acres (8,325 ha) of high density late seral spruce-fir on the Sierra Madre, 2,831 acres (1,146 ha) of high density late seral ponderosa pine on Laramie Peak Range and 5,659 acres of grass/forb as the largest patch and 613 acres (248 ha) of high density midseral lodgepole pine as the largest forest patch on Sherman (Pole) Mountain.

Where dissimilar HFTs occur adjacent to each, there is an influence of each HFT upon the other. The influence of this edge environment extends some distance into each of the HFTs that adjoin. This depth of edge influence may leave a core area within each patch beyond the edge influence zone (Baker 2000). Core areas or interior forest habitat represent an important component of the landscape. Cores were calculated using a 0, 30, 60 or 90 meter edge factor which varied based on the adjacency of HFTs.

Without the influence of roads:

- The total core area of the Snowy Range is 21.5% with lodgepole late seral core area at 11.9% and spruce/fir late seral core area at 8.9% of the landscape (total acres analyzed for the Snowy Range = 532,455).
- The Sierra Madre Range total core area is 23.7% with lodgepole late seral core area at 13.4% and spruce/fir late seral core area at 14.3% of the landscape (total acres analyzed for the Sierra Madre Mountain Range = 362,205).
- Laramie Peak Range total core area is 12.6% of the landscape (total acres analyzed for the Laramie Peak Range = 437,759) and is 14.8% of the landscape for the late seral ponderosa pine, the dominant cover type.
- Sherman Mountain Range (Pole Mountain) total core area is 27.5% of the landscape (total acres analyzed for the Sherman Mountain Range = 55,577) and is 5.2% of the landscape for ponderosa pine late seral, the dominant forest cover type.

With the influence of roads included:

- The Snowy Range total core area is 20.5% of the landscape with lodgepole late seral core area at 11.2% and spruce/fir late seral core area at 8.5% of the landscape (total acres analyzed for the Snowy Range = 532,455).
- The Sierra Madre Range total core area is 22.6% with lodgepole late seral core area at 12.5% and spruce/fir late seral core area at 14.0% of the landscape (total acres analyzed for the Sierra Madre Mountain Range = 362,205).
- Laramie Peak Range total core area is 12.6% of the landscape (total acres analyzed for the Laramie Peak Range = 437,759) and is 14.7% of the landscape for the late seral ponderosa pine, the dominant cover type.
- Sherman Mountain Range (Pole Mountain) total core area is 26.3% and is 4.9% of the landscape (total acres analyzed for the Sherman Mountain Range = 55,577) for ponderosa pine late seral, the dominant forest cover type.

Landscape metrics that were used to quantify landscape structure are presented in the following tables. These metrics provide information about the connectivity and/or fragmentation of patches within a landscape. The abundance, productivity and diversity of organisms are integrally linked to the characteristics of their ecosystems. The dispersal and migration of animals is often linked to availability of suitable habitat for those activities. There is also information on this analysis process in Appendix B – Biological Diversity Analysis.

The **mean patch size** is the sum, across all patches of this type divided by the number of patches of the same type. Since there are generally more small patches than large patches and since this information is based upon the number of patches, this statistic best presents information about the smaller patches in the landscape. The **weighted mean patch size** is the sum, across all patches of this type multiplied by the proportional abundance of the patch. This statistic best presents information about the larger patches in the landscape. The **size range** is the largest observed value minus the smallest observed value. This statistic presents information about the spread of the data.

The **total length of edge** for each patch is displayed in the column titled "Total Edge." **Landscape shape index** presents information about the complexity of the patch shapes. The most simple shape (a square) is represented by a LSI of 1. Shapes with more complexity are represented with increasing numbers. A patch with an LSI of 34 is more complex than a patch with an LSI of 11.

The edge between two different patches was assigned a distance value prior to analysis with FRAGSTATS (see earlier discussion of HFTs and Appendix B for details). Similar type patches had low edge values and dissimilar patches had higher edge values. The core of each patch is computed based upon the edge value assigned for each adjacent patch. The **mean core area** best presents information about the smaller patches in the landscape while the **weighted mean core area** best presents information about the larger patches in the landscape. The **core range** is the largest observed value minus the smallest observed value.

Fragmentation and/or connectivity of habitats may be different for those species that are sensitive to the presence of roads than for those species that are not sensitive to the presence of roads. Therefore, the landscapes (mountain ranges) of the MBNF were analyzed both with and without roads as fragmenting features. For the analysis with roads as fragmenting features, roads were assigned a 30-meter pixel width and an edge value for their position to adjacent patches. Similar to the assignment of edge values for different patches, edge values were greater where roads were adjacent to dissimilar patches and smaller where roads were adjacent to similar patches.

The following tables present information on existing landscape metrics by mountain range for the MBNF for the HFTs within the four major cover types (lodgepole pine, spruce/fir, ponderosa pine and aspen). There are 13 different statistics presented for each HFT displayed.

Each HFT occupies a certain percentage of the landscape analyzed. The landscape refers to the total National Forest System Acres for each mountain range. The column headed "% Landscape" displays the information about how much of the landscape a particular patch type occupies. The number of patches for the landscape is also displayed.

The patch type is label assigned to the patches prior to analysis. The labels and their significance are:

- LPLS – lodgepole late seral
- LPES – lodgepole early seral
- SFLS – spruce/fir late seral
- SFES – spruce/fir early seral
- PPLS – ponderosa pine late seral
- PPES – ponderosa pine early seral
- AALS – aspen late seral
- AAEA aspen early seral

Table D-31. Patch Size and Core Area Without Consideration of Roads as a Fragmentation Element by Mountain Range for HFTs within Major Cover Types

Mtn Range	Patch Type	Total Patch Type Acres	% Land-scape	# Patches	Mean Patch Size Acres	Area Wtd. Mean Patch Size Acs	Size Range Acres*	Total Edge Miles	LSI	Total Core Area Acres	Core % of Land-scape	Mean Core Size Acres	Area Wtd Mean Core Area Acres	Core Size Range Acres
Laramie	LPLS	14,444	3.3%	259	56	298	1,062	509	21.7	9,342	2.1%	36	246	1,041
Peak	LPES	374	0.1%	18	21	43	89	21	7.3	81		4	8	23
437,795	SFLS	1,888	0.4%	50	38	176	496	81	11.4	1,072	0.2%	24	149	475
acres	SFES	18	<0.1%	3	6	8	8	1	2.2	2		<1	1	2
	PPLS	77,018	17.6%	765	101	873	2,833	1,786	34.0	64,629	14.8%	84	799	2,742
	PPES	2,858	0.7%	51	56	220	398	83	11.8	1,391		27	131	304
	AALS	844	0.2%	56	15	25	58	64	11.6	419	0.1%	7	13	36
	AAES	127	<0.1%	7	18	27	32	8	4.9	31		4	7	15
Sherman	LPLS	2,210	4.0%	66	33	98	303	118	12.8	421	0.7%	6	20	54
Pole	LPES	1,120	2.0%	13	86	290	465	40	7.6	910		70	251	413
Mtn	SFLS	20	<0.1%	2	10	15	15	1	2	1	<0.1%	<1	1	1
55,575	SFES	0	0	0	0	0	0	0	--	0		0	0	0
acres	PPLS	6,298	11.3%	85	74	218	556	215	12.4	2,894	5.2%	34	120	323
	PPES	1,853	3.3%	31	60	166	396	71	10.8	1,458		47	127	335
	AALS	585	1.1%	29	20	42	93	44	8.3	112	0.2%	4	7	28
	AAES	799	1.4%	37	22	47	102	64	14.3	604		16	37	81

**% of Landscape -% of NFS acres for Mountain Range*

**Mean – the sum, across all patches of this type divided by the number of patches of the same type.*

**Area weighted mean – the sum, across all patches of this type multiplied by the proportional abundance of the patch.*

**Range – the largest observed value minus the smallest observed value.*

**LSI –landscape shape index increases without limits from a minimum of 1 as the shape becomes more irregular.*

Table D-32. Patch Size and Core Area Without Consideration of Roads as a Fragmentation Element by Mountain Range for HFTs within Major Cover Types

Mtn Range	Patch Type	Total Patch Type Acres	% Land-scape	# Patches	Mean Patch Size Acres	Area Wtd. Mean Patch Size Acs	Size Range Acres*	Total Edge Miles	LSI	Total Core Area Acres	Core % Land-scape	Mean Core Size Acres	Area Wtd Mean Core Area Acres	Core Size Range Acres
Sierra	LPLS	83,097	22.9%	689	121	1,505	5,144	2,563	46.6	48,500	13.4%	70	963	3,808
Madre	LPES	13,739	3.8%	1,053	13	67	379	760	41.1	3,881		4	34	262
362,205	SFLS	65,175	18.0%	318	205	7,785	20,805	1,492	29.0	51,881	8.2%	163	6,685	17,883
acres	SFES	2,498	0.7%	221	11	56	231	145	18.5	577		3	25	161
	PPLS	0	0%	0	0	0	0	0	--	0	0%	0	0	0
	PPES	12	<0.1%	1	12	12	0	1	1.6	4		4	4	0
	AALS	29,273	8.1%	274	107	935	1,528	872	24.1	19,175	5.3%	70	651	1,114
	AAES	2,417	0.7%	52	47	151	417	89	12.1	1,489		29	103	267
Snowy	LPLS	121,158	22.8%	1493	81	1,575	7,785	4,112	61.5	63,367	11.9%	42	1,061	5,343
Range	LPES	39,844	7.5%	1415	28	104	945	1,774	56.5	14,714		10	54	679
532,455	SFLS	85,631	16.1%	819	105	10,970	29,355	2,708	49.5	47,483	9.0%	58	6,542	17,325
acres	SFES	11,124	2.1%	344	32	156	719	510	30.7	4,011		12	77	375
	PPLS	1,296	0.2%	26	50	222	429	41	5.5	899	0.2%	35	181	357
	PPES	0	0%	0	0	0	0	0	--	0		0	0	0
	AALS	6,831	1.3%	234	29	107	225	394	23.5	2,996	0.6%	13	58	211
	AAES	1,705	0.3%	71	24	54	124	97	15.1	833		12	29	70

**% of Landscape -% of NFS acres for Mountain Range*

**Mean – the sum, across all patches of this type divided by the number of patches of the same type.*

**Area weighted mean – the sum, across all patches of this type multiplied by the proportional abundance of the patch.*

**Range – the largest observed value minus the smallest observed value.*

**LSI –landscape shape index increases without limits from a minimum of 1 as the shape becomes more irregular.*

Table D-33. Patch Size and Core Area (*With Consideration of Roads)* as a Fragmentation Element

Mtn Range	Patch Type	Total Patch Type Acres	% Land-scape	# Patches	Mean Patch Size Acres	Area Wtd. Mean Patch Size Acs	Size Range Acres*	Total Edge Miles	LSI	Total Core Area Acres	Core % Land-scape	Mean Core Size Acres	Area Wtd Mean Core Area Acres	Core Size Range Acres
Laramie Peak With Roads 437,795 acres	LPLS	14,428	3.3%	262	55	297	1,062	510	21.7	9,318	2.1%	36	245	1,041
	LPES	372	0.1%	18	21	43	89	21	7.3	81		4	8	23
	SFLS	888	0.4%	50	38	176	497	81	11.4	1,185	0.3%	24	149	475
	SFES	18	<0.1	3	6	8	8	1	2.2	2		<1	1	2
	PPLS	76,884	17.6%	792	97	823	2,832	1,797	34.2	64,198	14.7%	81	751	2,742
	PPES	2,848	0.7%	52	55	220	399	83	11.8	1,386		27	131	304
	AALS	843	0.2%	57	15	25	61	64	11.6	417	0.1%	7	13	36
	AAES	127	<0.1%	7	18	27	32	8	4.9	31		4	7	15
Sherman (Pole) Mtn With Roads 55,575 acres	LPLS	2,181	3.9%	73	30	93	300	120	13.2	385	0.1%	5	18	51
	LPES	1,120	2.0%	13	86	290	465	40	7.6	910		70	251	413
	SFLS	20	<0.1%	2	10	15	15	1	2	1	<0.1%	<1	1	1
	SFES	0	0	0	0	0	0	0	--	0		0	0	0
	PPLS	6,241	11.2%	99	63	210	533	220	12.8	2,775	5.2%	28	113	316
	PPES	1,818	3.3%	35	52	132	335	75	28.2	1,360		39	96	245
	AALS	574	1.0%	32	18	40	96	45	8.7	91	0.2%	3	5	15
	AAES	797	1.4%	40	20	46	98	64	14.3	576		14	35	80

**% of Landscape -% of NFS acres for Mountain Range*

**Mean – the sum, across all patches of this type divided by the number of patches of the same type.*

**Area weighted mean – the sum, across all patches of this type multiplied by the proportional abundance of the patch.*

**Range – the largest observed value minus the smallest observed value.*

**LSI –landscape shape index increases without limits from a minimum of 1 as the shape becomes more irregular.*

Table D-34 Patch Size and Core Area (*With Consideration of Roads)* as a Fragmentation Element

Mtn Range	Patch Type	Total Patch Type Acres	% Land-scape	# Patches	Mean Patch Size Acres	Area Wtd. Mean Patch Size Acs	Size Range Acres*	Total Edge Miles	LSI	Total Core Area Acres	Core % Land-scape	Mean Core Size Acres	Area Wtd Mean Core Area Acres	Core Size Range Acres
Sierra Madre With Roads 362,205 acres	LPLS	81,830	22.6%	944	87	918	4,404	2,682	49.1	45,152	12.5%	48	581	3,188
	LPES	13,447	3.7%	1140	12	59	341	778	42.6	3,468		3	29	262
	SFLS	64,841	17.9%	408	159	7,631	20,571	1,521	29.6	50,714	14.0%	124	6,504	17,551
	SFES	2,445	0.7%	238	10	52	223	149	19.1	522		2	23	154
	PPLS	0	0%	0	0	0	0	0	--	0	0%	0	0	0
	PPES	12	<0.1%	1	12	12	0	1	1.6	4		4	4	0
	AALS	29,054	8.0%	311	93	871	3,589	890	24.6	18,545	5.1%	60	580	2,308
	AAES	2,408	0.7%	57	42	149	419	89	12.1	1,473		26	102	267
Snowy Range With Roads 532,455 acres	LPLS	119,450	22.4%	1,832	65	1,314	6,825	4,223	63.6	59,706	11.2%	33	896	4,959
	LPES	39,292	7.4%	1,544	25	99	945	1,800	57.7	13,985		9	51	679
	SFLS	84,363	15.8%	1,086	78	9,019	26,243	2,789	51.4	45,060	8.5%	41	5,305	15,281
	SFES	10,895	2.0%	402	27	152	718	522	31.7	3,685		9	73	374
	PPLS	1,296	0.2%	26	50	222	429	41	5.5	899	0.2%	35	181	358
	PPES	0	0%	0	0	0	0	0	--	0		0	0	0
	AALS	6,696	1.2%	255	26	100	384	396	23.8	2,744	0.5%	11	50	265
	AAES	1,683	0.3%	77	22	53	125	98	15.3	793		10	28	70

**% of Landscape -% of NFS acres for Mountain Range*

**Mean – the sum, across all patches of this type divided by the number of patches of the same type.*

**Area weighted mean – the sum, across all patches of this type multiplied by the proportional abundance of the patch.*

**Range – the largest observed value minus the smallest observed value.*

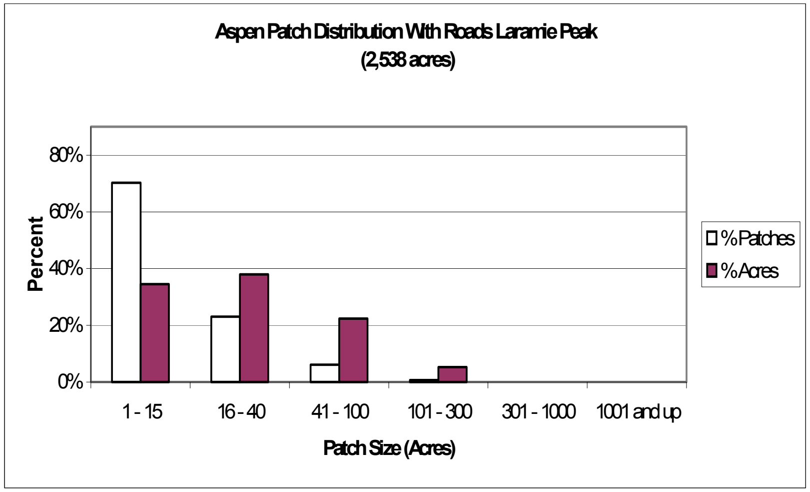
**LSI –landscape shape index increases without limits from a minimum of 1 as the shape becomes more irregular.*

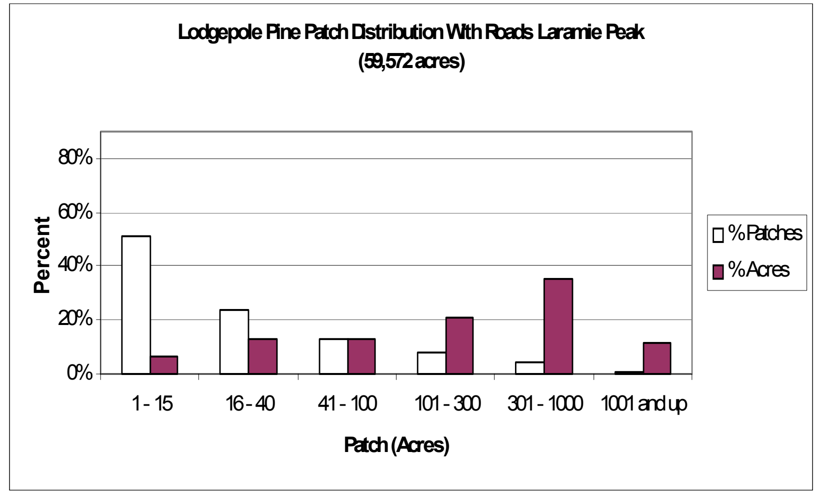
A patch size and connectivity that contributed to adequate habitat for the animals found historically on the MBNF must have existed over time. Von Ahlefeldt and Speas (Von Ahlefeldt and Speas 1996) provide a review of the animals found on the MBNF. Chapter 3 Wildlife and Appendix I Biological Analysis and Biological Evaluation provide information on the effects of patch size on specific species.

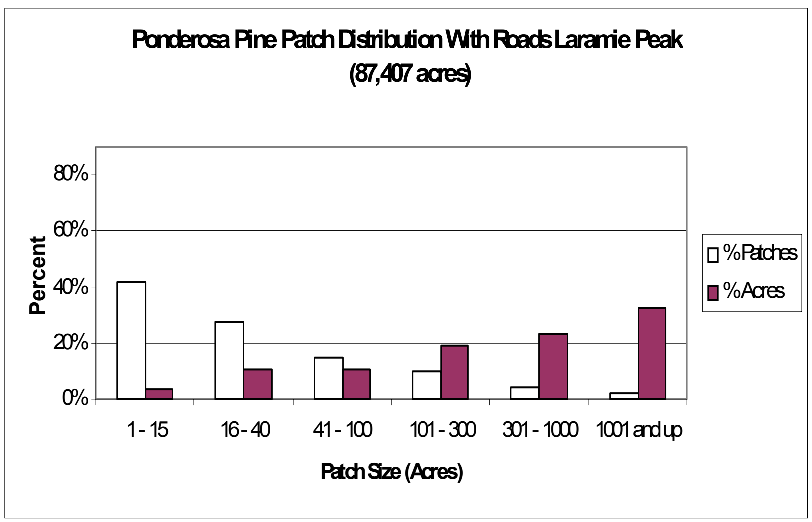
Baker (Baker 1994) reports that the amount of timber harvesting is a significant source of variation in landscape structure across the MBNF. Over much of the study area (Sierra Madre and Snowy Range selected area of the Medicine Bow National Forest), the forests are fragmented by timber harvesting and have lost interior habitat, with an associated increase in edge habitat as a result of post-1950 clearcut logging, group selection cutting, and partial cuts. The lack of interior forest is the most consistent indicator of fragmentation in this study (Baker 1994).

The following figures summarize the patch size for each mountain range.

Figure D-16 Patch Size and Frequency Histograms (Including Roads) Laramie Peak Mountain Range







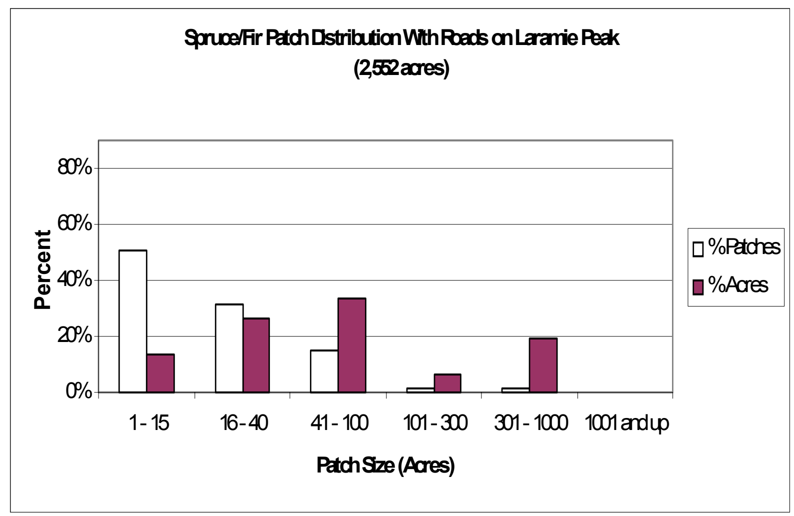
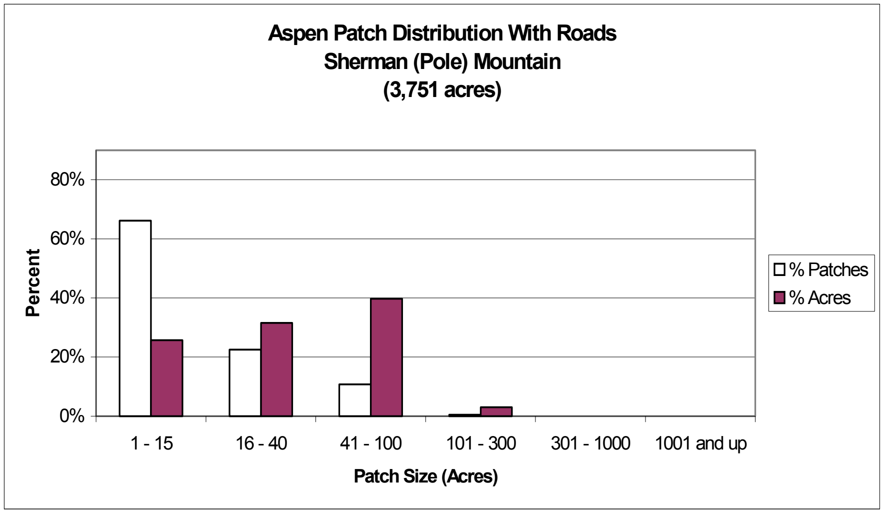
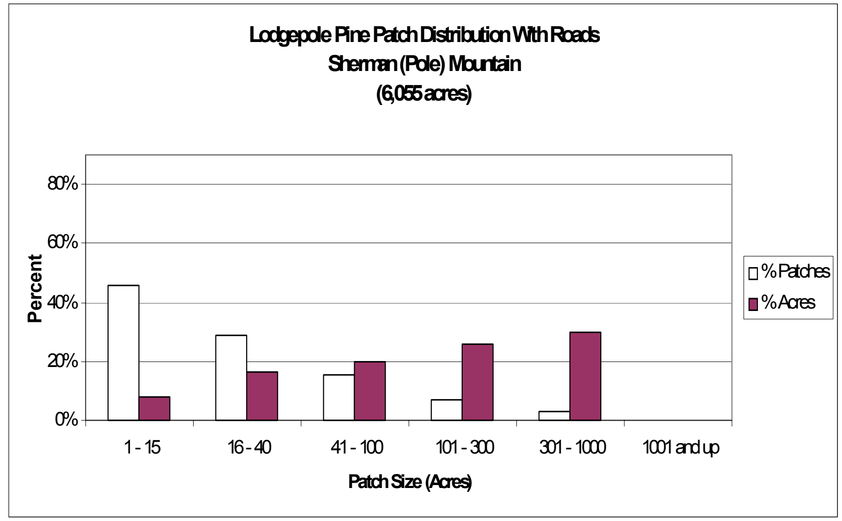
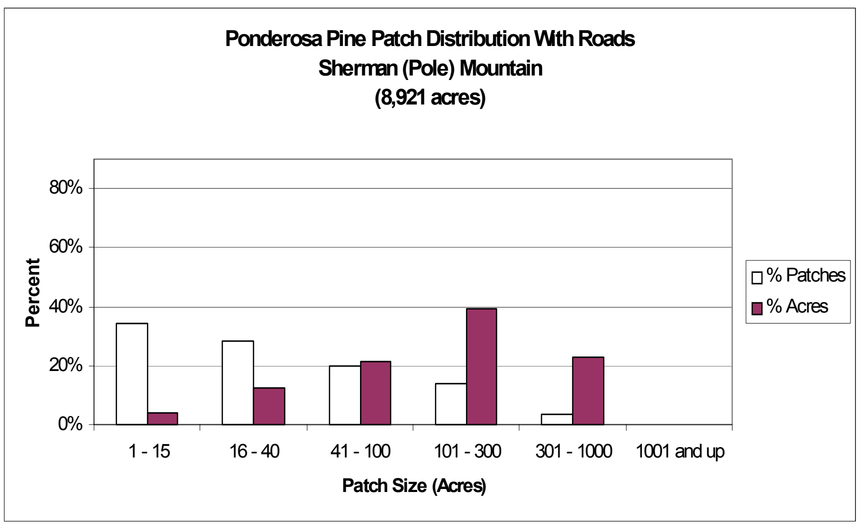


Figure D-17 Patch Size and Frequency Histograms (Including Roads) Sherman Mountain Range (Pole Mountain Unit)







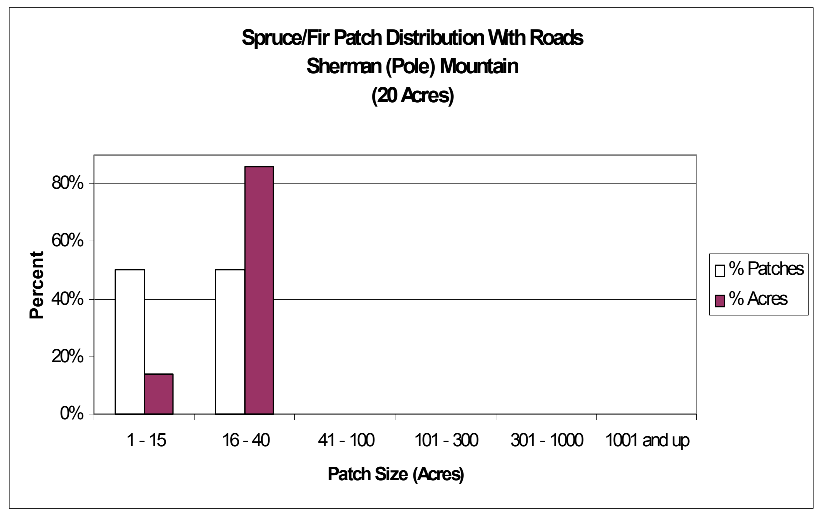
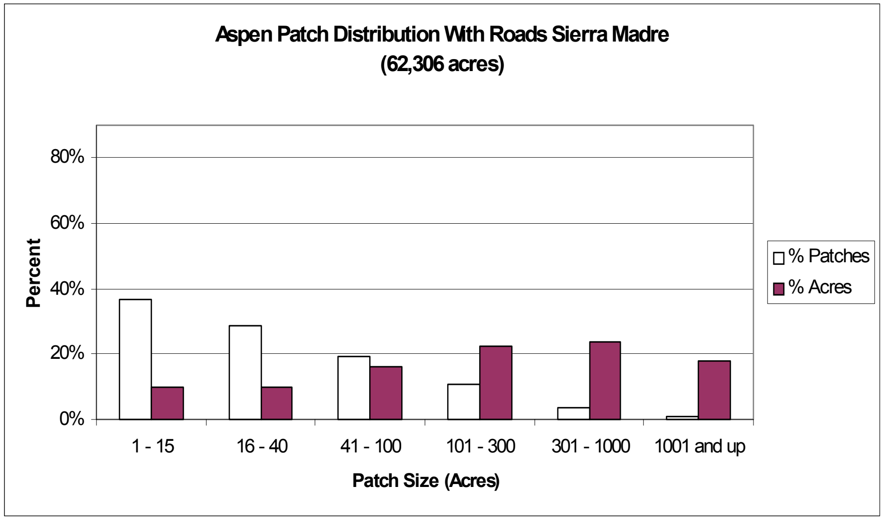
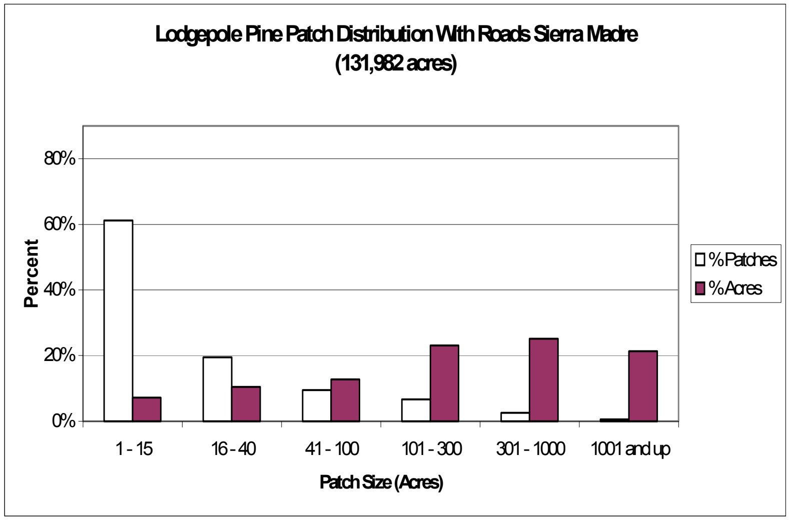
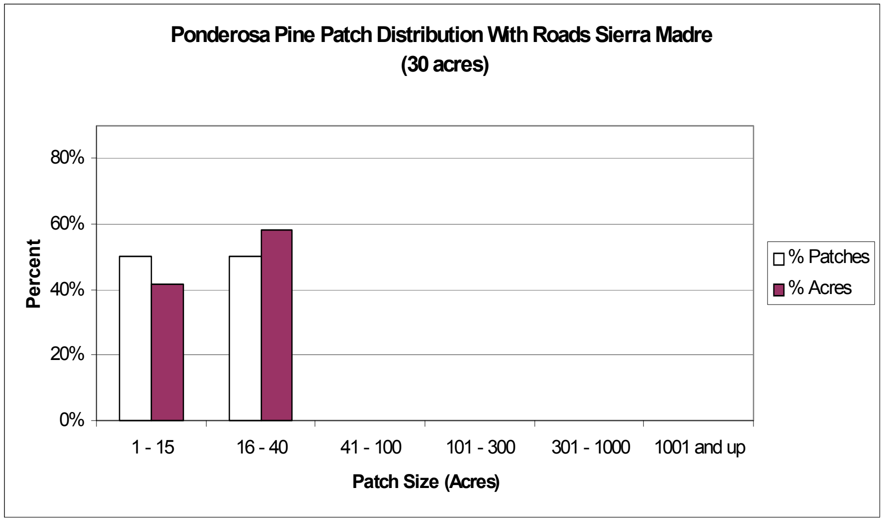


Figure D-18 Patch Size and Frequency Histograms (Including Roads) Sierra Madre







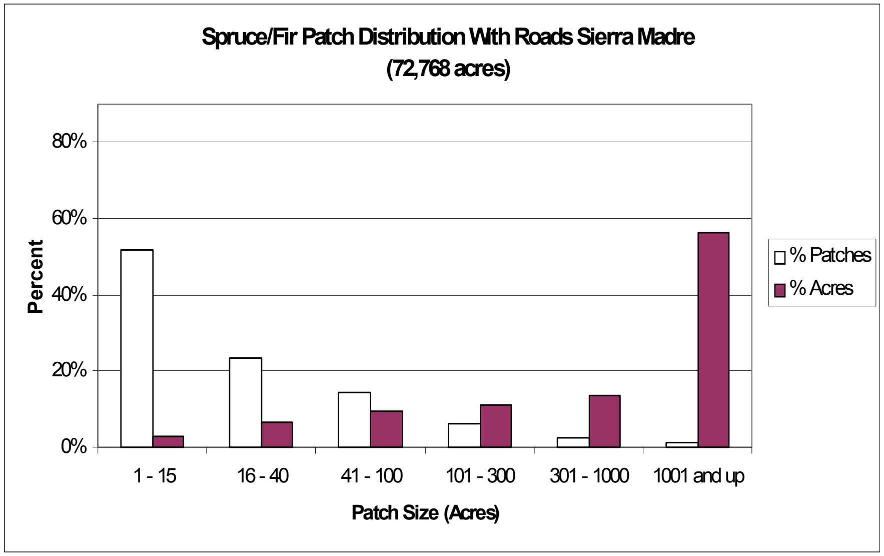
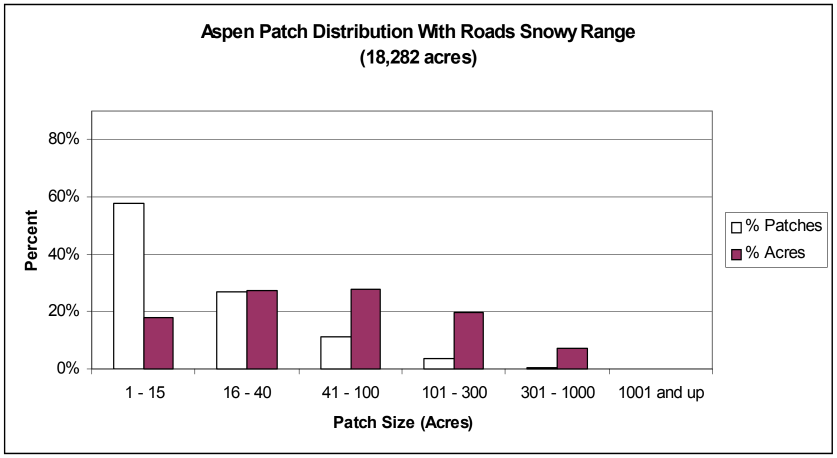
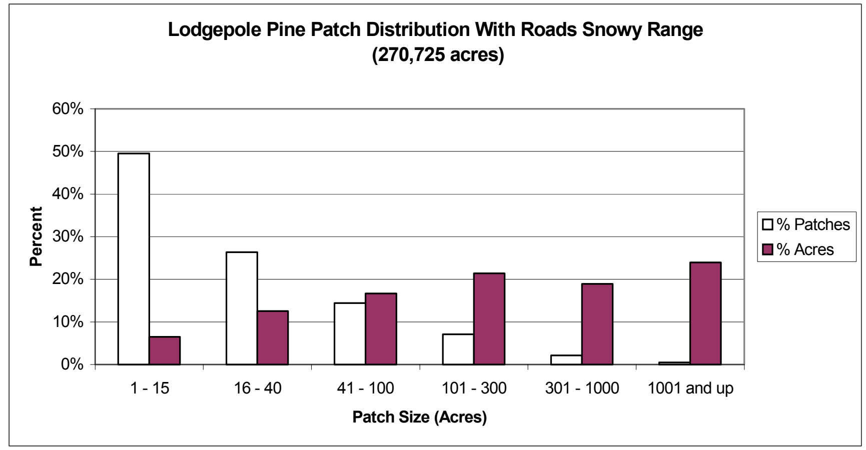
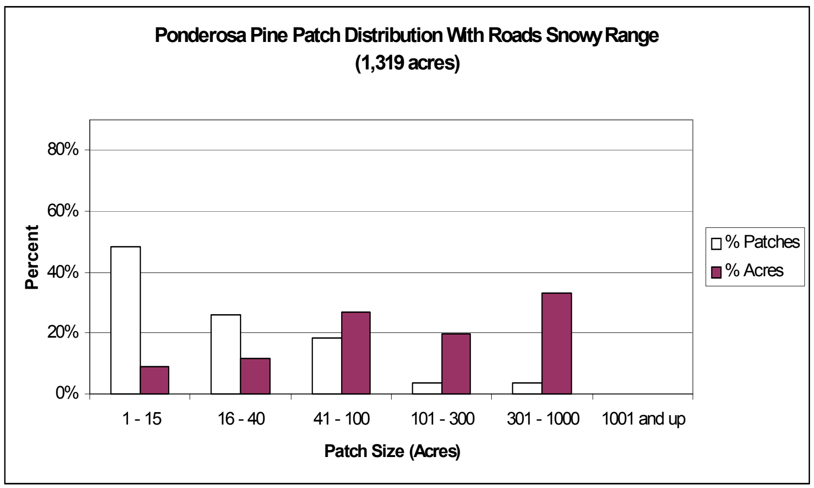
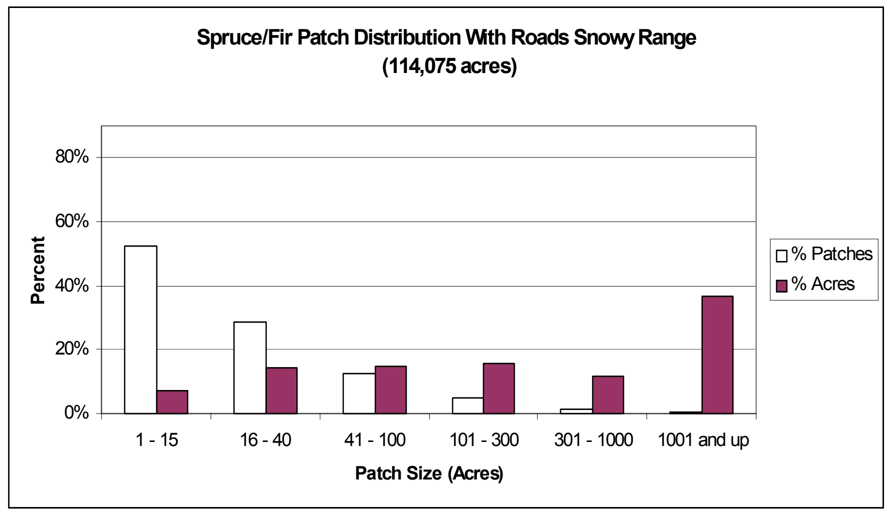


Figure D-19 Patch Size and Frequency Histograms (Including Roads) Snowy Range









Wildlife Considerations – Fragmentation

On the Medicine Bow NF, the current spatial distribution of patches of forest of different age has been created primarily by timber harvest and roads. This pattern differs from patterns created by natural processes in many respects. Patch size is smaller and there is less interior forest. Patches are more uniform in size. (Dillon and Knight 2000). The amount of high-contrast edge is increased in high-elevation forest where roads and timber harvest have occurred (Reed, Johnson-Barnard et al. 1996), Dillon and Knight 2000}. In addition to alteration in vegetation pattern, some stands have been fragmented by roads, trails, and clearcuts. (Reed, Johnson-Barnard et al. 1996), (Baker and Knight 2000).

The early studies of fragmentation focused on remnant patches of forest in landscapes converted to non-forest vegetation. In this use forest fragmentation is:

> "a landscape-level process in which forest tracts are progressively subdivided into smaller, geometrically more complex (initially but not necessarily ultimately), and more isolated forest fragments as a result of both natural processes and human land use activities (Harris 1984)."

Over time, the term came to be applied to other situations in which a continuous forest was altered by creation of openings within it. The resulting pattern is openings scattered in a matrix of forest rather than a "fragmented" forest with islands of trees in a matrix of unforested land. This "perforated" pattern does not meet the definition above of "fragmentation." Forest animals can theoretically, move through the whole forested area by moving around the openings in the continuous forest matrix. In a true "fragment," an animal would have to cross unforested land to reach islands of forest.

The pattern on the Medicine Bow is both perforated and fragmented. Past logging has left openings scattered in a matrix of forest. However, compared to the pattern created by natural processes, the Forest is also "fragmented," with the subdivisions created by roads dividing large blocks into small ones.

The landscape pattern can be described as "fragmented" (or "perforated") by comparison with the pattern created by natural processes. However, in addressing effects of spatial pattern, whether forest is "fragmented" depends on the characteristics of a particular species and how well it moves through the landscape. Because different species use the forest differently, a spatial pattern that hurts one species may have no effect on another.

Sources of Spatial Pattern on the Medicine Bow NF.

The spatial pattern currently found on the MBNF has been created by three factors:

1. a patchy physical environment (elevation, aspect, soil type, temperature, moisture, snow pattern, etc. (Romme and Knight 1981), (Knight and Reiners 2000);
2. superimposed on that pattern, effects of natural disturbances like fire, blowdown, and patches of tree mortality caused by insects and disease (Romme and Knight 1981),(Veblen 2000); and
3. human activities that alter connectedness and patch characteristics like shape, size, and isolation.

The general pattern of fire in this high elevation forest has been described (Romme and Knight 1981). The frequency at a site depends on the elevation, aspect, and moisture. On the cooler, moister north slopes fire is less frequent than on the lower or south-facing sites. Frequent small stand-replacing fires create a perforated pattern for many decades. However, at some point in a dry, hot period, a large fire occurs which may cover tens of thousands of acres. If the fire is intense, it can erase the "perforated" pattern and create a large area of relatively uniform age. If the fire is less intense, it leaves a new mosaic of severely burned, scorched, and unburned patches that experience variable patterns of succession following disturbance. Therefore, the range of possible conditions is broad, from continuous large blocks early in the stands life to an increasingly perforated pattern as the stand ages.

Changes in landscape pattern from HRV

Determining whether the current pattern of forest vegetation is significantly different from those created by natural processes is difficult because of the variation in the patterns that could be created by natural processes and by our lack if information on actual examples. Studies done using either unloggged areas or reconstructed landscapes concluded that current landscapes differ from those created by natural processes in at least the following ways: (1) decreased patch size; (2) increased patch density, total edge perimeter, and edge density; and (3) simplification of patch shape (into more rounded or square rather than irregular shapes) {Medicine Bow}; (Reed, Johnson-Barnard et al. 1996), (Reed, Johnson-Barnard et al. 1996); {Roosevelt NF}, (Miller, Joyce et al. 1996); and {Bighorn NF}, (Tinker, Resor et al. 1998) (Veblen 2000)). Both the Medicine Bow and Bighorn studies isolated the effects of logging from that of roads and concluded that roads contribute more to the observed differences than do harvested patches. These conclusions are also supported by the HRV Report on the Forest (Dillon et al 2003).

Effects of "fragmentation" on wildlife

The studies cited above used measures of habitat pattern (like interpatch distance, amount of edge, or patch size) describe changes in the spatial pattern in quantitative terms. The horizontal structure of the forest has been altered, and created a pattern the native species have not experienced before.

What is the biological significance of these changes? Native species are adapted to a pattern of patchiness and disturbance, or they would not have persisted. However, this does not mean that all species are can adjust to the new pattern created by human activities.

Many of the axioms on the topic arise from research in settings much different from that on the Medicine Bow NF. In assessing what research is applicable to the type of fragmentation found on the Medicine Bow, I consider the context, the scale, whether temporal factors were addressed, and whether an attempt was made to distinguish effects of fragmentation from effects of correlated variables.

Context.

"Fragmentation" on the Medicine Bow NF is created by (1) a *"perforated"* pattern of *temporarily-altered* young patches and strips in a *connected matrix of forest* and (2) narrow persistent openings (roads). Animals that will cross roads can move through the landscape without leaving forest, but the cut-over areas also regain cover and eventually become permeable to these same species. Patches isolated by logged areas become reconnected over time as shrubs and trees grow in cut-over areas. Even along large strip cuts that may isolate small animals with limited mobility, the populations will be connected over time as the forest regenerates. The nature of the altered habitat remains within the historic habitat type.

Edge effects. Frequently cited as adverse impacts of fragmentation are "edge effects." Some species increase at newly-created edges, others decline {Rosenburg and Raphael 1984}, (Schmiegelow and M 2002). Reviewing the literature on bird densities at forest edges, Schmiegelow and Monkkonen (2002) concluded that very few species clearly avoid edges, and that those that do are typically sedentary species of old forest. Despite a change in species composition, there may be no change in bird density.

In some investigations, the well-known "edge effect" of increased predation at bird nests did not occur outside of an agricultural setting (Andren 1994), (Schmiegelow and M 2002), (Lichstein, Simons et al. 2002) or when a broader array of predators (including small mammals as well as birds) was investigated (Haskell 1995). Sklepkovych (1997) found nesting success of the Siberian Jay to be higher close to edges than in interior forest.

This is not to imply that there are no edge effects- the physical environment changes, climatic condition may well affects factors like occurrence of lichen {Esseen 1994 cited in Schmiegelow and Monkonen 2002} and insects, affecting foraging rates by birds {Schmiegelow and Monkonen 2002}. Effects of edge may be beneficial or adverse, depending on the species {Yahner 1988}.

In addition, changes in the amount or the nature of edge from edge created by natural processes may affect species or the community composition.

There is no simple statement that generalizes the effect of edge on all wildlife.

Loss of interior forest. The pattern of past logging and the density of roads have reduced the amount of interior forest. (See von Ahlefeldt and Speas, 1996, Figure 6.31 for spatial pattern of each structural class, Figures 6.32 for pattern of various disturbances disturbance since 1950, and Figure 6.33 for interior forest in the mid-1990s.) Though no map of the pattern prior to logging is available, the original spatial arrangement can sometimes be deduced by the blocks that appears when a map or current mature/old (structural class 4 and 5) stands and a map of past harvest are combined (Kozlowski, pers. comm.) For animals that typically used large patches of mature/old forest, in "perforated" parts of the MBNF, resources and conditions associated with interior forest are less aggregated than in the past.

The role of scale. The scale of the animal's home range, the scale of the disturbance and residual patches, and the scale of the analysis area in the study will all affect whether a response to the pattern of habitat exists and/or is detected. A soil nematode in forest near a clearcut has such a small home range that it does not experience its habitat as "fragmented." However, a wide-ranging forest carnivore will have less of its preferred habitat in its original home range if clearcutting is done in the area.

Temporal factors. Most research assesses fragmentation at a single point in time. However, connectivity can be provided over time rather than just over space (Keymer, Marquest et al. 2000). Much of the thinking on fragmentation and connectivity developed in the relatively "static," long-lived, continuous forests of the Pacific Northwest or permanently-altered remnants of eastern deciduous forest. Findings are not necessarily applicable to the dynamic landscapes of the Rocky Mountains, where disturbance is frequent. Native animals evolved with this shifting mosaic of composition and structure over time. They survived either by moving through fragmented or young forest between old patches or because isolation for a matter of decades (as the forest recovered) did not lead to extirpation. Research carried on for only a few years may overestimate effects of fragmentation in forest.

On the other hand, there may be a time lag between the alteration of the habitat and the resulting change in species composition or abundance. Holding a home range or territory has many advantages. The benefits of retaining a home range, even with a decrease in the amount of prime habitat or with a less advantageous spatial arrangement, may outweigh the costs of seeking a new home range in a forest that is already filled with conspecifics. This effect of crowding by forest birds was reported in patches of boreal forest in the first year after the surrounding area was clearcut (Hejl 1992, Hannon and Schiegelow 2002).

Relative contribution of fragmentation versus correlated variables, especially habitat. Studies on fragmentation effect seldom accounted for the simultaneous loss of the original habitat. Fragmentation/perforation of a habitat by human activities is accompanied by other changes. In a forested setting, for example, logging always produces a reduction of mature forest in the area. This is obvious, but the effects of the amount of habitat lost have rarely been isolated from effects of pattern change.

Recent re-assessments have found that the effect of habitat loss in many cases is much greater than the effect of fragmentation under most conditions (Andren 1994), (Fahrig 1997), {Villard 2000}, (Lichstein, Simons et al. 2002). Theoretical approaches suggest that habitat will be the dominant factor until the amount of the original habitat is reduced to less than 30% of the original cover (Andren 1994), (Flather and Bevers 2002). In each of these modeling efforts, grid size in the model was the size of a patch affected by the disturbance. Further assumptions were that each patch was inhabited by more than one individual (a "population" in Andren, 2 individuals in Flather and Bevers), individuals did not use more than one patch, and the patches were isolated by "hostile" habitat. Thus, spatial pattern did not become important until the remaining original habitat occurred in separate patches; the effects were related to patch size and isolation. Based on this conclusion, one would not expect to see effects of spatial pattern in a context of "perforation" like that seen on the MBNF.

However, some species do not meet the assumptions used in this modeling. The disturbance may be "fine-grained" relative to the animals home range, with each individual using more than one patch and being able to move between them. For some species (habitat generalists or animals with low travel costs), the habitat separating patches of the original covertype is not hostile. The matrix habitat may recover over time so that the isolation is temporary.

Therefore, although the dominance of the effect of habitat loss (to the virtual exclusion of fragmentation effects) can be expected to apply to species that fit Andren's original assumptions, it may not apply to species that do not meet those assumptions. Andren assumed that the animals may need only some representation of a certain cover type in the home range (for example as nest sites), that the individual could expand its home range to capture enough resources, and that changes were still a result of habitat loss (see Andren's examples of the Black Woodpecker and Capercaille). However, an animal that is closely tied to a cover type for most of its needs and that has high travel costs may not meet these assumptions.

It is not surprising that different species would respond to a specific change in spatial pattern in different ways. If the animals respond just to habitat, the population should decline in a linear relationship with the amount of habitat lost. If 30% of the mature forest is logged in a certain area, and the population of forest voles, moths, or nematodes decreases by 30%, there is no indication of an effect of fragmentation independent of habitat loss. However, if when 30% of the habitat is logged, a wide-ranging species drops to 10% of its original population, despite the presence of 70% of the original habitat, it suggests a role of spatial arrangement.

Lichstein et al (Lichstein, Simons et al. 2002) addressed the relative contribution of habitat quantity and landscape pattern on the abundance of songbirds. They found that "…landscape effects are less important than local [habitat] factors in determining songbird species abundance in our primarily mid- to late-successional study area. After controlling for local habitat variation, landscape variables explained only a small amount of the variation in the species data" (p. 850). Of 25 species, none was correlated with landscape variable (when controlled for local conditions) that was even 1/3 the strength of the correlation with local habitat (when controlled for landscape). For many species the landscape correlation was extremely low or no landscape correlation was detected. This suggests that, for animals using space at the scale employed by songbirds, fragmentation effects at the scale of timber harvest may not be crucial.

Perhaps the best documentation of sensitivity to pattern of habitat (rather than reduction of amount of habitat) comes from research in Quebec, Maine, and Utah on American marten (Chapin, Harrison et al. 1998), (Bissonette, Harrison et al. 1997), (Hargis, Bissonette et al. 1999), {Potvan 2000}. When 25-30 % of mature, residual forest had been harvested, the martens had declined to zero (or near zero) in the fragmented landscape. (If the animals responded only to loss of habitat, about 70% of the original number would be expected to be present). Marten territories are heterogeneous- they use a number of habitats including non-forested areas where there is cover- but seem to need a high amount of mature/old forest. As this habitat is reduced, home ranges must increase in size to provide enough resources. As resources (like food, den sites, subnivian resting sites) become more dispersed, it requires more energetic expenditure in travel costs than may be possible, especially in the winter snow.

In a study of martens on the Medicine Bow NF, marten populations did not decline significantly when 23% of an area was cut (The population did decline, but the change was not statistically significant.) Marten populations were tracked prior to timber harvest and for 4 years thereafter. (This was an experimental harvest done to investigate the effect of creating 200 small patch cuts, about 2 to 10 acres, on water yield in a drainage; it is atypical of usual forest practices). These results suggest that marten on the MBNF are not responding as much to spatial pattern as martens in the other studies. However, there are several possible explanations for the difference between these results and those on marten in other places.

A reduction of 25% may not be enough to trigger the decline in population;

The very small patch size may have a different effect than larger patches, though it should be noted that the martens were not hunting within the small openings (tracks were found only along edges (O'Doherty, pers. comm. 2002)).

The spatial arrangement of the remnant habitat is better for marten that that the pattern of forest left when large patches are removed

Because the martens were followed for only 4 years some residents may have been hanging on in home ranges of reduced value. As described above, over time populations may decline. (The studies in Maine and Utah were done in areas where the "patches" might be 35 or 40 years old).

The relatively small size of the total area in which the harvested units were located (relative to the size of marten home ranges) and the methods used in locating martens may not allow detection of changes in marten density. Scale of measurement of density is unclear in some of the studies and these differences may be significant.

If the results of the studies in Utah, Quebec and Maine are correct, there are serious implications for management to retain viability of all species. The American marten has been selected as a management indicator species to gather more information on the species' status on this forest, especially related to existing spatial pattern.

Conclusions on effects of spatial pattern.

Which animals are likely to be affected by fragmentation in addition to effects of habitat loss? Ignoring for the moment possible effects of edge, patch size, and patch shape, it seems to depend on the **relative scale** of the species home range and that of the new patches and remaining matrix.

1. For animals with very small home ranges compared to the size and shape of the residual forest patches, each home range is either completely altered (logged) or untouched (except those along the edges of the logging). Therefore, (ignoring edge effects), the decline in numbers will be close to proportional to the loss of habitat. (Fine scale home range, coarse scale matrix)
2. For animals with home ranges larger than the residual patches (say 10 times as big), the home range of each is partially logged. Unlike the previous cases with small home ranges, habitat quality within the home range is affected. A home range that provided adequate resources will no longer do so, and the home range must be expanded to adjust for the lower resource density. (Coarse scale home range, fine scale matrix.)

This is consistent with the two situations dealt with by Andren (1994); (1) above is comparable to the isolation of populations (island biogeography setting) and (2) above is comparable to the "fine-grained" landscape setting. In the latter case, like Andren, I expect that as the suitable habitat becomes more dispersed the home range will increase in size. However, unlike Andren, I expect that the effects of fragmentation will be felt at much lower levels of habitat loss than is the case for animals with small home ranges relative to the size of disturbed patches.

In addition to loss of habitat, other factors are also correlated with timber harvest and fragmentation. Roads often are built to the logging site. In addition to fragmenting large stands physically, these create a pathway for continuing human activity. The physical structure of edge is more likely to be "high-contrast," an abrupt transition between two structural types, than edges resulting from natural disturbance (Dillon and Knight 2000).

Effect of shape/configuration. As discussed above, pattern on the landscape may or may not have an effect beyond that of habitat loss. Shape of patch likewise affects the suitability for some species using the remaining forested habitat. Long narrow strips may contain as many acres as another patch that is circular, but both edge effects and travel costs (affecting foraging and territorial defense) will be much higher in the strip. The effects are related to the species' home range size and social system. The number of species and the proportion of forest birds (compared to generalists) declined in narrow riparian buffers, but not in those over 100 m (for number of species) or 200m (for proportion of forest birds) (Hannon, Paszkowski et al. 2002)

Conclusions.

The pattern created by logging and roads is **not** similar to the pattern created by natural processes. Whether a particular species is affected depends on its home range size, the extent its daily movements, its dispersal distance, and its ability to move safely through forest gaps. To best cover the needs of all species, management should imitate patterns created by natural processes.

It is impossible to generalize the results of fragmentation on "wildlife." For some species there may be close to a linear relationship with amount of habitat (unaffected by the spatial pattern). For others spatial patterns may be critical to their use of habitat: these include:

1. some small birds associated with old growth (Hermit Thrush, Brown Creeper, possibly Red-breasted Nuthatch (Keller and Anderson 1992), (Hejl and Paige 1994), (Ruefenacht and Knight 2000));
2. those sensitive to edge effects (though expected edge effects were not found in vertebrates by Ratti and Reese 1988, Keller and Anderson 1992, Cotteril and Hannon 1999, or Lichstein et al 2002), and
3. those with large home ranges (American marten, (Bissonette, Harrison et al. 1997), possibly Northern Goshawk (Reynolds, Graham et al. 1992).

The changes documented for individual species are logically consistent with the changes described in landscape variables (reduced patch size, reduced core, increased edge). They suggest that forest management should:

- Plan ahead for the location of large blocks of future old forest (100 or 200 years from the present) during selection of areas to be logged.
- Avoid reducing the size of existing large blocks of mature forest.
- Obliterate roads, especially those passing through an otherwise intact block of forest.
- Reduce further fragmentation by (a) clustering new units around existing ones and (b) by harvesting leave strips unless the regeneration is well along (>20 feet tall) and the decision is made to leave the strips uncut. If downed wood levels are low in the existing cuts, more dead and standing trees for supplementary downed wood should be left.

Clustering units and cutting leave strips should provide for desired timber output and creation of early successional forest to compensate for reduced levels of fire. It is not necessary or beneficial for wildlife to apply this everywhere the forest is currently perforated. The existing pattern will grow together into connected forest over time. Creating large units across the landscape is not needed to create a more natural pattern- this configuration occurred only in the years following major fires.

Effects of Fragmentation on Wildlife- Roads

Roads differ from timber-harvested areas because they are long and narrow and because they are long-lived features (they are not regenerating to native vegetation). Roads also are sites of human disturbance, which will be addressed in the section on Security Areas. This discussion will focus on the physical presence of the opening.

Roads vary greatly from narrow two-tracks to broad hardened surface roads to state highways. Effects on wildlife include alteration in the environmental conditions (temperature, light, moisture) in adjacent forest and along the verges, related changes in vegetation (and associated wildlife), and inhibition of free movement in formerly connected habitat.

- Gradients of environmental conditions from the road edge toward the center of the stand are steepest in wet, dark, dense forest, where the dry open conditions and light are radically different from forest interior that formerly extended for hundreds of miles with only small openings. Most of the literature in the edge effect of roads on adjacent forest was done in such settings, like the Pacific Northwest. In dry, more open forests (like ponderosa pine and much lodgepole) these effects are not as significant.
- Where verges are broad (especially along larger roads), there may be great alteration in the vegetation, with grass, forbs, and shrub species that would not occur in the forest canopy. Many of these species would occur along the edges following natural disturbance. Associated wildlife like butterflies and shrub nesting birds will move in and forest animals like deer and bears may selectively feed there. However, roads are also corridors for transport of weed seeds and many roadsides are highly altered communities composed of invasive noxious weeds. Though it has long been believed that predation rates on bird nests were increased (Wilcove 1985), it seems that this happens at forest edges associated with agricultural and human development (where predator numbers are related to those influences) but not in forests with timber management (Small and Hunter 1988, Haskell 1995).
- The barrier effect varies with species. Small animals usually remain in habitat with overhead cover to avoid detection by avian and other predators, and are less likely to cross openings of any kind than to remain under cover. Such animals often have small home ranges that are arranged on one side or the other of the road or, if there is a road in the home range, they cross it less than expected if they were as likely to cross the road as any other part of the territory e.g., (Meadows 2002). Larger animals may also cross roads less than expected (Mace, Waller et al. 1996), (Krebs and Lewis 1997), though this may be related more to avoiding disturbance than to the physical presence of the road.
- The barrier effect also varies with the size of the road and the level of traffic. Lynx crossed a major highway less than expected if movements were random {Apps, 1999} but freely crossed forest roads {McKelvey et al 1999}.

Overall, the physical effect of road corridors (in the absence of human use) has most adverse effect on wildlife when the road:

- Penetrates dense forest;
- Is wide (both the prism and cleared verges);
- Divides limited habitat essential to small animals (like riparian areas in habited by Preble's meadow jumping mouse); or
- Separates resources needed within the annual home range (like boreal toad hibernation and breeding sites).

Additional effects of roads on large animals will be addressed in the section on Security Areas/Roads.

Connectivity

The Medicine Bow National Forest is not a contiguous land unit. It is made up of four discrete sections of land that are located at high elevations (up to 12,000 feet) and separated by valleys that are around 7000 feet. Those sections are the Sierra Madre Section, the Snowy Range section of the Medicine Bow Mountains, and the Pole Mountain section of the Sherman Mountains, which is located between Laramie and Cheyenne. About forty miles northeast of the Snowy Range and to the northwest of Pole Mountain is the Laramie Peak area of the Laramie Mountain Range. Laramie Peak and Pole Mountain are north of Interstate Highway 80 while the Sierra Madres and the Snowy Range are south of Interstate Highway 80. This travel route strongly influences connectivity among the four sections.

Forest Service management is concerned mostly with movement within each of these sections. Different species use “connecting” habitat in varied ways. Some will use quite narrow “corridors” as travel paths (frequently riparian areas). Others need “linkage areas,” occupied by residents, for connections and gene flow to occur.

Connectivity is not always beneficial. Where connectivity of a particular habitat has been reduced from HRV, animals that were adapted to free movement through and area may be shut off from needed resources, face blocked migration pathways, or be unable to interbreed. However, increasing connectivity over HRV is just as bad- new predators and diseases may be introduced or locally-adapted populations may be “polluted” by genes from other populations.

Perforated landscapes (like much of the MBNF) may retain connectivity- apart from the long narrow stripcuts, most of the openings created by logging are relatively square and surrounded by intact forest. Though some leave-strips may be too narrow for travel (or occupation) by some species, it is generally possible to move long distances without leaving forest, even if this means zigzagging around clearcuts. The adverse effects of the perforated pattern on forest species appear to result from the low density of resources left after logging, rather than from a loss of “connectivity,” strictly speaking. The added travel costs of a circuitous route through the forest may contribute to making the habitat Snags and Coarse Woody Debris

Connectivity is important not only for forest dwellers, but for open country animals. Bighorn sheep, for example, avoid entering forest. The development of a forested band may be enough to isolate a herd into two separate units that no longer interact. On the Medicine Bow NF, bighorns move between summer and winter range through unforested areas; as these have grown into forest, the Wyoming Department of Game and Fish has expressed concern about the effects of the loss of connectivity on bighorns. Most animals that use early successional forest patches (rather than adjacent grass- and shrublands) are adapted for moving around and finding isolated patches or habitat, as the distribution of fire-created patches was discontinuous.

Conclusions on spatial patterns

The Medicine Bow Range and the Sierra Madre are each composed of a matrix of mature/old forest perforated with patches that are open, grass/shrub/ or young forest.

The perforated pattern created by timber harvest and the linear pattern created by roads have little effect on animals with very small home ranges (relative to the size of the blocks of remaining forest) independent of habitat loss. These animals can arrange their living spaces in the forested areas. Populations will decline linearly as the amount of the original habitat declines. Spatial pattern will not have a great separate effect.

Animals with large home ranges may increase the size of home range as habitat is lost within the home range. At a certain point, essential resources may become too dispersed to be used with a net energy gain, and the area may be abandoned.

Where habitat is bisected by a road, some small animals will not cross the openings; others will cross but will be exposed to predation and being hit by a vehicle while doing so. Larger animals may freely cross forest roads (like lynx {McKelvey et al 2000 in lynx book), show some avoidance but frequently cross (like martens {Robitaille and Aubry 2000), or show strong avoidance, especially during breeding season (like female wolverines {Krebs and Lewis 1998} and grizzly bears (Mace, Waller et al. 1996)).

Snags and Woody Debris

Snags and coarse woody debris are key components of forested ecosystems. Among other effects, dead wood influences ecosystem processes, provides essential habitat for animals ranging from insects to birds and mammals, and influences long-term soil structure (Simon, Schwab et al. 2002), (Graham, Harvey et al. 1994). The existing levels of snags and coarse woody debris are the result of historical natural process and disturbances as modified by forest management. Based on the 1999 Forest Inventory (Miles 2002), the MBNF has the equivalent of 1 new snag per 4 acres created annually.

Existing levels of coarse woody debris varies widely across the forest. Lower levels generally occur in harvested stands. Levels vary with the type of harvest and stand condition at the time of harvest. Debris levels in un-harvested stands can vary greatly depending on tree species, fire frequency, insect or disease activity and wind occurrence.

Key differences in snag and coarse woody debris retention exist between natural disturbances and timber harvesting. The structural differences created by the different disturbance processes last over the long-term and influence the species of animals, fungi, etc. that occur on the site (Volland and Dell 1981).

Timber harvest removes tree boles (large woody structure) while, depending upon the harvest type and associated fuel treatment, changing the distribution of small limbs from the canopy to near the ground. Harvested stands on the MBNF, support lower density of snags and less coarse woody debris than un-harvested stands (Dillon, Knight et al. 2003).

Natural disturbances involving insects and disease do not remove bolewood from a forest or consume small limbs. Some types of insect epidemics can result in the removal of needles or leaves although these insect epidemics are not commonly known to occur on the MBNF. (See Chapter 3 Insects and Diseases for more information on the major insects and diseases known to occur on the MBNF.)

Fire tends to consume leaves, small limbs, and forest litter and tends to leave large woody structure in the stand (standing and down tree boles) (NWCG 1994). Tinker and Knight (Tinker and D.H. Knight 2001) indicated that the amount of coarse woody debris consumed or by fire was about 8% (by volume) with an additional 8% (by volume) converted to charcoal for a fire in YNP. Wildfires burning under extreme conditions or when fuel moisture in large fuels is low can reduce or consume down logs and fires that burn through an area and then return to re-burn the same area can reduce or consume both down logs and standing boles (Gray and Franklin 1997). Even after an intensive fire, some of the wood remains in the form of snags.

Snag residence time varies by climate and cause of mortality. For Englemann spruce in Utah killed by spruce beetle, 84% of the killed trees were still standing after 25 years (Lowery 1982), (Mielke 1950). In a Colorado study for Engelmann spruce killed by spruce beetles, 8% of the snags had fallen after 10 years and 28% after 20 years (Lowery 1982), (Hinds, Hawksworth et al. 1965). For fire killed lodgepole pine in Montana, very few snags fell the first 2 years after the fire; then for snags smaller than 3 inches dbh, 27.9% fell each year. For snags 3 to 8 inches dbh, 8.4% fell yearly and snags larger than 8 inches dbh had a sporadic toppling rate with some predicted to stand indefinitely (Lyon 1977).

Coarse woody debris residence time also varies. Erickson et al. (Erickson, Edmonds et al. 1985) report that decay rate difference among ecosystems are due to local microclimate, the effects of resident decomposer organisms and the quality of the wood as a resource for the decomposers. Ecosystems with the lowest decomposition rates were characterized by low winter air temperatures and accumulations of snow. Low precipitation during the summer months on ponderosa pine sites also limited decomposition. Decomposition was slower in recent clearcuts than in forested areas. Fahey (Fahey 1983) reports for sites on the MBNF that the lowest forest floor residence times for woody material were observed in the highest elevation stands. The highest residence times for woody material were in the low elevation, open stands. Adjacent closed canopy stands at low elevations had lower residence times than the open stands. Boles that remained suspended retained 80-90 of their mass for over 100 years. The decomposition rate (*k* factor) for decaying bole wood for lodgepole pine stands is reported as 0.016 per year.

An analysis of snags at the Forest level was conducted using data from RMRIS. The following table displays the results of the analysis of snags for the MBNF.

Table D-35 MBNF Snags per acre from Inventory

Cover Type	Inventory %	Mean Recent Snags per acre	Mean Hard Snags per acre	Mean Soft Snags per acre	Mean All	Mini-mum	Maxim um
Lodgepole pine	68.9%	5.5	5.0	7.5	18.0	0	984
Spruce/fir	59.4%	5.4	12.3	11.6	29.3	0	711
Ponderosa pine	15.4%	13.1	2.9	4.5	20.5	0	651
Aspen	55.3%	8.2	7.9	13.9	30.0	0	880

Source: MBNF RMRIS database and MBNF GIS based on 500,317 inventoried acres in listed cover types.

An analysis of coarse woody debris at the Forest level was conducted using data from RMRIS. The following table displays the results of the analysis of coarse woody debris for sites of the MBNF.

Table D-36 Coarse Woody Debris from Inventories for Sites of the MBNF

# of Sites	Acres Represented	Pieces/acre > 5.0 inches
756	53,392	1-10
426	20,753	11-20
196	7,636	21-30
108	4,440	31-40
78	2,843	41-50
46	1,480	51-60
28	910	61-70
105	2,784	>70

Source: MBNF RMRIS database and MBNF GIS

Logging has replaced fire, for the most part, as the process that sets back succession in mature forests, with different effects on soil, legacy of wood, and understory plants. Fire consumes small diameter wood and needles, leaving tree boles; logging removes the tree boles and leaves smaller diameter branches and needles (and limited snag, snag replacements, and downed wood.) (Knight 1994)

Dillon et al.(Dillon, Knight et al. 2003) indicate that for low elevation forests, the amount and continuity of downed wood (fuels) in unmanaged areas has increased due to fire suppression . Dillon et al.(Dillon, Knight et al. 2003) also indicate that for both high and low elevation forests snag density and the amount of coarse woody debris in harvested stands is lower than the historic range of variability for unmanaged stands of comparable age and site conditions.

The abundance and distribution of riparian vegetation and large, woody debris have been reduced due to the activities associated with historic tie drives. For example, the removal of large trees adjacent to streams prior to tie drives has resulted in relatively young, even-aged stand of trees in the riparian zone. Instream-habitat features such as dammed pools and plunge pools are dependent on the availability of large trees to provide structural elements to form these habitats (Eaglin 2001).

PNV - Snags and Coarse Woody Debris

Snags and coarse woody debris have the potential to exist at higher levels than current levels. Natural processes create dead materials both at a steady state and in episodes. Dead wood can persist in Rocky Mountain ecosystems for 300 years or more (Harvey, Larsen et al. 1981). The accumulation rate can exceed the decomposition rate during periods of rapid mortality of large trees (Fahey 1983).

Wildlife Considerations – Snags and Woody Debris

Dead standing and downed wood provides essential habitat for many species and contributes to the attributes and functional features of most late- successional and old growth habitats.

Snags (standing dead trees, often with internal rot), are considered to be a unique habitat component. Snags provide habitat for nesting (in cavities or on branches), denning (in cavities along the trunk or at the base), rest sites, as lookout perches for visual foragers, as foraging sites (feeding on insects and microorganisms on or in the snag), and as the source of shelter and food for insects and other small organisms that live within the wood or bark of the dead tree. Often neglected is the key role of snags for communal roosting by small mammals (like flying squirrels) and small birds in winter. Cavities provide a somewhat insulated site for these small animals to gather and, tightly clustered, share heat and reduce heat loss to the environment.

Not all snags fill all these roles: hard snags have different functions and are used by different species than soft snags. A hard snag may serve as a perch and foraging site for bark-gleaners and as a nest location for birds, like the Brown Creeper, that typically nest in "young" snags with bark still attached. A large soft snag with rot in the heartwood is useable by excavators like woodpeckers. Even in a burned forest of dead trees, many woodpeckers (which crowd into the area to feed on larvae in the bark and wood) nest primarily in snags that were present before the fire {Hutto 1995}.

The most valuable snags for wildlife are those that (1) are located in riparian areas, (2) are large, and (3) have developed from a tree infected with fungus prior to its death- the fungus rots the heartwood while it is nourished by the living tree. Because of the last two of these factors, it takes a long time to produce a high quality snag. In determining the fate of each snag, the benefits of its removal should be weighed against the effect on wildlife over the interval it will take to replace it.

Though some categories of snag have the obvious benefits listed above, the ecosystem approach suggests that retention of the whole range of size class and degrees of decay that are found in a forest shaped by natural process should be represented in managed forests. Large snags are generally selected for retention because they are preferred by birds, survive longer, and provide better thermal protection in winter (Cunningham, Balda et al. 1980). Small snags are frequently used by birds for feeding (Haggard and Gaines 2001) and as nest sites for smaller species. Where snags meeting the criteria for "large" in that cover type are in short supply, smaller snags will fill many important functions and should be retained in the place of the missing larger ones.

Snags are often removed from forests to reduce fire hazard, in the course of timber harvest, to remove a safety hazard, and for firewood. In areas where these activities have been extensive, snags may be less abundant and/or of lower quality than occurred with natural processes. The range of decay in retained snags may be inadequate, or the though retaining the largest snags for animals with more restrictive requirements, may reduce habitat effectiveness for the whole community of snag-dependent species.

Downed wood comes either from live trees that die when they blow over or from fallen snags. Many native species- from microorganisms to top carnivores- rely on downed wood for essential parts of their life cycle. Downed wood and the micro-environment it creates are essential to individual species and to ecological processes that affect regeneration of trees and energy transfers in food webs. Downed wood provides cover from predators; resting and denning sites; fungi and insects eaten by small mammals, birds, and bears; and a structure that intercepts snow and provides an insulated area beneath the snow in which several species of small animal live in winter. Larger animals like lynx and bears use large downed wood for dens and rest sites.

High elevation forest, especially spruce/fir historically provided a high percentage of snags and downed logs. Snags and coarse woody debris are normally created as a result of fire, insects and disease outbreaks, and blowdown, but can also be created through management practices such as girdling and timber harvest.

In harvested stands, the density of snags and coarse woody debris has been reduced from the norms expected in unharvested stands (Dillon and Knight 2000).

Differences in legacy of dead wood following logging and that created by natural processes (especially fire). Logging has replaced fire, for the most part, as the process that sets back succession in mature forests, and has different effects on soil, legacy of wood, and understory plants than those of a fire. Fire consumes small diameter wood and needles, leaving tree boles; logging removes the trees boles and leaves smaller diameter branches and needles, limited snags, limited snag replacements, and less downed wood (Knight 1994).

After natural disturbances, the recently killed trees (as well as the snags that were dead at the time of the fire, if still standing) serve as feeding sites (on insects in the bark), nest sites, and foraging perches. (See section on “Loss of recently burned forest,” below) The boles of the dead trees remain on site and fall (either immediately or over time) to create a network of downed wood. Piles and logs suspended on their branches create habitat and resting sites; pathways in the shelter of large logs provide for movement across the site and between piles. Much of the dead wood is hard and is suspended above the ground. The downed wood persists on the site for many decades.

After burns and insect-induced tree mortality, dead trees do not necessarily fall in one event. Dead standing trees may continue to fall for several decades, providing a range of many sizes and decay classes while the stand matures. As the supply of legacy wood declines, the stand reaches the age when it generates its own dead downed wood (from fallen branches and suppressed understory trees).

Logged sites differ from burned sites in the amount, spatial distribution, and temporal pattern of downed wood. Even with requirements for retention of dead wood, most of the trees boles (potential future snags and downed wood) are removed, greatly reducing recruitment and amount of downed wood. While this is most obvious in clearcuts, less intensive harvest may have the same effect over subsequent entries. In addition, the range of size, the spatial pattern, the range of degree of rot, and the amount of suspended wood are generally reduced compared to that following natural disturbance. Though some sites may naturally have little downed wood for at least some portion of its history (due to a reburn or other site history), this was not typical of vast expanses of lodgepole or spruce-fir forest most of the time.

Sites that have been logged in the past vary greatly in the amount of dead wood left behind (about 5 to 12 tons/acre over about 3” in diameter from a sample on the MBNF, (Tinker and D.H. Knight 2001)). Some sites have large amounts in a continuous pattern, but other sites have only isolated logs. The dispersed pattern provides less overhead protection from avian and other predators. Removal of branches from downed wood left after logging (to reduce fire danger) and lack of overlap of logs (piling and crossing each other) alters the physical structure compared to naturally created downed wood. Unlike the arrangement of downed wood after a fire or blowdown, dispersed logs do not provide large connected subnivian spaces and leaning logs that provide access points from the surface.

The sources of concern about snags and dead downed wood are not the immediate effects (the 10 to 15 years within the life of the Plan), but the (1) potential decline in downed wood over time at a site with regular, repeated clearcutting, (2) potential decline in size at sites cut at the minimum rotation (120 years), and (3) and a possible “gap” in production of downed wood when the material left behind in our current logging has decayed and the stand is not old enough to produce much dead material (Tinker and D.H. Knight 2001).

1. Potential Decline in Amount of Dead Down Wood (over 3”). In areas of timber emphasis (MA 5.13), where harvested stands may be cut again at the age of 100-120 years, repeatedly harvested stands may never reach an age where they produce much dead wood (from fallen branches and dying understory trees) during the life of the stand. Any dead wood generated in these stands is likely to be small material, created by competitive exclusion of smaller less healthy trees. Given the size of trees of that age, the downed wood left in the second cutting would come from relatively small live trees. It is unlikely that these sites would be occupied by species dependent on large downed wood from old trees. If a large contiguous block of the landscape were managed in this way, the entire block could lack essential habitat for species like the American marten and prey species like the red-backed vole would be expected to decline in abundance. Though the species may be viable on the planning unit because of adequate habitat in other places, the distribution or abundance across the landscape could be reduced.

In lodgepole, modeling of downed wood levels over long periods (1,000 years) showed that a range of 5-12 tons per acre (> 3” diameter, measured in clearcuts done 1991-1993) would produce downed wood at a rate about half that achieved in simulated fires (Tinker and D.H. Knight 2001). The standard for Alternatives B through E is 10-15 tons with 80% over 6”. The higher tonnage and larger size indicate that downed wood, though less than that created by fire, will be higher than the model based on the implementation under retention standards in the current plan.

2. Potential Decline in the Size of Snags and Dead Down Wood. Tinker and Knight (2001) note that the 100-year-old lodgepole was about 9.6 inches in diameter, while 200- and 300-year-old trees had increased to 11.2 to 12.8 in. (This seems like a small difference; however if a 9.6 “ tree increases diameter to 12 “, the area of a cross-section increases by 57%.) This difference is important to some nesting birds and winter roosting birds and mammals. The potential reduction in size is expected to be more pronounced in spruce/fir because of the greater size reached by old trees.

Even more pronounced is the reduction in size of downed wood. Only a few trees typically become snags (before replacement of the stand by disturbance), and retention of snag recruits may provide enough large snags. However, the majority of trees eventually become downed wood (all except what is consumed in a fire). Removal of most of the tree boles in the first entry will not leave many candidates to create large wood in the future (only the snags, snag recruits, and retained blocks in the interior of units in MA5.15).

3. A possible “gap” in production of downed wood when the material left behind in our current logging has decayed and the stand is not old enough to produce much dead material. The approximate residence time for logs on the floor of lodge pole forest in Wyoming is 100 years (Tinker and Knight 2001). In Colorado, lodgepole and spruce logs in decay class 5 had been on the ground for about 20 to 90 years; at that point the sapwood was flaking and easy to remove in chunks and the circumference was flattened. Logs had reached structural stage 6- little structural integrity left- as soon as 40 years, and on average at about 90 years {Brown et al 1998}). Once the legacy wood present at the time of the initial harvest is gone, second entries will tend to occur on sites with little existing downed wood. In addition to standing snags and snag recruits, there may be need to either increase the number of live trees left on the site or fell some living trees to provide residual downed wood.

Under natural processes, the trees standing today would provide the next generation of downed wood. Removing the boles inevitably reduces the supply of future downed wood. Because the effects of this removal are long-lasting, acres that are missing a generation of downed wood will accumulate across the landscape. The effects on wildlife and on nutrients and productivity over repeated entries are uncertain.

Ecosystem Processes and Functions

Succession is slow in Rocky Mountain coniferous forests because of the short cool growing season (Knight 1994). Decomposition is also limited by the cool and sometimes dry climate (Knight 1994). Under some circumstances decomposition under snow can approach rates during summer (Fahey 1983). Forest level growth, nutrient cycling and decomposition processes have been modified by land uses or disturbances. Graham et al. (Graham, Harvey et al. 1994) indicate that at least 5 tons per acre in ponderosa pine and 7-15 tons/acre in lodgepole pine and spruce/fir cover types are needed to maintain long-term site productivity. These values are based upon expected decomposition and length of time between timber harvests which are similar to those identified for the MBNF. Tinker (Tinker 1999) and Tinker and Knight (Tinker and Baker 2000) indicate that if several successive rotations occur in the same stand using 1985 Forest Plan Standards, levels will be lower than after the same number of fires on comparable sites.

Water is not evenly distributed on the Forest. High elevations are generally much wetter than lower elevations. More moisture falls on the west side of the Continental Divide than the east side. This distribution of water influences the spatial pattern of aquatic and riparian ecosystems. Water uses and diversions have affected the distribution of water on the MBNF and the quantity and timing of water available for ecosystems downstream of the MBNF (see Biological Analysis Appendix I for more details on downstream effects on Threatened and Endangered Species). The introduction of fish species may be affecting the ecological functions of aquatic ecosystems (See Chapter 3 - Aquatics Section for details).

The lack of certain extirpated large predators may be influencing ecological functions on the MBNF. Wolves and aspen abundance (Ripple and Larsen 2000), (Ripple, E.J.Larsen et al. 2001) and grizzly bears and meadow ecology (Tardiff and Standford 1998), (Mattson and T. Merril 2002)are examples of such effects. The extirpation of the American bison may have affected grassland patterns and aspen abundance (Knapp, J. M.Blair et al. 1999). The extinction of the Rocky Mountain Locust may have changed vegetation patterns and nutrient cycles in the grass and shrub areas, and changed nutrient accumulation in glaciers and snow fields (Lockwood, L.D. Debrey et al. 1994), (Lockwood and L.D. Debrey 1990), (Schell 1994).

Disturbances (Fires, Insects, Diseases, Wind)

Fires, floods, wind storms, landslides, insect infestations, diseases can create complex ecosystem and landscape structures over space and time, offering varied habitat for species and influencing ecosystem function. The disturbed forest patches typically go through various successional stages over time, until a relatively stable stage, such as an old-growth forest, eventually returns (Shinneman, McClellan et al. 2000).

Each major ecosystem type in the Southern Rockies may have a “characteristic” disturbance regime, natural disturbances are not always consistent or predictable and can vary in frequency, size, spatial patterning, and intensity over time. For instance, in some ponderosa pine forests, specific stand conditions or fluctuations in climate can induce more severe disturbance events, such as hot, stand-replacing fires. These less predictable and more variable disturbance regimes may even be the “norm” for some ecosystems. The landscape changes brought about by this natural variability in disturbance regimes help to create the diverse and dynamic landscapes that sustain wildlife populations (Shinneman, McClellan et al. 2000).

The Ecological sub-regions of the United States (McNabb and Avers 1994) discusses fire, insects and disease as the primary natural disturbance agents.

Fire

Fire is thought to be the most significant natural disturbance agent in high elevation forests of the Rocky Mountains. Wildfire has been an important influence on the patch and landscape structure, forest density, species composition and age of shrubland and forest vegetation throughout the MBNF. The management of wildfire and prescribed fire are discussed in the Fire and Fuels Section of Chapter 3 FEIS.

In ecosystems with frequent fire return intervals, fire regimes have been significantly altered through fire suppression. As a result the risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by the length of several return intervals (cycles). This results in dramatic changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Consequently, vegetation structure and sometimes composition have been significantly altered from patterns expected most frequently under a natural disturbance regime.

In ecosystems with frequent fire return intervals, fire regimes have been significantly altered from their historical range from fire suppression. The risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals. This results in dramatic changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Vegetation attributes have been significantly altered from their historical range.

At higher elevation, fires were less frequent and the stands had a mixed fire regime, with both ground fire and stand-replacing fire occurring in the past; the structure and fire pattern of this forest is probably consistent with historic forest patterns (Dillon, Knight et al. 2003).

For spruce/fir ecosystems with fire return intervals of 300 years or greater, fire regimes are within the historical range and the risk of losing key ecosystem components is low (Dillon, Knight et al. 2003). Vegetation attributes (species composition and structure) are intact and functioning within their historical range. The effects of suppression actions against fires and insects have also influenced the current composition, structure and functions of the terrestrial ecosystems (see previous sections on composition and structure for details).

The role that fire plays in an ecosystem is summarized by fire regime descriptions (Laverty and Williams 2000). These regimes are discussed in the fire and fuels section. The following table displays the national fire regimes.

Table D-37 Fire Regime Groups, Frequencies and Severity of Fire Regimes

Fire Regime Group	Frequency (Fire Return Interval)	Severity	Cover Types
I	0-35 years	Low severity	Ponderosa pine, dry site Douglas-fir
II	0-35 years	Stand replacement severity	Dry site grass and shrubs
III	35-100+ years	Mixed severity	Aspen, Limber pine, young, open grown Lodgepole pine
IV	35-100+ years	Stand replacement severity	Old, dense lodgepole pine
V	>200 years	Stand replacement severity	Engelmann spruce, subalpine fir

Large, stand-replacement fires are associated both with fuel loading and with drought cycles. There are 214,270 acres (20%) of the MBNF rated as condition class 2, where fire regimes have been moderately altered from their historical range and the risk of losing key ecosystem components is moderate. There are 82,708 acres where the hazard is high and 77,463 where the hazard is rated as extreme. (See Fire and Fuels section of this chapter for details). It is possible that many of these acres would burn in single year or in a series of drought years.

There is a lower probability of a large fire (event) than of a small fire (event) and that based upon conditions similar to "ordinary" conditions as described by Romme (Romme 2002), there is some probability of fires similar to those described for YNP by Renkin and Despain (Renkin and D. G. Despain 1992) and Romme and Despain (Romme and Despain 1989)(See Fire and Fuels probability discussion for details).

Although alterations in structure have been more apparent in ponderosa pine than in other forest cover types, the majority of ponderosa pine on the MBNF is still in mature low density stands.

Ponderosa pine stands at low elevations on the Laramie Peak range had more frequent fire than occurs today. Brown and Shepperd (Brown and W.D. Shepperd 2001) and Brown *et al*. (Brown, Ryan et al. 2000) discuss historic patterns of fire frequency for the Ashenfelder Basin area of the Laramie Peak Range and note that that area had longer fire free intervals than other areas studies within the Rocky Mountain region.

However, both insect epidemics and wildfires have affected the Laramie Peak Range since these observations. An extensive mountain pine beetle epidemic occurred between 1988 and 1994. Documents from the Cold Spring Ecosystem Management Project (USDA FS Douglas Ranger District 1998) stated that there was extensive tree mortality on 7,500 acres due to that epidemic. The changes from this epidemic are reflected in the RIS data.

Recent fires on the Laramie Peak Ranger District encompassed 16,194 acres of ponderosa pine. An analysis of possible change indicated that following these fires, stand structure reflects expected conditions under natural disturbances regimes.

The observed alteration in the frequency of fire (prior to recent fires) may have had several effects. Ponderosa pine can withstand fire burning around its base, but it experiences higher mortality from fire that reaches the crown and destroys the needles. Denser understories can carry fire into the crowns of mature and old pines, killing them. Stands that would have been perpetuated as a mosaic of old forest for centuries may now be subject to stand replacing burns that, if intense, can kill every tree. Alterations that are most likely to affect habitat for wildlife species are the denser stand structure at low elevations (i.e., near the grassland ecotone) and changes in the type and frequency of fire.

Observed alterations in structure may be due to fire suppression, however Dillon *et al*. (Dillon, Knight et al. 2003) suggest that ponderosa pine in this area is subject to several different fire regimes and likely exhibit dense multi-story structure under some circumstances, with natural disturbance regimes. Shinneman and Baker (Shinneman and W.L. Baker 1997) indicate that ponderosa pine forest can be subject to non-equilibrium dynamics and exhibit both open canopy structures and dense canopies under different fire regimes.

In addition, as litter on the forest floor has grown deeper (from accumulation of needles and other organic material)(Dillon, Knight et al. 2003), a ground fire that moves through will smolder longer. The deeper flammable ground cover can lead to fire conditions that destroy portions or all of the cambium of mature and old trees. Where the cambium is not killed around the entire circumference, the tree will have a fire scar and continue to live. Fires that burn in deep duff may burn in a way that was not typical of fires in the past, and may reduce habitat components for species that require large trees.

Ponderosa pine trees that survive a ground fire can develop resin at the base. When the tree dies, the snags may stand for many decades. Trees that are not “hardened” by several ground fires and lack this resin develop into snags that rot at the base and fall within a few years (Arno pers. comm.).

In the past, when fire burned in ponderosa pine, patches of trees were killed or damaged. These burned trees provided habitat for bark beetles and woodborers that provide food for woodpeckers (especially the Lewis’). Other animals and plants benefit from downed wood. With less frequent fire, understory vegetation persists longer. Shrubs become woody and produce less nourishing forage for ungulates.

Detailed fire histories for a large extent of the Medicine Bow National Forest are lacking such that an accurate and detailed description of “natural” fire regimes is difficult. However, some local research on fire occurrence, fire history and historic range of variability is available (Dillon and Knight 2000), (Honaker 1995), (Romme 1977).

Veblen *et al.* (Veblen 2000) and Brown *et al.* (Brown, Kaufmann et al. 1999) have the following observations on fire regimes: The natural fire regime for many of these forests may have been more variable than previously thought, consisting of both frequently occurring, low-intensity surface fires and less-frequent, but regularly occurring, large, stand-replacing fires, as was found to be the case on portions of Colorado’s Front Range and in the nearby Black Hills of Wyoming and South Dakota.

A recent study in Colorado’s northern Front Range suggests that less than half of the ponderosa pine forests had park-like forest structures in the late 1800s, and upper elevation ponderosa pine forests may have supported stand-replacing fires (Veblen 2000).

Dillon *et al.* (Dillon, Knight et al. 2003) report that there is some evidence that surface fires may have occurred historically in lodgepole pine forests, which could have killed some of the pines selectively, but it is doubtful that such fires would burn over large areas.

Von Ahlefelt and Speas (Von Ahlefeldt and Speas 1996) report that fire occurrence has gone through three distinct phases since fur trappers, miners, and settlers came to the area. Effects differ for the Sierra Madre, Medicine Bow Mountains, Sherman Mountains and Laramie Mountains.

<u>A few large man-caused fires between about 1840-1870.</u> (This includes Battle Creek, and possibly some of the fires on Libby Flats that burned spruce-fir near the trails which crossed the Snowy Range). Fires and logging removed timber from extensive areas of the Sherman Mountains (Pole Mountain). Brown and Shepperd (Brown and W.D. Shepperd 2001) and Brown *et al*. (Brown, Ryan et al. 2000) discuss historic patterns of fire frequency for the Ashenfelder Basin area of the Laramie Peak Range and note that that area had longer fire free intervals than other areas studies within the Rocky Mountain region.

<u>Numerous fires from about 1870 until about 1910</u>. Most of the effects from these fires are in the Sierra Madre (except for higher elevations and rugged topographic areas), the southern Medicine Bow Mountains and areas near the edges of the Medicine Bow Mountains. Slash from tie-hacking and other cutting contributed to large, destructive fires. Ignition rates were increased by human activity, especially in the Medicine Bow Mountains.

Few acres burned in many small fires, larger acreages burned in a few large man-caused fires from 1911-present. Ignition rates continue to increase from human activity, but increasingly effective fire suppression limits the size of all fires (1911-present). Fire suppression has reduced post-burn forest and the abundance of associated species of plants, insects, and birds. (This may not be true in the Laramie Peak Unit following the fires of 2002.)

For low elevation forests, forest floor depth has increased (Dillon, Knight et al. 2003). (This allows fires to burn longer around the base of trees that are normally resistant to fast moving ground fire resulting in penetration of heat to the cambium, which can kill the tree.) The reduction in low-intensity fire has reduced hardening of base of tree with resin, likely affecting the persistence of future snags (Arno, pers comm).

Insects and Diseases

Insects and disease contribute to disturbance processes in the forested ecosystem. They are relatively widespread across the Forest. Bark beetles can act as a stand replacement process similar to fire but at times may occur at low levels that affect small groups of trees and influence within stand structure more than landscape structure. Changes in stand composition and structure can be changed relatively rapidly by insect attacks. Insects, along with fire, have been an important influence on the patch and landscape structure of the MBNF. The effects of insects and diseases are discussed in detail in the Insects and Diseases section of Chapter 3 of the FEIS

Engelmann spruce is affected primarily by spruce beetle (*Dendroctonus rufipennis*). Lodgepole pine is affected primarily by the mountain pine beetle (*Dendroctonus ponderosae*) and dwarf mistletoe (parasitic plants). Western balsam bark beetle primarily affects sub-alpine fir and is an increasing concern for the MBNF.

Diseases (dwarf mistletoe, root and other root/heart rots, aspen decline) mostly operate within stands and influence growth and structure of individual trees. Dwarf mistletoe is noted for reducing tree growth and ultimately the supply of forest products but also provides wildlife habitat structure and food not found in areas without mistletoe. Dwarf mistletoe frequently works more slowly than insects and may take decades to change forest stand composition or structure. In the earliest surveys of the Rocky Mountains, the distribution of severe mistletoe damage was described as scattered and localized. Johnson *et al.* (Johnson, Hawksworth et al. 1978) reported that 60% of all lodgepole pine on the MBNF were infected with dwarf mistletoe. Infections occur primarily on unharvested stands or stands which were selectively cut.

Armillaria root disease has been observed on lodgepole pine, ponderosa pine, and subalpine fir, but is of minor concern on the Forest. Comandra blister rust has also been observed on lodgepole pine and ponderosa pine but is also of minor concern. Aspen is affected by a variety of canker, stem, and root decays that are collectively known as aspen decline. White pine blister rust (*Cronartium ribicol*a) affects limber pine with the effects most prevalent on Pole Mountain (Jacobi and H. J. S. Kearns 2003). Various heart rots affect the different forest tree species. While they reduce merchantable volume in some instances, they also create structure for wildlife habitat (Sullivan 2003).

Dillon *et al.* (Dillon, Knight et al. 2003) note that for both high elevations (above 7,800 feet) and low elevations (below 7,800 feet), the abundance of diseases including dwarf mistletoe is within the historic range of variability.

The following table displays information regarding the incidence of insects and diseases since 1996.

Table D-38 Aerial Observations of Incidence of insects and diseases since 1996.

	1996 Acres	1997 Acres	1998 Acres	1999 Acres	2000 Acres	2001 Acres
Insects						
Douglas-fir beetle		253	19	2	85	52
Spruce beetle		108				101
Mountain pine beetle	340	850	620	2,360	1,270	6,425
Western balsam bark beetle	1,769	26,782	2,959	15,710	7,277	29,400
Unidentified bark beetle					6	
Pine engraver		1	36			
Spruce budworm				526	623	776
Unidentified defoliators			69			15
Diseases						
Armillaria root rot				21		
Dwarf mistletoe	810	8,511	7,704	643	318	78
Unidentified disease			139			
Winter damage			19			
Other						
Aspen decline		2,756	70	33	142	499

Source: GIS summary of aerial reconnaissance flights.

Insect risk is medium high or high on greater than 22,687 acres across the forest (from 172,129 inventoried acres).

The following table displays the acres in medium high or high risk of insect attack by cover type from inventory information:

Table D-39. Medium high and high risk of insect attack for inventoried acres.

Cover Type	Risk Rating	Acres
Lodgepole pine	4	3
Spruce/Fir	4	15,080
Total For Risk Rating 4 (Medium High)	**4**	**15,082**
Lodgepole pine	5	1,906
Ponderosa pine	5	2,561
Spruce/Fir	5	3,137
Total for Risk Rating 5 (High)	**5**	**7,604**
Total For Risk Rating 4 and 5	**4 and 5**	**22,687**

Source: RMRIS database based on 172,129 inventoried acres. Based on Logan, Schmid and Mehl (Logan, Schmid et al. 1980) for Spruce-fir; Stevens, McCambridge, Edminster (Stevens, McCambridge et al. 1980) for ponderosa pine; and For Amman, McGregor, Cahill, Klein 1977} for lodgepole pine.

When similar insect risk rating procedures are applied to all acres by cover type, Insect risk is high on 153,073 and medium 354,533 acres across the forest. (The methodology for this analysis is displayed in Appendix B – Insect Risk Analysis.)

The following table displays the acres by level of risk of insect attack by cover type:

Table D-40. Insect Hazard Using Hazard Rating Procedures

Cover Type	Risk Rating	Acres
Lodgepole pine	Low	148,911
Spruce/Fir	Low	48,014
Ponderosa Pine	Low	148,911
Lodgepole pine	Medium	384,884
Spruce/Fir	Medium	131,537
Ponderosa pine	Medium	227,996
Lodgepole pine	High	105,183
Spruce/Fir	High	6,149
Ponderosa Pine	High	41,741

Source: Hazard Rating based on RMRIS data –see Appendix B –Insect Risk Analysis for methods. Based on Schmid, Frye (Schmid and Frye 1976) for Spruce-fir; Stevens, McCambridge, Edminster (Stevens, McCambridge et al. 1980) for ponderosa pine; and For Amman, McGregor, Cahill, Klein 1977} for lodgepole pine.

Wind

There were 844 acres of wind damage identified in aerial damage surveys over the last 5 years for the MBNF. In 1997, just south of the MBNF, a windstorm felled trees over 13,000 contiguous acres (Routt Divide blowdown). This type of wind incident is historically rare on the MBNF. Smaller events are more common. The wind risk rating for the MBNF is lower than for the Routt National Forest (Kane, B.G. Brown et al. 1999). Many blowdown events in forested stands are associated with the edges of timber harvest units, where wind patterns have been changed by the removal of trees.

At lower elevations, aspen forests were less susceptible to blowdown and spruce-fir forests were more susceptible. At higher elevations, closer to the Continental Divide, younger stands were less susceptible than older stands (Baker et al. 2001). These results suggest that both topography and vegetation structure can influence the extent and pattern of damage, but that the effects vary with elevation and wind intensity (Dillon, Knight et al. 2003).

Aspen has relatively weak stems and brittle branches, and is therefore easily damaged by heavy snow accumulation, avalanches, and wind (Veblen and Lorenz 1991).

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PNV - Fire, Insects, Diseases, Wind.

Non-stand replacement fires can affect stand density and can change habitat structure from one density class to another. Stand replacement fires dramatically change habitat structure and replace late successional stages with early successional stages. Wildfires can leave unburned or lightly burned patches within the fire perimeter that influence the pattern and availability of habitat.

Gray and Franklin (Gray and Franklin 1997) report that: Fire frequency, intensity and size can influence the nature of forest development, ecosystem processes and abundance of native species. Tree establishment can be delayed where forest sites are burned over more than once.

Land Uses

Since the 1860s, the Medicine Bow National Forest has been a source of timber products. The earliest harvests used tie drives on the streams to move the timber to the source of demand. Later harvests moved the wood via roads constructed throughout the forest. The cutting and removal of trees from the forest environment and the transportation systems used have changed the composition, structure, and function of the forest and the riparian areas from that which existed before (Von Ahlefeldt and Speas 1996). Prior to the turn of the century, domestic stock grazed throughout the Medicine Bow National Forest. The initial grazing occurred with few constraints. Since the incorporation of the area into the National Forest System, grazing has been subject to increasing regulation and control (Thybony, Rosenberg et al. 1985). There is more information on grazing and non-forest vegetation in the previous section on composition changes and in FEIS Chapter 3 – Livestock – Big Game and FEIS Chapter 3 Vegetation.

Fire suppression has been mandated across the MBNF by the 1985 plan. Insect suppression has occurred more frequently since the increased availability of insecticides after World War II. There is more information on the effects of suppression on vegetation composition in the previous section on composition changes and potential natural vegetation and on fire and fuel management in FEIS Chapter 3 – Fire and Fuels Management.

Gold was discovered in 1856 in the Medicine Bow Mountains. Copper mining occurred in the Rudefeha area. Mining and the effects of previous mining are still present today. There is more information on this in FEIS Chapter 3 – Minerals.

Water diversions began in 1851 and now occur on many streams. Other water projects include trans-mountain diversions and construction of large reservoirs. Fish introductions began 1874 and fish stocking has occurred since 1890.

Recreation uses have occurred since the early 1920s, and continue to increase in diversity and amount. There is more information on past and present recreation uses of the MBNF in FEIS Chapter 3 – Recreation.

The Ecological Sub-regions of the United States (McNabb and Avers 1994) presents mining, trapping and hunting, timber harvest, grazing, pattern of ownership and recreation as the major land uses for the NHEUs. These land uses could lead to a change in land use patterns but there is no information on the patterns of land uses for the NHEUs.

Trapping and Hunting

Trappers explored throughout the region, during the 1820s-1840s. Declines in beaver populations may have had significant ecological impacts on aquatic and riparian habitats in the ecoregion. Beaver has been reintroduced and is filling suitable habitat on the forest (Shinneman, McClellan et al. 2000).

There is not a viable population of Canada lynx on the MBNF, but the species' past status is uncertain. Northern river otter were extirpated and, while apparently recovering, are still very rare.

White-tailed Ptarmigan have not been recorded in the Snowy Range for over 20 years. Amphibians such as the boreal toad are exhibiting reduced populations. It is not known whether wood frogs and northern leopard frogs are within the historic range of variability.

Management of game animals is designed to maintain high productivity for hunting. Ungulate sex ratios and age class structure are different from those of herds that are not hunted. The population of elk is at or near historic highs.

Mining

The gold rush and early mining era had more significant and long-lasting impacts on the Southern Rockies' ecosystems than fur trapping. The most significant impact of the mining boom was that the promise of "striking it rich" brought thousands of people to the Southern Rockies (Shinneman, McClellan et al. 2000).

Gold was discovered in 1856 in the Medicine Bow Mountains. Mining and the effects of previous mining are still present today. Water diversions began in 1851 and now occur on many streams. Other water projects include trans-mountain diversions and construction of large reservoirs. Fish introductions began 1874 and fish stocking has occurred since 1890 (Von Ahlefeldt and Speas 1996).

The mining boom encouraged the expansion of transportation routes, such as wagon roads, stagecoach routes, and railroads. Railroads in particular were instrumental not only in getting minerals out of the region, but in bringing resources, new industries, new residents, and tourists into the Southern Rockies (Shinneman, McClellan et al. 2000).

Timber Harvest

Many areas have been logged and managed for more than 100 years. Between early Euro-American settlement and World War II, local communities and mining camps often extensively logged low-elevation ponderosa pine and Douglas-fir forests for local timber supplies. Some forests were also cut by early lumber operations that moved over large areas with mobile sawmills, and other forests were logged heavily to supply railroad ties for the rapidly expanding railroad system. From the 1950s on, clearcut harvest techniques were used over extensive areas on certain national forests in the ecoregion, especially on the Rio Grande and the Medicine Bow National Forest in Wyoming (Shinneman, McClellan et al. 2000).

Since the 1860's, the Medicine Bow National Forest has been a source of timber products. The earliest harvests used tie drives on the streams to move the timber to the source of demand. Later harvests moved the wood by roads constructed through out the forest. The cutting and removal of trees from the forest environment and the transportation systems used have changed the composition, structure and function of the forest and the riparian areas from what existed before (Von Ahlefeldt and Speas 1996).

Grazing

Livestock have been introduced into nearly every ecosystem type in the West, including deserts and other habitats that were not historically impacted by high grazing intensities from native herbivores. Nearly 70% of the 17.9 million acres of U.S. Forest Service lands in the ecoregion are under active grazing allotments and another 10% are under inactive allotments. Roughly 70-80% of state and federal public lands in the ecoregion are actively grazed, and 80-90% are open to livestock grazing. In addition many private and tribal lands are also actively grazed (Shinneman, McClellan et al. 2000).

Also, since the 1870's, domestic stock has been grazed on the Medicine Bow National Forest. The initial grazing occurred without many constraints. Since the incorporation of the area into the National Forest System, grazing has been subject to increasing regulation and control (Von Ahlefeldt and Speas 1996).

Some meadows and shrublands were grazed more heavily in the early 1900s than previously, but current management practices appear to be creating conditions that are within the historic range of variability (Dillon, Knight et al. 2003). Brown-headed Cowbirds, a native species, may be artificially concentrated each year in songbird habitat by the pattern of livestock grazing (Cerovski, Gorges et al. 2001). This reduces reproduction in native birds.

Riparian vegetation and stream-channel geometry have changed due to historic livestock grazing in the Sierra Madre, primarily west of the Continental Divide (see Aquatics section of AMS for details). Changes in bank structure affect some animals that nest or den in burrows or on bank ledges.

Patterns of Ownership

A complex pattern of public and private land ownership has been established in the Southern Rockies. This pattern owes its existence to a history of both land acquisition by the U.S. government and transfer of public lands to private interests through mining claims, farmland acquisition under the Homestead Act of 1862, and other means. The U.S. government also retained large portions of the land and eventually allocated these lands to newly established public agencies such as U.S. Forest Service (USFS), National Park Service (NPS), and Bureau of Land Management (BLM). Western states were also granted "school trust" lands from the federal government, inheriting millions of acres (usually in separate square mile sections) that were intended to be leased or sold to raise money for public education (Shinneman, McClellan et al. 2000).

Recreation

Recreation use has occurred since the incorporation of the area into the National Forest System and continues to increase in diversity and amount. Winter recreation (especially, but not exclusively, motorized recreation) creates disturbance and snow compaction in openings, over wetlands, and along linear routes.

Wildlife Considerations – Snow Compaction

Snow is an integral component of habitat. Snow depth and characteristics affect animals' access to prey or vegetation, the ease of travel, and availability of insulated microsites. Modern human activities, particularly use of snowmobiles and skiing, have the potential to alter snow conditions.

Winter in the mountains of Wyoming poses challenges for warm-blooded animals. In addition to snow, extreme cold and wind make it difficult to maintain a positive energy balance, that is, to provide more calories (whether from stored fat, stored food, or by active foraging) than the animal must consume each day to maintain its body heat. Many native animals meet this challenge by leaving the area (migration) or by storing fat and reducing energy demand (hibernation). Most of the breeding birds migrate south for the winter. Some birds and mammals move to lower elevation where the weather is less extreme and snow is less deep. Black bears and many rodents hibernate.

However, even at high elevation, some animals are present and active all winter. Some animals have anatomical adaptations for locomotion on or through snow (like the large feet of snowshoe hare or the shoulder structure and long legs of the moose which allow it to move through deep snow and to spend the winter at higher elevation than deer and elk (Marchand 1996). Animals that are active on the surface may change color to provide camouflage (like ptarmigan, weasels, snow buntings, and snowshoe hares). Insulation may be increased by the growth of a denser coat (shrew article) or deposition of subcutaneous fat. Many animals have seasonal physiological adaptations, like changes in metabolic rate, fat storage, or ability to mobilize energy in response to cold (e.g. Merritt 1984). Other species live in or beneath the snow.

Animals that live in snowy environments are adapted for survival with snow. They may rely on snow for creation of sheltered microsites or for competitive advantage over species lacking their adaptations. High mortality or reduced reproduction may occur in years with little snow {Formozov 1946, Jannett 1984, Merritt 1985, Merritt 2003}. Alterations in snow compaction have implications both for animals that live above the snow ("supranivian") and for those that live on or below the ground surface, at the base of the snowpack ("subnivian").

Supranivian species at high elevation include the lynx and the snowshoe hare, both of which have large feet and long legs that support them on top of the snow when another animal of the same weight would sink and be unable to travel efficiently.

In an early assessment of the effects of snow compaction on animals, Bury {1978} concluded that the animals most affected were small mammals that live beneath the snow and are active during the winter. A review some of the features of the snowpack that affect subnivian wildlife habitat is given in the *Wildlife section of Appendix D (Biological Diversity.* For a more thorough review, see {Pruitt 1960, Halfpenny 1989, and March and 1996}. For an extensive review of the physical properties of snow and the ecology of snow-covered ecosystems, see(Jones, Pomero et al. 2001).

Alterations in Snow Compaction with Winter Recreation

Skiing, snowshoeing, and snowmobiling alter the formation of the snowpack. On the Medicine Bow NF, snowmobiling affects far more area than downhill skiing, cross-country skiing, and snowshoeing. In the first snows of the season, any of these uses will compress the snow hard against the ground (in the same way that snow freezes to a driveway under tire tracks). Unlike natural snow, this compacted snow is not likely to melt off (after an early snowfall followed by mild weather), terminating access to food earlier in the autumn. Compacted snow will also melt later in spring, again denying access to food supplies for animals that survived the winter. Finally, this compression onto the ground eliminates the basis of the formation of the subnivian space (the air space under the snow around grass and other clumps of low vegetation) replacing it with a dense layer that animals cannot burrow through.

These winter recreation activities also alter the density of the snowpack. The degree of natural compaction of snow is variable. In open windy settings, snow is blown and the “arms” of the flakes are broken, forming pellets that lie in a dense pack. However, even in the open areas in the Snowy Range, snowmobile and ski tracks are clearly visible, indicating that compaction (at least in portions of the area) is increased compared to that created by natural forces. In more sheltered forested areas, the fluffy snow becomes denser over time because of changes in physical structure (metamorphosis as water molecules migrate in the snowpack), compression by overlying snow, and by alteration (even melting) at the surface. However, it generally remains far too soft to support a walking person, for example, unlike a track created by skiers or snowmobiles.

Studies in the Snowy Range at the Glacier Lakes Ecosystem Experimental Site found that the density of snow on snowmobile trails was 1.5 to 2 times as dense as snow off trails {Musselman, pers. comm.}. These results are similar to those of Schmid {1971} in Minnesota. Compaction may occur in off-trail areas because about 75% of the compaction of fresh snow caused by snowmobiles can be attributed to the first pass {compared to compaction after 5 sequential passes, Keddy et al. 1979}.

Environmental consequences for Wildlife Snow Compaction

There are five possible effects of snow compaction on wildlife.

1. **Effects on lynx** (**and other species) of increases in other predators** at high elevation. Lynx, with their large feet, long legs, and light bodies, have a competitive advantage over coyotes, bobcats, and other predators in deep soft snow. Without a compacted travel route, these other species would have to struggle through long distances of deep snow to reach high elevations where snow may be compacted enough for them to move easily. These predators, like coyotes, may compete for prey with lynx (Buskirk, Romme et al. 2000) if they are able to hunt off-trail.. There is no direct evidence of this effect beyond anecdotal sightings and inference from range alterations on Cape Breton Island (Parker, Maxwell et al. 1983).

2. **Reduction of the insulation of the snowpack**. Many animals have behavioral adaptations (rather than anatomical or physiological adaptations) that permit them to survive in this harsh environment. They seek microclimates that are less severe; many of these microclimates depend on the insulative capacity of snow.

Scientists studying subnivian animals define the onset of "winter" by the "hiemal threshold," the time when snow is deep enough to stabilize temperature at the ground surface (6 to 10 inches)(Pruitt Jr. 1957). Regardless of fluctuations in ambient air temperature, the temperature at the base of the snowpack stays within a few degrees of freezing (0 degrees centigrade).

Compaction reduces insulation by reducing or eliminating the air spaces between snow crystals. When snow 15 inches deep was compacted by multiple snowmobile passes, ground surface temperature fell from 0 degrees to –12 to –15 degrees centigrade (Schmid 1971).

The relatively constant temperature at the base of the snowpack not only provides a relatively warm and less variable condition for animals active at the surface, it also prevents the soil from freezing, protecting animals hibernating below the surface. Severely compacted snow may freeze to a depth of 18" (Cooper, pers. comm.) Wood frogs, hibernating in leaves or duff at the ground's surface, are adapted to survive freezing at a few degrees below zero, but none has survived temperatures below –7 degrees centigrade {Marchand 1996, p. 139}.

In addition, the relative warmth at the ground surface creates a temperature gradient across the snowpack, from the very cold air at its top to the relatively warm (freezing) temperature at its base. In the mountains of Wyoming, there is also a humidity gradient from the dry air at the surface to moist air at the base of the snowpack. These two gradients drive the movement of water vapor from the base of the snowpack up into the snowpack, where it freezes. The loss of water from snow near the ground alters the form and texture of the snow. This altered snow, "depth hoar," is soft and easy for animals to burrow through. The water movement also enlarges gaps where the snow was "shaded" by rocks, vegetation, and other structures. These two effects are critical for formation of the subnivian space where small mammals live.

3. **Reduction of the amount and connectivity of the subnivian space.** Compaction of shallow snow reduces the formation of the subnivian space by compressing snow to the ground. Even in deeper snow, compaction interferes with the passage of water vapor through the snowpack both by reducing the temperature gradient (and therefore reducing differences in water vapor pressure and slowing sublimation at the base of the snowpack) and by physical restriction of passage through the compacted layers.

In an open area (like a meadow, old harvest unit, or wetland) that receives frequent compaction (by snowmobiles or skiers), especially if this started early in the season, there may be little or no useable subnivian habitat.

Under uncompacted snow, small mammals use the subnivian space that forms under shelters (like a tuft of vegetation, a shrub, or along a log) and travel between sites using the developing gap under the snow or by burrowing through depth hoar. Movement is inhibited where snow is compacted. The failure of formation of either a gap or soft depth hoar creates barriers impassible to subnivian animals.

For animals that are active under the snow to survive the winter, they must have a large enough area to provide nest sites and a feeding area large enough for them to gather enough food to survive. Small mammals with very small home ranges are probably more affected by the loss of the suitable habitat (subnivian space) than by loss of connectivity. However, animals with larger home ranges may need resources spread over a slightly wider area. Barriers would force them to travel over the snow (risking predation), if they were able to find large enough patches to survive.

In Minnesota, vole populations were compared for two areas that initially had similar populations of voles. After 12 weeks of trapping, half of the area was compacted by snowmobile and was re-compacted following each snowfall (for a total of 5 days of use in the 12-week experimental period). Snow cover ranged from 26 to 39 cm- 10 to 15 inches- at the time of the first compaction. Results showed that:

- In the area that was compacted, no voles were found following compaction by snowmobiles until after snow melt in spring. Trapping success in the control area remained the same throughout the winter.
- No voles marked on sites that were later compacted were ever captured again. {Jarvinen and Schmid 1971, Schmid 1971 winter mortality}.

At such relatively shallow snow depths, the subnivian space was probably crushed, and most of the suitable microhabitat destroyed. If any patches of suitable space remained, they were no longer connected. The temperature at the surface would have fallen greatly, eliminating shelter from extremes of cold.

If compaction is delayed until 27" of snow are on the ground, most of the changes in snow density occur near the surface {Halfpenny and Ozanne 1989, p. 260}. The subnivian space is not crushed and formation of depth hoar may have begun. The effect of reduced movement of air and water vapor through the compacted layer is not known.

Another factor that reduces the amount and connectivity of usable subnivian habitat is the accumulation of toxic gasses. For example, CO_2 has been shown to affect the distribution of animals under the snow, and its accumulation is associated primarily with the hardness and density of the overlying snow (Penny 1978).

4. **Reduction in the accessibility of food**. In fall, weight on the earliest (shallow) snow not only compacts it, but also compresses the vegetation beneath it. Vegetation that is compressed against the ground is not available as food to subnivian animals (Spencer 1984). A similar result may follow compaction of late spring snows. These normally brief periods of snow cover are prolonged by the slower melting of the compacted snow and the vegetation is encased in icy snow (Keddy, Spavold et al. 1979). This shortens the foraging season on those sites for herbivores {Beauvais pers. comm.}. For animals that store food for winter, like pikas, the lengthening of the period when forage is unavailable may reduce survival in years of high snow cover.

The persistence of snow cover depends not only on intensity but also on frequency of use that compacts the snow. In areas that are used repeatedly over a winter, each successive snowfall is compacted, leading to greater density of the snowpack as a whole (Keddy, Spavold et al. 1979).

5. **Alteration of ecological processes in the soil**. In addition to the effects on vertebrates mentioned above, snow compaction and the associated effects on temperature can alter the

small organisms (insects, mites, fungus, microbes, etc). that live in the soil and are the prey base for many small mammals, birds, and even large animals like bears. Meyer {1993} reported that compaction of the snow cover by snowmobiles for ski runs reduces the abundance of the whole soil fauna by 70%. Nutrient cycles and humus formation may be affected by the curtailment of soil microbe activity (Wanek 1971). Areas with extreme compaction (like alpine skiing slopes) are most likely to face the possibility of these adverse effects.

Variation in snow compaction and subnivian animals on the Medicine Bow NF

Downhill skiing is limited to the Snowy Range Ski Resort and telemarking on steep slopes, mostly on high stony mountains. Snowshoeing and cross-country skiing is concentrated along groomed trails that are limited in area: use is along linear trails. Few people ski extensive distances off-trail. Though large animals often react more to non-motorized than to motorized users, backcountry non-motorized is uncommon enough that it has little effect on wildlife populations.

The largest area of snow compaction is done by snowmobiles, which have a much greater daily range than non-motorized uses. Use and impacts vary with setting.

1. In <u>densely forested</u> settings, most snowmobile use on the Medicine Bow NF is on linear routes (roads) that lack woody debris and are not good habitat for small mammals. Compaction creates a barrier to subnivian movement, which is already impeded by the lack of vegetative and other structure on roads.

2. In <u>open areas within forest</u>, compaction of snow by snowmobiles may adversely affect the survival of shrews, voles, squirrels, and amphibians. These areas include open forest, meadows, riparian areas, wetlands, and, occasionally, past harvest units (either those with little structure or when snow cover is deep enough to cover the downed wood. Habitat quality may be reduced for the predators of these small mammals like Boreal Owls, goshawks, other forest owls and hawks, and marten.

Wetlands within the forest are of special concern for two reasons: first, wet meadows and wet lake edges may support relatively high densities of small mammals (including the sensitive Pygmy Shrew) and second, these areas are commonly used by snowmobiles as “play areas” and are heavily compacted if there is a reasonable route to them. Shrews build insulated nests under the snow and make foraging forays every few hours. An animal that could maintain its nest at a high enough temperature and could gather enough food to survive at a temperature near freezing could not necessarily do the same if the soil temperature fell to –15 degrees C.

3. <u>Above treeline</u>, snow characteristics are different from those in forested areas because of the effect of wind and topography. Wind-blown snowflakes are re-shaped as the delicate structure is broken and the “flakes” become pellets that pack tightly together when they settle. The snowpack is naturally more compacted that a forest snowpack. Snow collects in concave places (and sites downwind of a structure like a tree or boulder) and blows off convex sites {Pruitt, 1984, Hiemstra et al 2002}. In places this is obvious (vegetation may show through wind-blown sites, and huge drifts may accumulate downwind of trees), but in other places it may be difficult to estimate snow depth from the surface. However, small mammals select hollows that are filled with deep snow, either for their subnivian qualities or because these areas have higher moisture (and productivity) in the snow-free season (Pruitt 1984).

Snowmobile use above treeline is heavy and continuous within a few hundred yards of main travel routes. Farther off-trail, large "play" areas of desirable terrain may be essentially continuously compacted, but overall use becomes less continuous. Much of the area is compacted when snow is still shallow; other areas are not affected until snow is several feet deep. Some uncompacted sites exist, but these are not correlated with areas of most value to subnivian mammals. The lack of surface evidence of concavities makes management of snowmobile use around specific sites infeasible. Only area closures of regions with a high density of concavities like wetlands, lakes, and hollows would protect samples of this habitat.

Pikas, insectivores, and some rodents remain active throughout the winter, continuing to feed under the snow. Most of the subnivian animals are small. There are obviously limits to how large an animal can be and still slip through the small spaces available. However, another related feature is the relationship between size and ability to generate heat and store energy. Small animals have a relatively large surface area (from which they radiate heat) compared to the body's volume (throughout which they generate heat from muscle activity and metabolic activity). In addition to having less area to store fat and other energy sources, they lose relatively more heat to the environment than do large animals. Furthermore, for an animal to remain small (or at least slim) enough to use the subnivian space, it cannot put on bulky layers of fat or a thick insulated coat.

For these animals, snow cover is not a handicap but an essential feature of the environment.

- The snow's insulation maintains a relatively constant temperature (about freezing) and protects them from extremes of temperature and wind that would quickly be lethal. Their energetic cost of warming ingested food and water is reduced. Insulated nests need only protect them against moderated temperatures.
- The snow cover provides some protection from predation, and allows the very small shrews to forage in intervals evenly spaced through the day and night. (They cannot store enough energy to survive more than a few hours without feeding.) Though owls and coyotes are known for their ability to locate prey under snow by sound, snow is effective cover against visual hunters.

Some animals are active both above and below the snow. Martens, with a long, thin body shape, lack of fat storage or physiological adaptation, and relatively thin coat rely on basking in the sun and on resting sites under the snow (usually cavities in large downed logs) in extremely cold weather (Buskirk, Forrest et al. 1989). Red squirrels store cones in hollow logs and other structures and become subnivian during extreme cold. Other animals are almost exclusively subnivian in cold weather and suffer high mortality in winters with little snow. These include small rodents, especially voles, which provide a main prey base for carnivores like Northern Goshawk, Boreal Owl, and American marten. For a more thorough review see Pruitt (Pruitt Jr. 1960) and Halfpenny (Halfpenny and Ozanne 1989). The effects of snow compaction are discussed in detail in the Wildlife section and Aquatics section of Chapter 3.

Summer recreation (motorized use on designated trails and use on trails above tree-line) creates disturbance. Dispersed recreation sites are focused on lake shores and along streams, altering vegetation, compacting soil, and creating disturbance.

Part 2 – Single Species Assessment

This section of the document lists the individual species that are believed to be species of viability concern and their threats. They include threatened, endangered and proposed for listing by the USFWS, candidate species for listing by USFWS, Region 2 Regional Forester Sensitive Species and other species of local concern. These species are believed to need special consideration over the basic ecosystem composition, structure and function as described in Part 1 – Ecosystem Assessment.

According to von Ahlefeldt and Speas (Von Ahlefeldt and Speas 1996), the Medicine Bow National Forest provides a wide diversity of habitats that support:

- 75 mammals;
- 227 birds;
- 19 reptiles;
- 6 amphibians;
- 24 fish species
- 1,150 vascular plant species

Eleven native fishes occur or occurred in the past in the Little Snake River drainage of Wyoming. Eight native fishes occur within the MBNF boundary. Thirty-five fish species are considered native to the North Platte River drainage; twenty-five species have been collected in Wyoming. Prior to 1874, only four species (white sucker, longnose dace, longnose sucker, and creek chub) were found in the Forest. Nineteen fish species, including all extant trout, have been introduced into the North Platte River drainage; eight of which have been found within the National Forest.

There are at least 1,150 vascular plant species that occur on the MBNF (Von Ahlefeldt and Speas 1996). There are two Federally threatened plant species known to occur downstream of the MBNF which may be subject to offsite impacts.

The following lists are divided into three categories: (1) ESA listed species that are regulated by the USFWS, (2) Regional Forester Sensitive Species and (3) Species of Local Concern on the MBNF planning area. This section contains lists of species and threats to their viability for ESA listed and Regional Forester Sensitive species. The full assessment for ESA listed species can be found in FEIS – Appendix I: Part 1. The full evaluation for Regional Forester Sensitive species can be found in FEIS – Appendix I: Part 2. Animals of Local Concern and Plants of Local Concern are listed and evaluated at the end of this section.

ESA Listed Species

The following tables contain Endangered, Threatened, Proposed and Candidate species and the threats to their viability.

Table D-41. ESA Listed Species with Habitat on the MBNF.

Listed Species and Status	Threats
Canada lynx *Lynx canadensis* Threatened	Low population. Age/structure class distribution of lodgepole and spruce/fir. Loss of large trees that provide denning, mature multistoried habitat. Thinning of young forest (reducing prey). Snow compaction (increasing competition from other predators). Possible mortality associated with winter access (incidental to targeted species, especially bobcat).
Preble's meadow jumping mouse *Zapus hudsonius preblei* Threatened	Change in riparian habitat structure- overgrazing, conversion to agriculture or development. Diversion of water to irrigation of crops. Replacement of native grasses with non-native, pesticide use.
Bald eagle *Haliaeetus leucocephalus* Threatened	Loss of cottonwood community; loss of large diameter trees within ¼ mile of lakes, rivers, and large streams; disturbance (recreation, development) near nests (no roosts on forest).

Table D-43. ESA Listed Species that are Extremely Rare or Not Present on the MBNF.

Listed Species and Status	Threats
Black Footed Ferret *Mustela nigripes* Endangered	The U.S. Fish and Wildlife Service included this species as occurring on the Medicine Bow-Routt NF (Letter, 7/22/03). No records of this species are known within the boundaries of the Medicine Bow National Forest (based on the WYNDD, the Wyoming state database of wildlife observations, and ranger district knowledge or records). No suitable habitat is known to occur. Ferretts prey on black-tailed prairie dogs which are anR2 Sensitive or Candidate species.
Wyoming Toad *Bufo baxteri* Endangered	Presently, chytrid fungus appears to be the primary threat to the persistence of Wyoming toads in the Laramie basin. Other human activities in the past are believed to have diminished the numbers of Wyoming toads and the extent of their suitable habitats.
Ute ladies' –tresses *Spiranthes dilulvialis* Threatened	Changes in natural stream dynamics and habitat destruction from development on private lands are the primary threats from human activity. Certain management activities on the MBNF that would affect the hydrology of streams and riparian areas downstream of the MBNF can cause a loss of equilibrium within riparian systems resulting in excessive flooding events along drainageways, sedimentation, and/or channelization.

Table D-42. Off-Forest Species Subject to Effects and Threats.

Listed Species and Status	Threats
Ute ladies' –tresses *Spiranthes dilulvialis* Threatened	Changes in natural stream dynamics and habitat destruction from development on private lands are the primary threats from human activity. Certain management activities on the MBNF that would affect the hydrology of streams and riparian areas downstream of the MBNF can cause a loss of equilibrium within riparian systems resulting in excessive flooding events along drainageways, sedimentation, and/or channelization.
Colorado Butterfly Plant *Gaura neomexicana var. coloradensis* Threatened	Threats to the species across its range include; haying, grazing, herbicide spraying and urban expansion. The primary threat, however, may be vegetative succession in the absence of periodic disturbances that makes habitat unsuitable for seedling establishment

Table D-43 Candidate Species and Threats on MBNF

Listed Species and Status	Threats
Black-tailed prairie dog *Cynomys ludovicianus* Candidate	Sylvatic plague, habitat conversion.
Western Yellow-billed Cuckoo *Coccyzus americanus ssp. occidentalis* Candidate	Loss of cottonwood riparian forest with understory shrub in the Western U. S. and Canada is believed to be responsible for the decline in the western subspecies. In addition to removal of the overstory trees, this change is associated with altered water flow due to dams and irrigation diversions, to grazing of this habitat which prevents establishment of seeding cottonwoods, and to conversion to agriculture and other development.
Western boreal toad *Bufo boreas boreas* Candidate	Alteration in hydrology of small ponds, transmission of disease by forest visitors (for example on waders), and mortality from traffic are likely to occur, but none is know to be a major factor. Removal of beaver dams can decrease habitat. Alteration of terrestrial habitat away from water (forest substrate and pattern of downed wood) may reduce suitable resting and hibernation sites. Snow compaction over hibernation sites would reduce the temperature at hibernation sites in detritus and shallow burrows, but the effect of this change has not been demonstrated.
Slender Moonwort *Botrychium lineare* Candidate	Threats may include activities that change the canopy cover, soil temperature, or soil moisture of moonwort habitat . The effects of management activities such as prescribed fire on moonwort species are not well understood. In some areas, fire could possibly benefit moonwort habitat by reducing the litter accumulation and competition from other plants. Repeated removal of the spores, e.g., by grazing, can cause a population to eventually die out

Downstream Species

The U.S. Fish and Wildlife Service (USFWS) has documented the need to consider additional species occurring downstream in the Colorado and Platte River systems. The following list reflects the downstream ESA listed species on the Platte River system. The threat to their continued existence is water depletions.

- Whooping Crane, *Grus Americana* (E) and designated critical habitat
- Bald Eagle, *Haliaeetus leucocephalus (*T)
- Eskimo Curlew, *Numenius borealis (*E)
- Interior Piping Plover, *Charadrius melodus (*T) and designated critical habitat
- Interior Least Tern, *Sterna antillarum (*E)
- Western Prairie Fringed Orchid, *Platanthera praeclara (*T)
- Pallid Sturgeon, *Scaphirhynchus albus*, (E)

The following list reflects the downstream ESA listed species and designated critical habitat on the Colorado River system. The threat to their continued existence is water depletions.

- Bonytail, *Gila elegans (*E)
- Colorado Pikeminnow, *Ptychocheilus lucius* (E)
- Humpback Chub, *Gila cypha (*E)
- Razorback Sucker, *Xyrauchen texanus* (E)

Region 2 Regional Forester Sensitive Species

The Regional Forester's list of sensitive species was updated on Nov. 3, 2003. In preparing this update, the Region evaluated nearly 1,000 animal and plant species against eight standard criteria important in determining species viability. Teams of Forest Service biologists, botanists and other specialists used species evaluations and other available information to develop preliminary recommendations, which were then reviewed internally and by partner agencies. All comments received were considered in preparing the final sensitive species list.

Sensitive species are those plant and animal species, designated by the Regional Forester, whose population viability is a concern on National Forests and Grasslands within the Region. Sensitive species may also be those species whose current populations and/or associated habitats are reduced or restricted or their habitats and/or populations are considered vulnerable to various management activities, and special emphasis is needed to ensure they do not move towards listing as threatened or endangered. The species on the Regional Forester list that are believed to have habitat on the MBNF are assessed in this section.

The 1993 Regional Sensitive Species Lists and updates to 2001 were used in the DEIS. Species that were analyzed in the DEIS but not included in the following list due to changes in the list are:

- Dwarf shrew (*Sorex nanus*)
- Ringtail (Bassariscus astutus)
- Common Loon (*Gavia immer*)
- Osprey (Pandion haliaetus)
- Merlin (Falco columbarius)
- Greater Sandhill Crane (*Grus canadensis tabida*)

- Golden-crowned Kinglet (*Regulus satrapa*)
- Fox Sparrow (Passerella iliaca)
- Brown Creeper (Certhia americana)
- Pygmy Nuthatch (*Sitta pygmaea*)
- Tiger salamander (*Ambystoma trigrinum*)
- Larimer Aletes (*Aletes humilis*)
- Clustered Lady's-Slipper Orchid (*Cypripedium fasciculatum*)
- Sidesaddle Bladder Pod (*Lesquerella arenosa* var. *argillosa*)
- Alpine Feverfew/Wyoming Feverfew (*Parthenium alpinum*)
- Laramie False Sagebrush (*Sphaeromeria simplex*)

The following table displays the species that are on the 2003 Regional Forester's Sensitive Species list and have habitat on the MBNF. A complete evaluation of the species in contained in Appendix I – Part 2 Biological Evaluation.

Table D-44. R2 Sensitive Animal and Plant Species on the MBNF and Their Threats.

SENSITIVE SPECIES	THREATS
Mammals	
Pygmy shrew *Sorex hoyi*	Loss of downed wood and disruption of habitat at the edge of wetlands may reduce habitat suitability. Recreation resulting in compaction of snow, especially near wetlands, may be a threat.
Fringed myotis *Myotis thysanodes*	Colonies are very sensitive to disturbance in abandoned mines and caves and have high site fidelity. These gregarious bats are susceptible to vandalism and disturbance by humans visiting caves and abandoned mines. Disturbance in and near roost sites may cause abandonment of area and loss of local population. Habitat loss occurs with closure of abandoned mines that are dangerous to the public unless bat gates are installed. Though this is an artificial habitat, if natural cave populations have been lost, the abandoned mine habitat should be protected.
Townsend's big-eared bat *Corynorhinus townsendii*	Colonies are very sensitive to disturbance in abandoned mines and caves and have high site fidelity. Recreation and other disturbance in and near roost sites may cause abandonment of area and loss of local population. Habitat loss occurs with closure of abandoned mines that are dangerous to the public unless bat gates are installed. Though this is a man-made habitat, if natural cave populations have been lost, the abandoned mine habitat should be protected. Day roosts may be located in trees and snags. Alteration of forest and riparian zones that converts moist areas to drier types have an adverse effect on prey.
Black-tailed prairie dog	See Candidate Table Above.
White-tailed prairie dog	Threats to this species have been identified as poisoning, shooting, agricultural development, urbanization, and sylvatic plague. Poisoning and shooting have not been as great a threat to white-tailed prairie dogs as it has been to black-tailed prairie dogs. White-tailed prairie dogs have not been perceived as threatening grazing lands nearly as much as the black-tailed prairie dog. They do not normally remove tall vegetation from around their burrows and within their colony as black-tailed prairie dogs do.
American Marten *Martes americana*	Loss in amount of primary habitat (late successional forest, especially spruce/fir but also lodgepole if structural elements are present) and severe fragmentation of patches of late successional forest reduce habitat suitability for marten. Inadequate retention and provision of long-term gradual recruitment of downed wood reduces insulated subnivian winter resting sites, denning sites, and prey density. Suspended downed wood is needed to create patches of subnivian habitat over a square meter in size for winter foraging. Large downed logs (from old trees with heartrot) are used for denning and for subnivian resting sites. Compaction of snow may allow larger mammalian predators to enter the marten’s winter habitat. These may compete for the same prey and may also kill martens. Trapping is a continuing source of mortality. Fur prices are low at this writing, and few trappers are active, but a renewal of interest could have adverse effects on the Medicine Bow population because there is access to much of the suitable habitat by snowmobiles.

SENSITIVE SPECIES	THREATS
Wolverine *Gulo gulo*	Road construction that increases human disturbance reduces the breeding range of wolverines. Winter recreation in previously remote areas will probably drive reproductive females out of the area.
Northern River Otter *Lontra canadensis*	Disturbance, cabin leases, and grazing may affect otter populations. Removal of trees and snags along rivers and streams reduces rest sites, den sites, and quality of fish habitat. Changes in habitat following loss of beaver may remove structural features used by otters.
Birds	
Northern Goshawk *Accipter gentiles*	Goshawks are sensitive to disturbance at nest sites. Development of an understory in a previously open forest (like ponderosa pine) reduces foraging habitat. Lost of mature/old trees in stands with open understories reduces nesting habitat.
Ferruginous Hawk *Buteo regalis*	The species is sensitive to human activity near the nest. Habitat loss occurs in conversion of native grassland to agriculture or residential development. Consuming small mammals with residues of rodenticides may poison ferruginous hawks.
Peregrine Falcon *Falco peregrinus anatum*	Disturbance at nest sites by rock climbers. Taking of young by falconers. Predation on fledglings by Golden Eagles. Mortality from collisions with fences and powerlines. Contamination of prey with bio-accumulating pesticides (which are still used within the wintering range of the species).
Northern Harrier *Circus cyaneus*	Heavy grazing that removes cover for nest sites and conversion of grass habitat to crop production. Disturbance at nest sites.
Columbian Sharp-tailed Grouse *Tympanuchus phasianellus columbianus*	The small isolated populations are vulnerable to local extinctions and to loss of genetic variation. Disturbance at the lek (the site of display and breeding), overgrazing, fire suppression, conversion of habitat to agricultural use, and pesticide use are threats to the subspecies.
Greater Sage Grouse *Centrocercus urophasianus*	Loss of sagebrush mosaic, fragmentation of large tracts of sagebrush, alteration of the grass/forb understory, and disturbance at leks have been the major threats to Sage Grouse. The declining range, reduced population, and increasing isolation of breeding populations make the species vulnerable to further local losses.
White tailed Ptarmigan *Lagopus leucurus*	Grazing and recreation are possible sources of stress on ptarmigan populations.
Mountain plover *Charadrius montanus*	Reduced grazing on wintering grounds. Loss of prairie dogs which create bare ground conditions.

SENSITIVE SPECIES	THREATS
Boreal Owl *Aegolius funereus*	Boreal owls are limited in the MBNF by the abundance of large snags with cavities, by the amount of old forest with complex structures, and possibly by prey density. Snags are lost by firewood collection and in timber harvest. Lack of dead downed wood recruitment over time would reduce habitat suitability for the Boreal Owl's prey.
Short-eared Owl *Asio flammeus*	Loss of vertical structure due to habitat conversion or overgrazing could adversely affect the species.
Flammulated Owl *Otus flammeolus*	Loss of a mosaic of open and dense mature/old ponderosa pine.
Yellow-billed Cuckoo *Coccyzus americanus*	See Candidate Table Above.
Lewis' Woodpecker *Melanerpes lewis*	Fire suppression has reduced the abundance of open-structured ponderosa pine. Removal of snags and old forest and post-burn salvage sales reduce the amount and quality of habitat. Firewood collection of snags from low elevation forest and riparian cottonwood removes nesting habitat.
Black Backed Woodpecker *Picoides arcticus*	The primary threats are from fire suppression, salvage logging, and removal of snags.
American three-toed woodpecker *Picoides dorsalis*	The primary threats are from logging activity. Removal of snags and old forest, fragmentation of blocks of mature/old forest, and salvage sales reduce the amount and quality of habitat.
Olive-sided Flycatcher *Contopus borealis*	Fire suppression and salvage logging can reduce suitable habitat. Snags are cut in forested areas along edges of units to reduce safety hazard to loggers, reducing habitat adjacent to created openings.
Brewer's Sparrow *Spizella breweri*	Alteration of mixed sagebrush grassland habitat by changes in grazing and fire.
Sage sparrow *Amphispiza belli*	The amount and quality of habitat for the Sage sparrow is affected by grazing and prescribed burning in sagebrush. Conversion of sagebrush to agricultural land and removal of old dense stands of sagebrush are major threats across the species' range.
Loggerhead Shrike *Lanius ludovicianus*	Loss of structure in grassland habitat, conversion to crop production.

SENSITIVE SPECIES	THREATS
Amphibians	
Northern leopard frog *Rana pipiens*	Unknown. Mass mortality related to the chytrid fungus occurred in Arizona in 1999. Alteration in hydrology of small ponds, transmission of disease by forest visitors (for example on waders), and mortality from traffic are likely to occur, but none is know to be a major factor. Logging adjacent to breeding sites, trampling of pond edges by livestock are possible sources of reduction of habitat quality. The reason for the nationwide decline in northern leopard frog's populations is not known.
Wood frog *Rana sylvatica*	The restricted range of this population and its separation by hundreds of miles from other wood frog populations puts it at risk. With such a small population, an extreme natural event or disease could reduce the local numbers below a level likely to sustain a viable population. The widespread decline of amphibians worldwide and the lack of a known cause are further causes of concern. Threats include presence of predatory non-native fish and poisoning of ponds in fish management. Possible impacts may arise from alteration of shoreline by logging and livestock. Removal of canopy near breeding ponds may reduce reproduction by raising water temperature and exposing eggs to sunlight (which increases susceptibility to mold).
Western boreal toad *Bufo boreas boreas*	See Candidate Table Above.
Fish	
Colorado Cutthroat Trout *Oncorhynchus clarki pleuriticus*	Several conditions constitute threats to the persistence of Colorado River cutthroat trout. Examples of existing or possible threats include: introduced trout; water diversions; illegal harvest; livestock overgrazing; sedimentation from roads and poorly maintained irrigation ditches; and whirling disease.
Mountain Sucker - *Catostomous platyrhynchus*	Habitat alterations (water developments and habitat fragmentation) and introductions of non-native, predatory fish are the predominant threats to the mountain sucker due to human activities.
Flannelmouth Sucker - *Catostomous latipinnis*	Because the Flannelmouth sucker utilizes spawning habitats in small, tributary streams, it is important that large-river, stream, lake, and reservoir habitats remain as unfragmented as possible so that successful spawning is possible. Activities that negatively impact water quantity and quantity as well fragment habitats essential to the species survival threaten its persistence.
Hornyhead Chub - *Nocomis biguttatus*	Activities that negatively impact water quality and water quantity are problematic for the persistence of honyhead chub populations. In addition, habitat fragmentation and introductions on non-native trout have probably affected the abundance and distribution of this species in the Forest.

SENSITIVE SPECIES	THREATS
Plains Minnow - *Hybognathus placitus*	Activities that negatively water quantity are problematic for the persistence of plains minnow populations. In addition, habitat fragmentations due to water development and introductions on non-native trout have probably affected the abundance and distribution of this species throughout its historic range in Wyoming. Finally, the plains minnow is easily seined and used as a baitfish. Overexploitation by baitfish anglers may negatively impact populations of plains minnows in Wyoming.
Insects	
Hudsonian emerald *Somatochlora hudsonica*	Alteration of structure or degradation of water quality in high elevation fens.
Mollusks	
Rocky Mountain capshell *Acroloxus coloradensis*	Water quality conditions other than requirements of moderately warm (16-21 degrees C), alkaline (between pH 7.0 and 8.0), well-oxygenated (7.0-8.0 mg/L) water that contains bound carbonates (CaCo3).
Plants	
Laramie Columbine *Aquilegia laramiensis*	The species' primary habitat on ledges and crevices in granite cliffs is largely inaccessible and resilient. The species is reported extending down into forested habitats and has been located in areas proposed for timber harvest (Beyer 2002). Some populations could also potentially be threatened by over-harvest for garden use.
Park milkvetch *Astragalus leptaleus*	Threats from human activities include livestock grazing on both National Forest and private lands, disturbance associated with actions on nearby forestlands such as road construction for timber harvest and development on private lands and trampling.
Slender Moonwort *Botrychium lineare*	See Candidate Table Above.
Leathery grape-fern *Botrychium multifidum*	Threats from human activities include recreation, livestock grazing on both National Forest and private lands, disturbance associated with actions on nearby forestlands such as road construction for timber harvest and development on private lands and activities that change the canopy cover, soil temperature, or soil moisture. Fires, except where exceptionally hot, pose no threat to Botrychium species because of their ability to forego emergence above ground some years. However, very hot fires that desiccate the soil and kill the underground parts or the associated mycorrhizae would be harmful. European earthworms can have an adverse impact on moonworts by removing or reducing the natural litter layer that conserves moisture and provides nutrients.
Lesser panicled sedge *Carex diandra*	Lesser panicled sedge sites could be subject to browsing and/or trampling impacts. Other threats from human activity could include wetland development on both NFS lands and private lands. Extant populations appear to be stable to partly declining due to habitat loss. Recreational use within riparian areas could remove and/or injure plants, alter soil properties, disturb floating coniferous log habitat, change the hydrologic regime and/or reduce the overall vigor of sedges.

SENSITIVE SPECIES	THREATS
Bristly-stalked sedge *Carex leptalea*	Populations of bristly-stalk sedge may be threatened by logging, grazing, trampling, road construction, wetland development or recreational impacts on its wetland habitat. Recreational use within riparian areas could remove and/or injure plants, alter soil properties, change the hydrologic regime and/or reduce the overall vigor of bristly stalk sedge.
Livid sedge *Carex livida*	The peatland habitat that this and other obligate fen plant species require is sensitive to hydrologic change and there is no known method for creating or restoring peatlands, therefore it is not possible to mitigate for their loss. Threats include activities which could cause hydrologic change include wetland development, concentrated livestock use, road building, logging, motorized recreation and peat mining.
Yellow ladies" slipper *Cypripedium parviflorum*	Yellow ladies' slipper is vulnerable to habitat loss, horticultural collecting, and medicinal collecting range wide. Its response to canopy removals is uncertain, but it is likely that it would not tolerate significant overstory removals or soil and hydrological changes. Yellow ladies' slipper is also vulnerable to changes in cover types from aspen to conifers. This species may be impacted by road construction or other ground disturbances associated with logging, recreation or development. Habitat may occur on lands designated as suitable for timber harvest where aspen is successional to conifers.
Round leaf sundew *Drosera rotundifolia*	The peatland habitat that this and other rare obligate fen plant species require is sensitive to hydrologic change and there is no known method for creating or restoring peatlands, therefore it is not possible to mitigate for their loss.
Boreal spikerush *Eleocharis elliptica*	Boreal spikerush may be impacted by degradation of wetland habitats by road building. The single Region 2 population is within the MBNF in an area managed for multiple use.
Slender-leaved buckwheat *Eriogonum exilifolium*	Documented threats to slender-leaved buckwheat include trampling by livestock and/or humans, road construction and maintenance, and illegal off-road ATV and motorcycle traffic. This species appears to benefit from some disturbance, since it has been observed to colonize road-cuts with exposed bare soil. Some habitat on private land has been lost to subdivision in the Laramie, Wyoming area.
Slender cotton-grass *Eriophorum gracile*	This species may be threatened by livestock grazing, trampling, and recreational use in its habitat. Weeds spread by pack stock could infest slender cotton-grass habitat. Slender cotton-grass is also vulnerable to hydrologic modification for water development, road construction, as well as peat mining and bog iron mining.
Hall's Fescue *Festuca hallii*	Hall's Fescue may be threatened by grazing. Suitable habitat is located in areas available for timber harvest. Competition from non-native plants could threaten Hall's fescue. The spread of non-native plants is associated with higher levels of human activities.

SENSITIVE SPECIES	THREATS
Rabbit Ears Gilia, Weber's Scarlet Gilia *Ipomopsis aggregata ssp. weberi*	Rabbit ears gilia may be impacted by herbicide spraying, grazing, timber harvest, road construction and maintenance, and other ground disturbing activities. The habitat in Wyoming may be susceptible to fire suppression and the resulting shrub encroachment. Competition from non-native plants could threaten rabbit ears gilia. The spread of non-native plants is associated with higher levels of human activities.
Simple kobresia *Kobresia simpliciuscula*	The peatland habitat that this and other obligate fen plant species require is sensitive to hydrologic change and there is no known method for creating or restoring peatlands, therefore it is not possible to mitigate for their loss. Activities which could cause hydrologic change to peatlands include wetland development, concentrated livestock use, road building, logging, motorized recreation and peat mining.
Colorado Tansy Aster (*Machaeranthera coloradoensis var. coloradoensis)*	Documented threats to Colorado tansy aster include trampling by livestock, road construction and road maintenance, off-trail ATV and motorcycle traffic and musk thistle population expansion.
Kotzebue grass of parnassus Parnassia kotzebueii	Threats to Kotzebue grass of parnassus include trampling, consumption by livestock. Summer recreational use, in alpine areas can remove and/or injure plants and/or alter soil properties. Winter recreation use could change the hydrologic and/or thermal regime and reduce the overall vigor of Kotzebue's Grass-of-parnassus. Management actions that compact or move snow can change water distributions and timing and change growing conditions.
White larchleaf beardtongue *Penstemon laricifolius ssp. exifolius*	Threats include livestock grazing on both National Forest and private lands, disturbance associated with actions on nearby forestlands such as road construction for timber harvest and development on private lands. It would generally not be directly affected by timber harvest activity, except in instances where a road or skid trail associated with timber harvest might cross a sagebrush and limber pine area. Road and/or trail construction associated with oil and gas leasing or recreation development would pose similar threats. There is some potential for impact to likely habitat from trampling by wildlife or recreational hikers, invasion by noxious or other aggressive non-native weeds, wildfire, or flood, but the risks are considered low, except where a population might occur next to a popular site.
Rocky Mountain cinquefoil *Potentilla rupincola*	Rocky Mountain cinquefoil may be vulnerable to horticultural collecting range wide. Habitat may occur on lands designated as suitable for timber harvest. This species may be threatened by grazing.
Nagoon berry *Rubus arcticus ssp. acaulis*	Habitat for nagoon berry is potentially impacted by grazing, logging, recreation use. Recreational use with riparian areas can remove and/or injure plants, alter soil properties and reduce the overall vigor of plants. In general, any activity that alters water levels may adversely affect this habitat.

SENSITIVE SPECIES	THREATS
Silver willow *Salix candida*	Threats include browsing and/or trampling impacts from domestic livestock. Recreational use within riparian areas can remove and/or injure plants, alter soil properties and reduce the overall vigor of willows. In general, any activity that alters water levels may adversely affect this species.
Autumn Willow *Salix serissima*	Threats include browsing and/or trampling impacts from domestic livestock. Recreational use with riparian areas can remove and/or injure plants, alter soil properties and reduce the overall vigor of willows. In general, any activity that alters water levels may adversely affect this species.
Low spike-moss *Selaginella selaginoide*s	Threatened by livestock trampling, roads or skid trails associated with timber harvest that cross riparian areas.
Lesser bladderwort *Utricularia minor*	Threatened by loss or deterioration of wetland habitat and/or water quality. Impacted by drainage, diversion, livestock use, road construction, increased sedimentation, nutrient enrichment, mining and fish introductions.
Great spurred violet *Viola selkirkii*	Threats include changes to canopy cover, soil temperature, or soil moisture. Impacts from trampling by wildlife or recreational hikers, invasion by noxious or other aggressive non-native weeds, wildfire, or flood.

Species of Local Concern

The following table displays the two mammals, two birds and twenty-six plants that are identified as Species of Local Concern. The table lists the names, rankings, habitat, distribution on the MBNF and threats.

Table D-45. Ranking, Habitat, Distribution and Threats of Species of Local Concern on the MBNF.

Species of Local Concern	Ranking	Habitat	Distribution on MBNF	Threats
Mammals				
Pika	G5T5 S3	Talus slopes/outcrops of rock above 8,000 feet, set in tundra or broken subalpine forest	Alpine areas of the Sierra Madre and Snowy Range.	Isolation, grazing, disturbance associated with recreation
Bighorn Sheep	G4 S3/S4	Rock outcrops, cliffs, and canyons	Laramie Peak, Douglas Creek, Encampment River.	Introduction of parasites and diseases
Birds				
Brown-capped Rosyfinch	G4 S1	Above timberline, in low grass, cushion plant, and lichen encrusted or bare rock	Snowy Range	Isolation, disturbance associated with recreation
Brown Creeper	G5 S4	Large blocks of old spruce-fir and lodgepole forest	Primarily Sierra Madre and Snowy Range	Alteration of forest structural components and fire
Plants				
Moschatel	G5 S1, Low	Limestone cliffs, Spruce/fir forests	1 population Snowy Range	Isolation, habitat disturbance, logging
American alpine lady fern	G4G5 T4T5 S1, Low	Talus, streams	1 population Snowy Range	Overcollection, trampling from recreation
Dissected bahia	G5 S1S2, Low	Sherman granite, sagebrush, Ponderosa Pine	Laramie Peak, Pole Mountain, Sierra Madre	Isolation, grazing, fire
Alpine kittentails	G4 S1, Med	Talus, alpine cushion plant communities	Snowy Range	Isolation, trampling
White river kittentails	G4	Sherman granite, aspen,	Pole Mountain, Laramie Peak	Isolation, grazing, trampling,

Species of Local Concern	Ranking	Habitat	Distribution on MBNF	Threats
	S1, Med	willows	Range	fire
Clustered Lady Slipper	G4 S2, Med	Mature lodgepole pine and spruce/fir forests and openings close to such forests	Sierra Madre and Snowy Range	Canopy cover changes from logging or fire, trampling, grazing, collecting
Showy draba	G3? T3Q S1, Med	Wet meadows, spruce/fir forests, willows	Sierra Madre has one known population in Wyoming	Isolation, grazing, logging
Flat-top fragrant goldenrod	G5T5 S1, Low	Streambanks, sand bars	Laramie Peak Range and Pole Mountain	Hydrologic changes, isolation, grazing, trampling
Bigelow's prairie gentian	G5 T4 S1, Low	Sherman granite, sage-brush-mdws, stream-sides	Pole Mountain	Grazing, fire, isolation, competition from invasive plants
Oak fern	G5 S1, Low	Spruce/fir forests, streams, cliffs	Sierra Madre	Logging, fire, grazing, isolation
Thread rush	G5 S1, Low	Wet meadows, streambanks	One occurrence Sierra Madre	Hydrologic changes, isolation, grazing, trampling
Northern white rush	G5 T5 S1, Med	Bogs, willows, stream-banks	One occurrence Snowy Range	Hydrologic changes, isolation, grazing, trampling
Narrowleaved bladderpod	G4 T3? S1, Med	Sagebrush, grass, gravel	Sierra Madre	Isolation, logging, grazing, fire, trampling
Bigelow's grounsel	G4? T3T4 S1, Low	Wet meadows, willows, spruce/fir forests	Sierra Madre, Snowy Range, Pole Mountain	Isolation, logging, hydrologic changes, grazing, fire, trampling
Slender-leaved lovage	G5 S1, Low	Meadows, streamsides	Sierra Madre	Isolation, logging, grazing, trampling
Broad-leaved twayblade	G5 S1, Low	Grass, aspen, alder	Snowy Range, Laramie Peak Range	Over-collecting, isolation, logging, grazing, trampling
Marsh felwort	G5	Wet meadows, willows	Snowy Range and Pole	Hydrologic changes, isolation,

Species of Local Concern	Ranking	Habitat	Distribution on MBNF	Threats
	S1, Med		Mountain area	grazing, trampling
Saffron groundsel	G4 S1, Med	Wet meadows	Snowy Range	Hydrologic changes, grazing, recreation use, isolation
Streambank groundsel	G5 T? S1, Low	Wet meadows	Sierra Madre, Snowy Range, Pole Mountain	Hydrologic changes, grazing, recreation use, isolation
White scorpion-weed	G4G5 S1, Low	Mdws, aspen, S/F. LPP	Sierra Madre, Snowy Range, Pole Mountain	Competition from invasives, isolation, fire, grazing
Rocky Mountain phacelia	G3? S2, Med	Foothills, draws, clay banks	Snowy Range, Pole Mountain, Laramie Peak Range	Mineral development, grazing, fire, isolation
Flatleaf pondweed	G5 S1, Med	Aquatic, streams, lakes	Snowy Range	Hydrologic changes, isolation
Western goldenweed	G4? T4? S1, Low	Mid-elev meadows, aspen	Snowy Range, Laramie Peak Range	Grazing, hydrologic changes, isolation
Porter's aster	G3G4 S1, Low	Aspen, LP, DF, Limber pine, shrubs	Sierra Madre, Snowy Range	Fire, logging, isolation, grazing
Western trillium	G5 S2 Med	Old growth forests	Snowy Range	Canopy changes and fragmentation from logging or fire, grazing, isolation
Squashberry	G5 S1 Low	Streambanks aspen, spruce/fir forests	Snowy Range	Grazing, logging, fire, isolation

TNC NATURAL HERITAGE RANKING: GLOBAL RANK (G): based on range-wide status of a species.

G1 -- Critically imperiled globally because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction. (Critically endangered throughout its range).

G2 -- Imperiled globally because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extinction throughout its range. (Endangered throughout its range).

G3 -- Very rare or local throughout its range or found locally in a restricted range (21 to 100 occurrences). (Threatened throughout its range).

G4 -- Apparently secure globally, though it might be quite rare in parts of its range. especially at the periphery.

G5 -- Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

GQ -- Indicates uncertainty about taxonomic status.

G? -- Indicates uncertainty about an assigned global rank.

TRINOMIAL RANK (T): Used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.

STATE RANK (S): based on the status of a species in an individual state ranks may differ between Wyoming and neighboring states based on the relative abundance of a species in each state.

S1 -- Critically imperiled in state because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extirpation from the state. (Critically endangered in state).

S2 -- Imperiled in state because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extirpation from the state (Endangered or threatened in state).

S3 -- Rare in state (21 to 100 occurrences).

S? -- Indicates uncertainty about an assigned state rank.

SH -- Of historical occurrence, not documented in Wyoming since 1920.

--No State rank available at this time.

Wyoming Natural Diversity Database (WYNDD) Conservation Priority

Low, Med – Medium, High

Watch – Watch list-- No WYNDD conservation priority available at this time.

WYNDD Intrinsic Vulnerability H – high, M – medium, L – low

Species by Species Evaluation – Animals of Local Concern

In addition to animal species that are sensitive at the Regional scale, each Forest has the discretion to consider assessing species that may be of "local concern." These species may be doing very well on some administrative units, but be less successful on others and in need of careful attention. Local endemics, even if not known to be at risk, may be worth added analysis if small population size and/or isolation make the populations vulnerable.

The following evaluations disclose the predicted likelihood of persistence for mammals and birds of local concern.

Pika - *Ochotona princeps saxitilis*

Status and distribution of species

In North America, pikas occur throughout the Rocky Mountains and coastal ranges. Other species of pika occur in Asia and Europe. In Wyoming, pikas are found in the NW corner of the state, in the Bighorn Mountains, in the Sierra Madre, and the Snowy Range. The Wyoming pika have been separated into 4 subspecies (corresponding to the geographic areas listed), though only the Bighorn subspecies may be a valid subspecies (Clark and Stromberg 1987).

Status and distribution on the Medicine Bow NF

Pikas occur in the alpine areas of the Sierra Madre and Medicine Bow (Snowy Range). Whether these are distinct subspecies is unclear.

Habitat

Pikas are found near talus slopes or outcrops of rock above 8,000 feet, set in tundra or broken subalpine forest. Adjacent meadow must be available for feeding. Pikas gather food in the summer and fall, storing it in the spaces between rocks in talus or boulder piles. They remain active all winter in this environment, feeding on this stored food.

Threats, limiting factors, and vulnerabilities

By virtue of their habitat on rocky peaks, pika populations are often isolated. The Bighorn Mountains population (probably a subspecies) was assessed by the R2 team for proposal as a sensitive species because of its demographic characteristics (poor dispersal to other populations, isolation, small population, R2 Species Conservation Project species assessments). The team concluded that the Bighorn Mountain pika did not warrant sensitive status because most of its habitat was in wilderness and there were no threats.

Of twenty-five pika populations in the Great Basin that were present during the 20th century, seven (28%) were extirpated by 1999 (Beever, Brussard et al. 2003). There were no obvious changes in the habitat at each site. Factors correlated with persistent colonies include larger area of talus, higher elevation, lack of livestock grazing, greater distance to a primary road, and wilderness management. Several of these variables are correlated with each other, so it is not possible to determine causation. Great Basin populations are isolated by long distances, but if the dispersal distance of pikas is only 10 to 20 km (as estimated by Hafner), the Medicine Bow and Sierra Madre populations are effectively isolated (Beever, Brussard et al. 2003).

The Medicine Bow and Sierra Madre populations of pikas have the same vulnerabilities as the Bighorn and Great Basin population. However, the Medicine Bow and Sierra Madre are heavily used for winter recreation whenever there is snow. Snow compaction and disturbance may reduce food and increase energy demands for pikas (see below). Summer recreation is also more intense than at remote pika sites, since a state highway crosses the mountains and makes pika habitat easily accessible.

The territorial defense of meadow foraging areas and haystacks suggests that food gathered for winter is a limiting factor in pika survival.

Changes from HRV in factors that may affect the species

Yearlong disturbance due to human activity in a formerly remote area may alter habitat use and increase energy demand during winter, when available food is limited.

In autumn, snowmobiles or skiers compact the first snows against the ground, leaving forage beneath it unavailable to pikas gathering the last of their winter food. Compaction causes loss of insulation of the snowpack over wintering habitat where excessive high-marking by snowmobiles or skiing occurs.

Meadows in the Snowy Range alpine zone are in grazing allotments, though these are currently inactive. Grazing of grass/forb communities can substantially reduce forage for pikas (Species Conservation Program 2001). Recreation that compacts snow over foraging areas and wintering habitat may alter the winter energy budget.

Conclusion on viability concern on the Medicine Bow NF

Primary referenced used are Clark and Stromberg (Clark and Stromberg 1987), Species Conservation Project Assessment for the Bighorn Mountain Pika, and Chris Ray (pers. comm.).

Environmental Consequences and Viability

The evaluation criteria for the pika are compaction of snow over foraging habitat and disturbance from recreation.

Table D-46. Viability conclusions for pika

	Alt A, B, C, D DEIS, D FEIS E	Alt F
Abundance and distribution	Very localized, isolated. Abundance unknown.	Very localized, isolated. Abundance unknown.
Likelihood of persistence- 15 yr.	Likely	Likely- elimination of off-trail snowmobiling
Likelihood of persistence- long-term	Uncertain- viability concern	Likely- elimination of off-trail snowmobiling
Certainty	Low	Low

Bighorn Sheep - *Ovis canadensis*

Status and distribution of species

The Bighorn Sheep occurs in mountains in southern Canada, the western U.S., and northern Mexico.

Status and distribution on the Medicine Bow NF

There are three herds on the MBNF.

The **Laramie Peak** herd occupies "adequate habitat" in the southern portions of the Laramie Peak Unit, but the habitat in the northern portions of the herd unit is marginal (WGFD, letter 10/28/2002 attachment). All Forest Service grazing allotments are now occupied by cattle except one occupied by domestic sheep at the northwestern end of the unit. This allotment is about 5 miles from a mapped bighorn home range (off-forest, based on WYGF data); though the area used by the domestic sheep is primarily out on the plains where bighorns are unlikely to occur, there is a chance that a young ram would move that far. There is no restriction on grazing by sheep on the allotments now occupied by cattle, though the effects on bighorns would be assessed if a change to sheep use were proposed. The Forest Service ownership is fragmented and interspersed with private land. There is nothing to prevent use by sheep on that land, though currently only a few small "hobby" herds are present. These small herds tend to be confined, but could be visited by bighorn rams wandering during breeding season.

The **Douglas Creek** herd (in the SE Medicine Bow Mountains) occupies the rocky area and canyons that lie in and north of the N. Platte Wilderness. In summer, bighorns may be seen at the top of the Medicine Bow range, along Highway 130. Both rams and ewes have been seen in this area, which is probably part of the historic summer range for the species. The recent lack of large burns has left dense forest that reduces connectivity between this high-elevation summer range and the lower wintering grounds. There are eight grazing allotments in the Medicine Bow range, running from the tundra (where bighorns have been seen) to the northeast. The high-elevation allotments are currently vacant (though recent queries have been made about use for sheep.) The other allotments on the Medicine Bow Range are either vacant or used by cattle, but there is no restriction on use by domestic sheep. Use of these allotments as a grass bank for sheep has been discussed.

The **Encampment River** herd has not flourished, though the reason for this is not clear. Though the herd's summer range overlaps several active grazing allotments occupied by sheep and Chlamydia has been found in the herd (Loose 2002), (Cook, Irwin Larry L et al. 1998). *Pasteurella haemolytica* has not been documented. However, the overall condition in the herd is poor; there is evidence that poor quality forage may be a contributing factor (Loose 2002), (Cook, Irwin Larry L et al. 1998). The Wyoming Interagency Bighorn Working Group ranks this herd as lowest priority (of 3 classes) for investment in habitat improvement.

The following maps display Bighorn sheep winter, summer, and crucial ranges.

Map D-6 Bighorn sheep range Sierra Madre and Snowy Ranges

Map D-7 Bighorn sheep range Laramie Peak and Pole Mountain

Habitat

In summer, open areas near rock outcrops, cliffs, and canyons. Bighorns remain close to rugged terrain, which is used as escape cover from predators, especially when young lambs are present. An elevational migrant, bighorns winter in grassland and shrub on hillsides with limited snow cover.

Changes from HRV in factors that may affect the species

The presence of new diseases and parasites has had the most effect on bighorns. Genetic alteration has occurred because of past hunting that eliminated populations that were restocked from other areas. Disturbance from increased recreation in summer and from snowmobile use in fall, winter, and spring. Snowmobiling is not permitted in winter range.

Threats, limiting factors and vulnerabilities

The primary threat is the introduction of parasites and diseases (especially *Pasteurella haemolytica*) by domestic sheep (Schommer and Woolever 2001). Young bighorn rams wander long distances (sometimes over 25 miles) in the breeding season. These individuals may become infected and bring the disease back to the rest of the bighorn herd.

Disturbance from human activity alters foraging pattern and causes stress. Fire suppression has decreased connectivity on habitat as forest invades grassland (including migratory routes between some summer and winter ranges.)

Environmental Consequences and Viability

Management direction in the revised Plan protects sheep winter range and lambing areas from disturbance. Additional direction is given for Geographic Areas that form the core of the herds' yearlong range, but the bighorns are not confined to those areas and may be exposed to domestic sheep on adjacent GAs. None of the GAs with mapped bighorn range on the Laramie Peak Unit or the Snowy Range currently have any active sheep grazing allotments.

The Laramie Peak herd has a moderate-high likelihood of persistence under current forestwide and grazing allotment standards. With separation of grazing from domestic sheep, the likelihood increases, but there is still risk from domestic sheep on adjacent land of other ownerships.

The Douglas Creek herd has a moderate probability of persistence under current forestwide and grazing allotment standards. Even with the management direction given above in the 5 central Geographic Areas in its range, there is still risk of contagion from domestic sheep on adjacent GAs or on other ownerships.

The Sierra Madre herd has a low-moderate probability of persistence under current forestwide and grazing allotment standards. The herd's range overlaps with active grazing allotments and forage conditions are poor.

The likelihood is low that all three herds will persist in the long-term without intervention (augmentation or restocking). The likelihood of long-term persistence of two herds is moderate (one of them might be affected by existing threats). The likelihood of long-term persistence of one herd is moderate to high.

Maintenance of all three herds across the current range on the Forest is unlikely under current direction. The Forest Service's responsibility to maintain viable populations does not mean that populations must be maintained at 100% of potential; rather there is a balance between this requirement and other multiple use objectives. For most species, it is possible to achieve this balance across the whole range of the species in the planning unit. There may be 80% or even 60% of potential numbers, but this can be spread over the whole area inhabited (i.e., the animals may occur at lower density). Bighorns are different for two reasons. First, the herd size cannot be reduced below about 125 without loss of long-term genetic viability (Schommer and Woolever 2001), though this could be maintained by occasional introductions of unrelated bighorns. Second, infection of the herd by *Pasturella haemolytica* carried in by domestic sheep does not have a graduated response, increasing with the number of infected vectors: rather, once the disease is in the bighorn herd, mortality is 75% to 100%, and surviving ewes often do not reproduce for several years (Schommer and Woolever 2001). The response is "all or none," and is devastating to the bighorns. Bighorns range widely in suitable habitat and can be expected to contact domestic sheep at a considerable distance.

As a result, the only way to provide for both domestic sheep grazing and bighorns is to emphasize one or the other on each mountain range. This is consistent with the philosophy developed by the Wyoming State Interagency Bighorn Working Group (Kevin Hurley, personal communication; the Working Group's final document is not yet published). Bighorns are considered a viable species statewide (the species is still hunted). Since bighorns can come in contact with domestic sheep when they leave NFS land, the MBNF cannot ensure that bighorns on NFS land will remain free of *Pasteurella haemolytica* and other diseases transmitted by domestic animals.

- The Laramie Peak Unit is the largest and healthiest of the three herds (over 200 animals), with few domestic sheep in the area (though there is a large amount of private land mixed in with National Forest land). An interagency Plan for this species will be used to guide vegetation management in the area.
- The Douglas Creek herd (in the Snowy Range) is second in size and in priority to the state. None of the domestic sheep allotments in the range has been occupied since 1997. In Alternative D-FEIS, Geographic Areas within the mapped range of this herd have standards for avoiding and minimizing the risk of contact between the species; adjacent GAs have guidelines with the same direction. Domestic sheep (and goat) grazing will be allowed only if the domestic species are unlikely to come in contact with bighorns (for example, because of a topographic barrier, presence of a herder, seasonal movements, etc.)
- The Sierra Madre was chosen as the range in which domestic sheep grazing is emphasized in Alternatives B through E because:
    - The bighorn herd there (the Encampment River herd) is classified as lowest priority (Level 3) at the state level (the Bighorn Working Group). State Game and Fish biologists have ranked the herd third of the three herds on the MBNF because it has done poorly over the years.
    - There are 7 active domestic sheep allotments in the Sierra Madre (compared to none in the Snowy Range).
    - There are active domestic sheep allotments in the mountains to the south of the Sierra Madre on the adjoining Routt National Forest, but not south of the Snowy Range.

- The Encampment River herd's population (in the Sierra Madre) is the lowest of the three herds on the Forest (around 50), is well below the genetically viable limit (of 125), and has not shown increases over the years.

The Encampment River herd will still be managed to maintain ungulate habitat, mostly winter forage (by prescribed burns in the Encampment GA), though the WDGF will put its efforts and funding into improvement of habitat for higher priority herds.

Alternative A does not provide a specific standard requiring separation of domestic sheep and bighorns. Alternatives except for A and E differ in the direction for the Medicine Bow Range (the Douglas Creek herd). Alternatives B, C, D-DEIS, and E include guidelines for separation of the species in the Geographic Areas containing mapped bighorn range. In Alternative D-FEIS, this guideline is elevated to a standard in these GAs and is also added (as a guideline) to the adjacent GAs. Alternative F has a standard requiring prevention of any interaction of bighorns with domestic sheep and goats, presumably by eliminating livestock grazing in all areas in or near bighorn range.

The evaluation criterion for bighorn sheep is separation from domestic sheep.

Table D-47 Viability conclusions for bighorn sheep

	Alternative A	**Alternatives A, B, C, D-DEIS, E**	**Alt D-FEIS**	**Alternative F**
Abundance and distribution	No specific protection from contact with domestic sheep. May be loss of one or more herds.	Loss of one or more of the current three herds would reduce numbers and distribution. Likely loss of Encampment herd; higher probability of loss of Douglas Cr herd than other alts.	Likely loss of Encampment herd. Better protection of Douglas Creek herd than all alts except F (added guidelines to adjacent GAs.)	Most protection of all three herds, management of domestic sheep to avoid adverse effects on bighorns and ensure viability of all three herds.
Likelihood of persistence-15 yr.	Species probably present, but more risk of loss of herds than in other alternatives.	Species present; loss of at least one or even two herds possible, to disease contracted from domestic sheep on the MBNF.	Species present but reduced numbers; loss of at least one herd possible. Greatly improved chance of persistence of the Douglas Creek herd compared to Alts A, B, C, and D-DEIS.	Highest probability of persistence (may still become infected with *Pasteurella* by contact with sheep off-Forest.)

	Alternative A	Alternatives A, B, C, D-DEIS, E	Alt D-FEIS	Alternative F
Likelihood of persistence-long-term	Loss of two or even all three herds possible.*	Species present but loss of one or two herds possible.*	Species present and likely to persist in Laramie Range and Medicine Bow Range (Douglas Cr. Herd)	Species present and likely to persist in Laramie Range and Medicine Bow Range (Douglas Cr. Herd) and possibly on the Sierra Madre (Encampment herd if threats can be isolated and removed).
Certainty	Moderate	Moderate	Moderate/high	Moderate/high

** Even without specific standards, the effects on bighorns will be taken into account before domestic sheep would be permitted on allotments near bighorns. Given the desirability of the species as a game species and as a "watchable" species, and given the acknowledged vulnerability of entire herds to contact with domestic sheep, it is likely that contact between bighorns and domestic sheep will be avoided. Risk is greater in these alternatives based solely on Plan direction in these alternatives compared with the others.*

Brown Creeper - *Certhia americana*

Status and distribution of species

Widely distributed across forested regions of the northern hemisphere from south-central Alaska to Central America, with nine subspecies recognized, as referenced in Rio Grande N.F. Species Assessment 2002 (Ghormley 2002). It is primarily associated with western and northern coniferous forests in the contiguous United States and becomes less common in the Appalachians as they extend southward.

The Brown Creeper has a global conservation status ranking of G5, indicating that it is demonstrably secure globally although it may be quite rare in portions of its range (CNHP 2002), as referenced in Ghormley 2002. This species is not well sampled by standard Breeding Bird Survey (BBS) routes. It currently has no federal status that warrants special conservation considerations, but is designated by Partners in Flight as a "level 2" (monitoring) species.

Status and distribution of species on the Medicine Bow N.F.

The Brown Creeper occurs at low density on the Medicine Bow NF year round, in large blocks of old spruce-fir and lodgepole forest.

Habitat and natural history

Brown Creepers are closely associated with older forest conditions throughout their range regardless of forest type Raphael and White (Raphael and White 1984), Hejl et al (Hejl, Hutto et al. 1995); Young and Hutto, as referenced in Ghormley 2002. In ponderosa pine, creepers occurred in either old growth or in mature forest with at least 70% overstory canopy cover (Mills, Rumble et al. 2000). Brown creeper habitat associations in the western U.S. have led them to be considered as interior old growth species (Hejl and Wood 1990), (Hejl, Hutto et al. 1995; Ghormley 2002). Differences in abundance may even occur between mature and old growth forest, with the species more closely tied to structural conditions rather than a particular forest type. Numbers may increase significantly after fire (Apfelbaum and Haney 1981).

The Brown Creeper is the only species of small bird that is consistently found to be affected by fragmentation of old growth at the scale created by Forest Service timber harvest in the last half of the 20th century.

Trees selected for foraging are often more closely associated with size rather than species and selection is most likely related to the bark characteristics of older trees.

Nests are most often constructed behind a piece of peeling bark. Snags in the early to mid-stages of decay (Class 2[1]) primarily serve as nesting substrate; however, excavated cavities, natural deformations or live trees with loose slabs of bark may also be used (Ghormley 2002). Nest sites are often located in the lower portion of the tree bole.

Information pertaining to a recommended number of snags for Brown Creepers is primarily absent from the available literature (Ghormley 2002). Although Brown Creepers are not technically cavity-nesters, it is suggested that similar nesting benefits could be derived by meeting the large-diameter snag requirements needed for other associated species (Ghormley 2002).

Changes from HRV factors that may affect the species

In high elevation forest, patch size is smaller and there is less interior forest that was typical of the past. Patches are more uniform in size; high-contrast edge is increased because of roads and clearcutting; density of snags and coarse woody debris is lower in harvested stands (Dillon and Knight 2000). Forested stands are fragmented by roads, trails, clearcuts, rights-of-way, and home development (Knight and Reiners 2000); (Cerovski, Gorges et al. 2001).

Large wood has been removed faster than it is replaced (Dillon and Knight 2000).

In low-elevation forests, density of large snags is reduced, and stands are younger and more uniform than in the past (Dillon and Knight 2000).

Threats, limiting factors and vulnerabilities

Brown Creepers are highly responsive to forest management activities that alter the structural components of its preferred habitat, regardless of the forest type examined and in most cases, of the type of silvicultural system used (Ghormley 2002). Brown Creepers also display declines in responses to fire, although they may use recently burned areas for short periods. A decline at forest edges created by forest cutting has also been displayed (Ghormley 2002). It is evident that Brown Creeper abundance is reduced, and often times eliminated, by reductions in the basal area of the large green tree component. Decreased abundance is closely related to reductions in basal area, canopy closure, or combinations of both. The quality, quantity, and distribution of suitable snags are consistently noted as a limiting habitat factor for brown creeper (Ghormley 2002).

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[1] Class 2 snags – represent a decay stage when branches begin to fall and bark loosens from the tree bole, with some bark and/or tops falling. Class 2 snags most often preferred by three-toed woodpecker and other primary cavity excavators for nest hole development.

Key factors limiting habitat quality include adequate snag structure and decay classes for nesting and adequate older live trees for foraging. Distribution of resources is important due to the susceptibility of the creeper to fragmentation effects.

Tree boles must have bark conditions that are suitable to support the incubating female and serve as a night roost for the fledglings.

The primary references used were Cerovski et al (Cerovski, Gorges et al. 2001) and the Rio Grande N.F. Species Assessment for the Brown Creeper (Ghormley 2002).

Environmental Consequences and Viability

Direct and indirect effects. Cumulative effects. Past logging of old growth on the MBNF and on adjacent ownerships has reduced and fragmented habitat for this species. Habitat has also been fragmented by creation of roads, trails, ski areas, and clearing around buildings in old growth. Activities that alter the pattern and amount of old growth have effects for centuries.

Evaluation criteria are the likelihood of timber harvest in existing old or late successional forest and retention of snags of all decay classes. Alternatives B, C, D and E have standards that require recruitment old growth in large patches and that the largest patches of existing old growth be retained intact. Alternative F would not cut existing old growth.

Logging of old growth would continue in Alternatives A, B, C, D-DEIS, D-FEIS and E, reducing habitat and fragmenting habitat for this species. The accompanying loss of snags (especially those in early decay classes) would remove potential nesting sites in those alternatives. The accompanying building of roads (though more limited than in the past, and mostly temporary) may fragment large stands used by Brown Creepers. This activity would occur most in Alternatives A, B and C. Fewer new roads would be built in Alternatives D and fewer still in Alternative E. No new roads would be constructed under Alternative F. Firewood collection would remove snags in all alternatives, but access would be reduced by the emphasis on road reduction in Alternative F.

Brown Creepers use large stands of old growth and are very sensitive to reduction of forest density and patch size. In alternatives with more MA 5.15, in which 20% of the trees will be left standing in regeneration units, more acres are treated per unit of timber in the annual timber harvest. Logging in lodgepole should focus on a younger age class (120 years) but to the extent that old growth is cut, more acres will be affected. (No regeneration cuts will occur in spruce fir.) Total acres affected depends on the combination of expected timber harvest and relative amount allocated to MA 5.13 and MA 5.15 (see following table). However, it is not possible to predict the amount or configuration of harvest in **old large stands** suitable for the Brown Creeper.

Table D-48 Total acres expected to be harvested (includes all ages and all harvest types)

	A	B	C	D DEIS	D FEIS	E	F
Decade 1 Experienced Budget Level (acres/yr)	2,323	3,113	2,859	3,100	3,139	2,741	1,733
Decade 5 Experienced Budget Level (acres/yr)	1,986	2,897	2,589	2,755	2,854	2,414	1,113

Alternative A has a lower standard for retention of old growth than the other alternatives and has no standard for providing recruitment old growth. Alternative F has the same low standard as Alternative A, but does not propose logging in old growth. Alternatives A, B, and C propose more timber harvest and more emphasis on management for timber output than other alternatives. Alternatives D-DEIS, D-FEIS and E increase the emphasis on ecological objectives over those alternatives. Alternative F would not allow harvest of old growth and would have little timber harvest and the least roads (reducing snag loss) and is most beneficial to the Brown Creeper.

Because of the uncertainty about amount and distribution of harvest in old growth stands in all Alternatives except Alt F, the outcomes and relative effects of alternatives have a high level of uncertainty. Brown Creeper was considered as an MIS, but was determined to be too hard to detect (because of natural low density of populations) to provide large enough sample sizes. However, though this species was not added to the R2 sensitive species list, there is enough concern to consider it of concern on the MBNF.

Table D-49 Viability conclusions for the Brown Creeper

	Alt A	**Alts B and C**	**Alt D FEIS**	**Alts D DEIS, and E**	**Alt F**
Abundance and distribution	Lower standards for retention of old growth and snags than other alternatives. Much timber emphasis land (MA 5.13 where little or no OG or security areas will be retained) :species is unlikely to persist in some GAs.	Loss over time in large blocks of MA 5.13 since these areas will generally lack retained large blocks of old growth and recruitment old growth. Reductions in abundance and in distribution.	Lacks the standard for old growth recruitment found in other all alts but A. (strategy and can be interpreted to provide future old growth, but not specific). Highest old growth- 25% in spruce-fir, 15% in lodgepole.	Loss of old growth over time in large blocks of MA 5.13, but a much smaller acreage than in Alts A, B, & C.	Retention of habitat components over most or all of current distribution; ecological design to retain large blocks and connectivity. No harvest of old growth. Most fire with loss of creeper habitat, creation of snags.
Likelihood of persistence- 15 year	Likely	Likely	Likely	More likely	Very likely
Likelihood of persistence- long-term	Uncertain- abundance and distribution reduced	Likely- probable reduction in abundance and distribution	Likely- some possible reduction	Likely- some possible reduction	Very likely
Certainty	Low/ Moderate	Low/ Moderate	Low / Moderate	Low/Moderate	High

Brown-capped Rosyfinch - *Leucosticte australis*

Status and distribution of species

The Brown-capped Rosyfinch breeds only in the southern Rockies from the Snowy Range south through Colorado and into New Mexico. The species is on the Audubon watch list (Cornell Lab website, 2/28/03). The species Heritage rating is G4/S1BS2N.

Status and distribution on the Medicine Bow NF

An isolated population occurs in the Snowy Range. Suitable habitat may also occur on the Sierra Madre, but no verified records exist. There has not been continuous monitoring that would detect any changes in population or in area used.

Habitat

In summer, rosyfinches are found above timberline, in low grass, cushion plant, and lichen encrusted or bare rock. Brown-capped rosyfinches nest on cliffs or rocky hillsides, often in a crack or crevice that provides overhead protection. Nesting and feeding occur near snowbanks. An elevational migrant, rosyfinches winter in grassland, sagebrush, and visit feeders in urban areas.

Changes from HRV in factors that may affect the species

Disturbance from increased recreation in summer may alter habitat use. Snow compaction from snowmobile use and skiing in winter may create different pattern and timing of snowmelt and alter vegetation. Climate change may reduce suitability of habitat and reduce the population, making this population more vulnerable to extirpation.

Threats, limiting factors, and vulnerabilities

The primary source of concern is the small size and isolation of the species' habitat on the MBNF. Recreation may have direct and indirect effects (see above).

Primary references used are Dorn and Dorn (Dorn 2001), Welp et al (Welp, Fertig et al. 2000), and R2 Species Conservation Project species assessments (USDA FS 2001).

Environmental Consequences and Viability

The Brown-capped rosyfinch has a relatively restricted global range. The Snowy Range population is the only one in the state of Wyoming and lies at the northern edge of the species range. The population is small and isolated, making it vulnerable to chance events. Even a small decline in number of birds could reduce the population to below numbers needed for long-term sustainability. The local extirpation of a species occupying similar habitat (White-tailed Ptarmigan) for unknown reasons also indicates a need to pay attention to this species. As an alpine obligate that feeds preferentially along melting snowbanks, a sustained increase in summer temperature could reduce the already limited habitat. Finally, the high rate of human disturbance (though not demonstrated to affect the birds' habitat or nesting) could exacerbate a decline associated with other factors.

All these factors suggest that the Brown-capped rosyfinch should be considered a "Species of Local Concern" on the MBNF. Despite the lack of known threats from Forest Service activities or information of a known decline, the species' demographics suggest that more information is needed to assign a probability of persistence of the Snowy Range populations.

If snow compaction (resulting in delayed snowmelt) is an adverse factor, the restriction of snowmobiles to road and trails in Alternative F could be beneficial. However, there is no evidence that this potential effect occurs.

The tundra area of the Snowy Range has been designated (November 2003) an Audubon "Important Bird Area" with an emphasis on the Brown-capped rosyfinch.

Evaluation criterion for the Brown-capped rosyfinch is emphasis on inventory and monitoring.

Table D-50 Viability conclusions for the Brown-capped rosyfinch

	All Alternatives
Abundance and distribution	Very localized
Likelihood of persistence-15 yr.	Likely, but uncertain because of lack of information
Likelihood of persistence-long-term	Uncertain because of lack of information
Certainty	Low

Species by Species Evaluation - Plants of Local Concern

Species of Local Concern (SLC) are species that are documented or suspected to be at risk at a forest-wide scale, but do not meet the criteria for regional Sensitive Species designation because they are reasonably secure within parts of their range within R2. These could include species with declining trends in only a portion of Region 2. Risk to species viability may differ at national, regional and local scales. Species at the edge of their range may not merit regional Sensitive Species status, but may be important elements of biological diversity for the Forest/Grassland unit (from R2 Planning Desk Guide Chapter 27: Selection of Sensitive Species, Species of Local Concern, and MIS in R2). Species of local concern are identified during revision of individual Land and Resource Management Plans.

The MBNF has identified plant species of local concern using the process documented in the Rocky Mountain Regional Planning Desk Guide Chapter 27 (USDA Forest Service 2003). Wyoming Natural Diversity Database (WYNDD) has identified plants of concern for Wyoming based upon occurrence and distribution within the state (Fertig and B Heidel 2002). This list was used to determine which species of special concern within the state occur on the MBNF. State species abstracts and information from the Rocky Mountain Herbarium on plant distribution within Wyoming were used to determine which species had an extremely limited distribution on the MBNF. Each species was evaluated based upon isolation from other populations, lack of dispersal mechanisms, population trends, habitat trends, habitat vulnerability and species life history and demographic characteristics.

The following plant species have been identified as being those for which population viability is a concern on the MBNF, as evidenced by:

- A significant current or predicted downward trend in population numbers or density, or
- A significant current or predicted downward trend in habitat capability that would reduce a species' existing distribution on the MBNF (Forest Service Manual (FSM) 2670.5).

Changes for the FEIS:

The development of the list of plant species of local concern was begun prior to the DEIS; however, anticipating changes in the R2 Regional Forester's Sensitive Species List and new information that was being released along with the 2003 list, the final analysis of species of local concern was delayed until the FEIS. The R2 sensitive species evaluation process considered over 900 plant species, provided 831 plant species evaluations and recommended 87 plant species for the 2003 R2 Regional Forester's Sensitive Species list. This process also provided some information at the Regional Scale about whether plant species should be considered for other emphasis species lists.

The following species were not considered as plant species of local concern for the FEIS because they were added to R2 sensitive species list in 2003 (USDA Forest Service 2003).

Astragalus leptaleus, Park milkvetch;

Carex diandra, Lesser panicled sedge;

Eleocharis tenuis var. *borealis*, Boreal spikerush;

Eriogonum exilifolium, Slender leaved buckwheat;

Salix candida, Hoary willow;

Urticularia minor, Lesser bladderwort;

The following species were not considered as plant species of local concern for the FEIS because they were dropped by WYNDD (because of documented abundance) or found not to occur on the MBNF:

Asplenium septentrionale, northern spleenwort;

Physaria vitulifera, Rydberd twinpod;

Aletes humilis, Colorado Aletes

Sisyrinchium pallidum, Pale blue-eyed grass

Pyrrocoma clementis var. *clementis*, Tranquil goldenweed;

The following species were not considered as plant species of local concern because there was not a documented significant current or predicted downward trend in population numbers or density, or a significant current or predicted downward trend in habitat capability.

Agrostis mertensii, Northern bentgrass;

Asplenium trichomanes, Maidenhair spleenwort;

Asplenium trichomanes ramosum, Green spleenwort;

Carex egglestonii, Eggleston's sedge;

Carex nelsonii, Nelson's sedge;

Carex occidentalis, Western sedge;

Carex oreocharis, Mountain loving sedge;

Carex parryana var. *unica*, Hall's sedge;

Carex sartwellii var. *sartwellii*, Sartwell's sedge;

Chionophila jamesii, Rocky Mountain Snow Lover;

Comarum palustre, Purple marshlocks;

Cymopterus alpinus, Alpine oreoxis;
Draba globosa, Rockcress draba;
Erigeron elatior, Tall fleabane;
Erigeron pinnatisectus, Pinnate fleabane;
Heterotheca pumila, Little golden-aster;
Ipomopsis aggregata var. *tenuituba*, Slender-trumpet ipomosis;
Juncus vasseyi, Vasey rush
Machaeranthera bigelovii, Bigelow's tansy-aster;
Mentzelia rusbyi, Rusby's stickleaf;
Menyanthes trifoliata,Buckbean;
Paronychia pulvinata, Rocky Mountain Nailwort;
Penstemon cyathophorus, North Park beardtongue;
Polypodium saximontanum, Rocky Mountain polypody;
Potamogeton amplifolius, Large-leaf pondweed;
Potamogeton friesii, Fries pondweed;
Potamogeton praelongus, White-stem pondweed;
Prenanthes racemosa spp. *multiflora*, Many-flowered rattlesnake root;
Saxifraga chrysantha, Golden saxifrage;
Selaginella mutica, Blunt-leaf spike-moss;
Selaginella underwoodii, Underwood's spike-moss;
Sparganium natans, Small bur-reed;
Talinum parviflorum, Small-flowered flame-flower;
Tonestus pygmaeus, Pygmy goldenweed.

The following species was not considered as plant species of local concern because field observations indicate that this species is more common than previously thought (Proctor pers. obs.):

Vaccinium myrtillus var. *oreophyllum*, Dwarf bilberry

The following species were not considered as plant species of local concern because standards and guidelines for protection of fens and the regional direction in the USFS memo 2070/2520-7/2620 which emphasizes the protection, preservation and enhancement of fens to all Region 2 forest supervisors (USDA Forest Service 2002):

Carex limosa, Mud sedge
Carex paupercula, Bog Sedge
Trichophorum pumilum, Rolland's bullrush

The following species was added to the list of plant species of local concern because it was no longer considered R2 sensitive species in 2003 (USDA Forest Service 2003) but it meets criteria for having a viability concern on the MBNF:

Cypripedium fasciculatum, Clustered Lady Slipper.

The following pages display the species by species evaluations of the Plant Species of Local

Concern for the MBNF. Rating category language from the *R2 Planning Desk Guide Chapter 27: Selection of Sensitive Species, Species of Local Concern, and MIS in R2* is shown in italics. Protection in the Plan for all plant species is evaluated considered the following Revised Plan 'Standard' management direction unless otherwise stated:

- Standards and guidelines for the protection of plants of local concern apply to the conservation of this species.
- Special Forest/Rangelands Products Standard One on Plant Collecting allows Botanical collection permits to be issued to authorize collection of plants or plant parts for other than threatened, endangered, sensitive species or species of local concern. Such collections must not jeopardize the continued vigor or existence of a plant population.
- Watershed conservation practices are required to be implemented during project level planning and implementation and will provide some protection for populations in streams, streamsides, lakes, wet areas and riparian areas.
- Allotment management plans can be modified to contain considerations for this species and exclosures constructed if needed to maintain viable populations. Area closures can be used to exclude recreation and other uses, if needed.

Adoxa moschatellina, Moschatel

Global and State Rankings

G5, S1, Low (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Circumboreal (NatureServe 2003).

Geographic Distribution Within the MBNF

There is only one known population Snowy Range; *few locations* (Fertig 2000), (Hartman and Nelson 1998.; Fertig 1999).

Dispersal Capability

This species has *very limited dispersal ability* (Heidel and W. Fertig 2001), (Crook and D. J. Bacon 2002). It is likely the remnant of a previous flora without dispersal mechanisms in the current climate and phtytogeography {Qian 1999}.

Abundance and Population Trend on the MBNF

There is only one population Snowy Range. It is rated as *rare- current abundance is low enough that stochastic and other factors lead to potential imperilment*. The population *trend is downward or suspected downward*.

Habitat, Trend and Vulnerability

The habitat for this species is limestone cliffs and seep areas within mature Spruce/fir and Douglas-fir forests (Fertig 2000), (Hartman and Nelson 1998.; Fertig 1999). There is a *decline in habitat quality*. Habitat is *very limited availability and is very vulnerable*.

Life History and Demographic Characteristics of the Species

This species has a high intrinsic vulnerability by WYNDD and is rated as having a *low* *reproductive rate or susceptibility to disease, predation or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include isolation, habitat disturbance and logging (canopy changes and ground disturbance) (Fertig 2000), (Hartman and Nelson 1998.; Fertig 1999).

Protection in the Plan

Standard

Environmental Consequences

Because there is only one known population risks are raised in alternatives with higher levels of management actions.

Alternatives A and B have a predicted low likelihood of persistence because of levels of logging and other sources of habitat disturbance. Alternative C, D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of lower levels of logging and habitat disturbance. Alternative F has a predicted high likelihood of persistence. Because it is difficult to predict the viability of small populations, the certainty is low.

Athyrium distentifolium var. americanum, American alpine lady fern

Global and State Rankings

G4G5, T4T5, S1, Low (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Western United States, Western and Eastern Canada (NatureServe 2003).

Geographic Distribution Within the MBNF

There is only one known population on the Snowy Range; *few locations* (Fertig 2000), (Hartman and Nelson 1998.).

Dispersal Capability

This species has *very limited dispersal ability* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2001a; USDA Forest Service Rocky Mountain Region 2001b). It is likely the remnant of a previous flora without dispersal mechanisms in the current climate and phtytogeography {Qian 1999}.

Abundance and Population Trend on the MBNF

There is only one known population in the Snowy Range. It is rated as *rare- current abundance is low enough that stochastic and other factors lead to potential imperilmen*t. The population trend is *downward or suspected downward*.

Habitat, Trend and Vulnerability

The habitat for this species is talus and streams. There are *stable amounts of suitable or potential habitat and relatively unchanged habitat quality*. There is *very limited availability of habitat and it is very vulnerable* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2001a; USDA Forest Service Rocky Mountain Region 2001b).

Life History and Demographic Characteristics of the Species

This species has a high intrinsic vulnerability rating from WYNDD and is rated as having a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include over-collection, trampling from recreation (Fertig 2000).

Protection in the Plan

Standard.

Environmental Consequences

Because there is only one known population risks are raised in alternatives with higher levels of management actions. Alternatives A, B, C, D DEIS, D FEIS and E have a predicted low to medium likelihood of persistence because of levels of recreation as predicted by Management area allocations and other sources of habitat disturbance. Alternative F has a predicted high likelihood of persistence because of lower levels of recreation and other sources of habitat disturbance as predicted by Management area allocations. Because it is difficult to predict the viability of small populations, there is a low level of certainty.

Bahia dissecta, Dissected bahia

Global and State Rankings

G5, S1S2, Low (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Southwest United States, Texas to California. Wyoming is at the northern edge of the range (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Within the MBNF

This species occurs on Laramie Peak, Pole Mountain, Sierra Madre; *few locations* (Fertig 2000), (Hartman and Nelson 1998.). It may have occurred in areas on Laramie Peak that burned in wildfires in 2001 and has not been searched for nor relocated since these fires. All Wyoming populations occur in the vicinity of the MBNF.

Dispersal Capability

This species *disperses only along corridors of suitable habitat* (Fertig 2000), (Fertig and S. Laursen 2002).

Abundance and Population Trend on the MBNF

This species occurs on Laramie Peak, Pole Mountain and the Sierra Madre. It is rated as *rare- current abundance is low enough that stochastic and other factors lead to potential imperilment*. The population trend is *downward or suspected downward* (Fertig 2000), (Fertig and S. Laursen 2002).

Habitat, Trend and Vulnerability

The habitat for this species is gravelly areas (Sherman granite) within sagebrush, open ponderosa pine and rocky streamsides. The habitat quality is *stable to declining* (Fertig

2000), (Fertig and S. Laursen 2002).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD and is rated as having a *low reproductive rate or susceptibility to disease, predation, or competition*.

Threats from Human Activity

Threats include isolation, grazing, wildfire and invasive species following fire or disturbance (Fertig 2000), (Fertig and S. Laursen 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a predicted low to medium likelihood of persistence because of levels of grazing and other sources of habitat disturbance. Alternative F has a predicted high likelihood of persistence although amount of potential wildfire will be highest under Alternative F and may pose a threat. Because it is difficult to predict the viability of small populations, the certainty of persistence is low to moderate.

Besseya alpina, Alpine kittentails

Global and State Rankings

G4, S1, Medium (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Southern Rocky Mountains (NatureServe 2003).

Geographic Distribution Within the MBNF

This species occurs on the Snowy Range; *few locations* (Hartman and Nelson 1998.; Fertig 2000).

Dispersal Capability

This species *disperses only along corridors of suitable habitat* (Fertig 2000), (Fertig and S. Laursen 2002).

Abundance and Population Trend on the MBNF

It is rated as *rare- current abundance is low enough that stochastic and other factors lead to potential imperilment*. The population trend is *stable* (Fertig 2000), (Fertig and S. Laursen 2002).

Habitat, Trend and Vulnerability

The habitat for this species is alpine cushion plant communities and talus. The habitat is *stable to declining* (Fertig 2000).

Life History and Demographic Characteristics of the Species:

This species is not rated for intrinsic vulnerability. It is rated as having a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig 2000).

Threats from Human Activity

Threats include isolation, trampling and disturbance to alpine cushion plant communities from recreation (particularly winter recreation) (Fertig 2000), (Bilbrough C.B., J.M. et al. 2000), (Williams, Brooks et al. 1998), (Neumann and H. G. Merriam 1972), (Knight, Anderson et al. 1975).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS and D FEIS have a predicted low to medium likelihood of persistence because of disturbance associated with recreation (especially motorized winter recreation) as predicted by Management area allocations and other sources of habitat disturbance. Alternative E has a predicted moderate likelihood of persistence. Alternative F has a high likelihood of persistence because of disturbance associated with recreation (especially winter recreation) as predicted by Management area allocations, restrictions on winter motorized recreation and other sources of habitat disturbance. Because it is difficult to predict the viability of small populations, the certainty of persistence is low to medium.

***Besseya plantaginea*, White river kittentails**

Global and State Rankings

G4, S1, Medium (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Southern Rocky Mountains (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Within the MBNF

This species occurs on Pole Mountain, Laramie Peak Range; *few locations* (Hartman and Nelson 1998.), (Fertig 2000). Wyoming populations occur on the MBNF or adjacent private lands.

Dispersal Capability

This species *disperses only along corridors of suitable habitat* (Fertig 2000).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is stable* (Fertig 2000).

Habitat, Trend and Vulnerability

The habitat is moist wooded slopes, edge of wet-moist meadows, Sherman granite, aspen, willows. The habitat *quality is declining* in areas. The habitat is *somewhat vulnerable and is somewhat limited* (Fertig 2000).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include recreational trail use and maintenance on Pole Mountain, isolation, grazing, trampling, fire (Fertig 2000), (Fertig and S. Laursen 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a predicted low to medium likelihood of persistence because of levels of recreation (particularly trail recreation on Pole Mountain) and other sources of habitat disturbance. Alternative F has a predicted high likelihood of persistence based on management actions and management area allocations (particularly in the Pole Mountain area). Alternative F has the highest amount of potential wildfire which may pose a threat. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to medium.

Cypripedium fasciculatum, Clustered Lady Slipper

Global and State Rankings

G4, S2, Medium (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Western United States (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Within the MBNF

This species occurs on the Sierra Madre and Snowy Range; *several locations* (Hartman and Nelson 1998.), (Fertig 2000).

Dispersal Capability

It has *very limited dispersal capability* (Fertig 2000), (Laursen and B. Heidel 2002), (McKee 2002). It is likely the remnant of a previous flora without dispersal mechanisms in the current climate and phtytogeography {Qian 1999}.

Abundance and Population Trend on the MBNF

This species is *uncommon – current abundance is large enough that demographic stochasticity is not likely to lead to rapid extinction, but in combination with highly variable environmental factors could pose a threat*. There is a documented *downwards trend* in populations (Fertig 2000), (Laursen and B. Heidel 2002), (McKee 2002).

Habitat, Trend and Vulnerability

Its habitat is mature lodgepole pine and mature spruce/fir forests and openings close to such forests. There is a *documented decline in habitat abundance and quality* (Fertig 2000), (Proctor 2002), (Proctor 2003). Re-occupation of vacated habitat by Clustered Lady Slipper has not been documented but is suspected to occur only after re-occupation and maturation of trees (100-200 years).

Life History and Demographic Characteristics of the Species:

This species has a moderate intrinsic vulnerability rating from WYNDD. *It has a low* *reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include canopy cover changes from logging or fire, trampling, grazing and collecting (Fertig 2000).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B and C have a predicted moderate likelihood of persistence in the short term and less likelihood of persistence in the long term because of levels of logging (canopy changes and ground disturbance particularly clearcutting) and other sources of habitat disturbance. Alternative D DEIS, D FEIS and E have a predicted moderate likelihood of persistence in the short and long term because of lower levels of logging and habitat disturbance. Alternative F has a predicted high likelihood of persistence because of low levels of logging and grazing. Alternative F has the highest predicted amounts of potential wildfire, which may pose a threat in the long term if fires are severe. Because it is difficult to predict the viability of small populations, the certainty of persistence is low to moderate.

Draba spectabalis var. oxyloba, Showy draba

Global and State Rankings

G3?, T3Q, S1, Medium (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Wyoming, Utah, Colorado (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Within the MBNF

The Sierra Madre has the one known population in Wyoming; *few locations* (Hartman and Nelson 1998.; Fertig 1999).

Dispersal Capability

It has a *very limited dispersal capability* (Fertig 1999). It is likely the remnant of a previous flora without dispersal mechanisms in the current climate and phtytogeography {Qian 1999}.

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downward or suspected downward* (Fertig 1999).

Habitat, Trend and Vulnerability

Its habitat is wet meadows, mature spruce/fir forests, willows. The *habitat trend is stable to unknown*. The habitat is *somewhat limited and somewhat vulnerable* (Fertig 1999).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low* *reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include isolation, grazing, logging (Fertig 1999), (Handley and S. Laursen 2002).

Protection in the Plan

Standards.

Environmental Consequences

Because there is only one known population risks are raised in alternatives with higher levels of management actions. Alternatives A, B, C, D DEIS, D FEIS and E have a predicted low to medium likelihood of persistence because of levels of logging and other sources of habitat disturbance. Alternative F has a predicted high likelihood of persistence because of low levels of logging and other human disturbances. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Euthamia graminifolia, Flat-top fragrant goldenrod

Global and State Rankings

G5, T5, S1, Low (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

United States and Canada (NatureServe 2003).

Geographic Distribution Within the MBNF

This species occurs on Laramie Peak Range and Pole Mountain; *few locations* (Hartman and Nelson 1998.), (Fertig 2000).

Dispersal Capability

This species *disperses only along corridors of suitable habitat* (Fertig 2000).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The population trend is *downward or suspected downward to unknown* (Fertig 2000).

Habitat, Trend and Vulnerability

Its habitat is streambanks and sandbars. Its *habitat is stable*. The habitat is *somewhat limited and somewhat vulnerable* (Fertig 2000). Its habitat is vulnerable to hydrologic changes from water diversions.

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include hydrologic changes (water levels and water quality) from water diversions and other management actions, isolation, grazing, trampling (Fertig 2000).

Protection in the Plan

Standard.

Environmental Consequences

Water rights and associated diversions are controlled by the state and not by the MBNF. Alternatives A, B, C, D DEIS, have a low likelihood of persistence because of levels of grazing and localized hydrologic changes from other management actions (vegetation changes), and other sources of habitat disturbance. Alternatives D FEIS and E have a moderate likelihood of persistence because of lower levels of hydrologic changes and habitat disturbance. Alternative F has a low concern because of low levels of grazing, hydrologic changes and other management disturbances. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Gentiana affinis var. *biglovii,* Bigelow's prairie gentian

Global and State Rankings

G5, T4, S1, Low (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Western United States and Western Canada (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Within the MBNF

The only population on the MBNF and in Wyoming is on Pole Mountain; *few locations* (Hartman and Nelson 1998.), (Fertig 2000).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig 2000).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downward to stable* (Fertig 2000).

Habitat, Trend and Vulnerability

Its habitat is grasslands, Sherman granite, sagebrush-meadows and streamsides. Its habitat quality is declining. The *habitat is somewhat limited and somewhat vulnerable* (Fertig 2000).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include grazing, fire, isolation, competition from invasive plants (cheat grass) (Fertig 2000).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a predicted low to medium likelihood of persistence because of levels of grazing, cheat grass invasion and other sources of habitat disturbance. Alternative F has a predicted high likelihood of persistence based on levels of grazing. Alternative F has the highest predicted amounts of potential wildfire, which may pose a threat. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Gymnocarpium dryopteris, Oak fern

Global and State Rankings

G5, S1, Low (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Circumboreal (NatureServe 2003).

Geographic Distribution Within the MBNF

This species occurs on the Sierra Madre; *few locations* (Hartman and Nelson 1998.; Fertig 2000).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig 2000), (Crook 2001), (Handley and S. Laursen 2002).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is declining to unknown* (Fertig 2000).

Habitat, Trend and Vulnerability

Its habitat is mature spruce/fir forests, streams and cliffs. Its *habitat is declining*. The habitat is *somewhat limited and somewhat vulnerable* (Fertig 2000), (Crook 2001), (Handley and S. Laursen 2002).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include canopy changes from logging, skid trails and roads, fire, grazing, isolation (Fertig 2000), (Crook 2001), (Handley and S. Laursen 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B and C have a low likelihood of persistence because of levels of logging and other sources of habitat disturbance. Alternative D DEIS, D FEIS and E have a moderate likelihood of persistence because of lower levels of canopy changes from logging and habitat disturbance from skid trails, roads and other management actions. Alternative F has a high likelihood of persistence from low levels of logging. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Juncus filiformis, Thread rush

Global and State Rankings

G5, S1, Low (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Circumboreal; secure in parts of Canada (NatureServe 2003).

Geographic Distribution Within the MBNF

There is one occurrence on the Sierra Madre; *few locations* (Hartman and Nelson 1998.; Fertig 2000).

Dispersal Capability

It has *very limited dispersal ability* (Fertig 2000), (Burkhart 2002), (Handley and S. Laursen 2002). It is likely the remnant of a previous flora without dispersal mechanisms in the current climate and phtytogeography {Qian 1999}.

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is stable to unknown* (Fertig 2000), (Burkhart 2002), (Handley and S. Laursen 2002).

Habitat, Trend and Vulnerability

Its habitat is wet meadows, streambanks. Its *habitat quality is declining*. The habitat is *somewhat limited and somewhat vulnerable* (Fertig 2000), (Burkhart 2002), (Handley and S. Laursen 2002).

Life History and Demographic Characteristics of the Species:

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include grazing and trampling in wet meadows, hydrologic changes (water levels and water quality) and isolation (Fertig 2000), (Burkhart 2002), (Handley and S. Laursen 2002).

Protection in the Plan

Standard.

Environmental Consequences

Because there is only one known population, risks are raised in alternatives with higher levels of management actions. Alternatives A, B, C, D DEIS, D FEIS and E have a predicted low to medium likelihood of persistence because of levels of hydrologic changes (water levels and water quality) from vegetation management actions, and from grazing and other sources of habitat disturbance. Alternative F has a predicted high likelihood of persistence because of reduced levels of hydrologic changes from vegetation management action and from reduced levels of grazing. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Juncus triglumis var. *albescens*, Northern white rush

Global and State Rankings

G5, T5, S1, Medium (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Northern Canada and Wyoming; extirpated in Montana (NatureServe 2003).

Geographic Distribution Within the MBNF

There in only one known occurrence on the Snowy Range; *few locations* (Mills and W. Fertig 2000), (Hartman and Nelson 1998.).

Dispersal Capability

It has *very limited dispersal ability* (Mills and W. Fertig 2000), (Handley, Heidel et al. 2002), (Handley, Heidel et al. 2002), (Burkhart 2002). It is likely the remnant of a previous flora without dispersal mechanisms in the current climate and phtytogeography {Qian 1999}.

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is stable to unknown* (Mills and W. Fertig 2000).

Habitat, Trend and Vulnerability

Its habitat is sedge meadows, bogs, willows, streambanks. Its *habitat is declining in quality*. The habitat is *somewhat limited and somewhat vulnerable* (Mills and W. Fertig 2000).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include hydrologic changes (water level and water quality), isolation, grazing, trampling (Mills and W. Fertig 2000).

Protection in the Plan

Standard protection plus the following protection.

Standards and guidelines for protection of fens and the regional direction in the USFS memo 2070/2520-7/2620 which emphasizes the protection, preservation and enhancement of fens to all Region 2 forest supervisors (USDA Forest Service 2002) will provide protection for populations in bogs.

Environmental Consequences

Because there is only one known population, risks are raised in alternatives with higher levels of management actions. Alternatives A, B, C, D DEIS, D FEIS and E have a predicted low to medium likelihood of persistence because of levels of hydrologic changes from vegetation management actions, grazing and other sources of habitat disturbance. Alternative F has a predicted high likelihood of persistence. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Lesquerella alpina parvula, Narrowleaved bladderpod

Global and State Rankings

G4, T3?, S1, Medium (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Wyoming, Utah, Colorado (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Sierra Madre, *few locations* (Hartman and Nelson 1998.; Fertig 2000).

Dispersal Capability

It has *very limited dispersal ability* (Fertig 2000), (Handley and S. Laursen 2002), (Johnston 2002). It is likely the remnant of a previous flora without dispersal mechanisms in the current climate and phtytogeography {Qian 1999}.

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is stable* (Fertig 2000) *to declining* (Proctor 2002), (Proctor 2003).

Habitat, Trend and Vulnerability

Its habitat is sagebrush, grass and gravel. Its *habitat is declining* (Proctor 2002), (Proctor 2003). The *habitat is somewhat limited and somewhat vulnerable* (Fertig 2000).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include vehicle use (OHV), isolation, skid trails and road construction associated with logging, grazing, fire, trampling (Fertig 2000), (Handley and S. Laursen 2002), (Johnston 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B and C have a low likelihood of persistence because of predicted amounts of skid trails and road construction associated with logging and other sources of habitat disturbance. Alternative D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of lower levels of logging and habitat disturbance. Alternative F has a predicted high likelihood of persistence because of low levels of activities associated with logging. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Ligularia bigelovii var. *hallii*, Bigelow's grounsel

Global and State Rankings

G4?, T3T4, S1, Low (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Wyoming, Utah, Colorado, Arizona, New Mexico (NatureServe 2003).

Geographic Distribution Within the MBNF

Sierra Madre; *few locations*. MBNF has 100% of Wyoming populations (Fertig 2000), (Hartman and Nelson 1998.).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig 2000), (Handley, Heidel et al. 2002).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is declining to unknown* (Fertig 2000), (Handley, Heidel et al. 2002).

Habitat, Trend and Vulnerability

It habitat is moist to wet meadows, willows, mature spruce/fir forests. Its *habitat is stable to unknown*. The *habitat is somewhat limited and somewhat vulnerable* (Fertig 2000), (Handley, Heidel et al. 2002).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include grazing, trampling, invasive species (Canada thistle) isolation, logging (canopy changes and ground disturbance), hydrologic changes (water levels and water quality) and fire, (Fertig 2000), (Handley, Heidel et al. 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of lower levels of grazing and associated habitat disturbance. Alternative F has a predicted high likelihood of persistence. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Ligusticum tenuifolium, Slender-leaved lovage

Global and State Rankings

G5, S1, Low (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Northwest United States (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Sierra Madre, *few locations* (O'Dea and W. Fertig 2000),(Hartman and Nelson 1998.).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (O'Dea and W. Fertig 2000; Handley and S. Laursen 2002), (Ladyman 2002).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downward to unknown* (Proctor 2002), (Proctor 2003), (O'Dea and W. Fertig 2000; Handley and S. Laursen 2002), (Ladyman 2002).

Habitat, Trend and Vulnerability

Its habitat is meadows and streamsides. Its habitat is *stable to unknown*. The *habitat is somewhat limited and somewhat vulnerable* (O'Dea and W. Fertig 2000; Handley and S. Laursen 2002), (Ladyman 2002).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include collection of roots for medicinal purposes, isolation, grazing, trampling (O'Dea and W. Fertig 2000; Handley and S. Laursen 2002), (Ladyman 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a predicted low to moderate likelihood of persistence because of levels of grazing and associated habitat disturbances. Alternative F has a high likelihood of persistence because of lower levels of grazing and low levels of other habitat disturbances. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Listera convallarioides, Broad-leaved twayblade

Global and State Rankings

G5, S1, Low (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Northwest United States, Northwest and Northeast Canada (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Snowy Range and Laramie Peak Range; *few locations* (Markow and W. Fertig 2000), (Hartman and Nelson 1998.).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Markow and W. Fertig 2000), (Handley, Heidel et al. 2002), (Ode 2001).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downwards to unknown* (Markow and W. Fertig 2000), (Handley, Heidel et al. 2002), (Ode 2001).

Habitat, Trend and Vulnerability

Its habitat is streambanks, lake margins, moist mature coniferous forests, grass, aspen and alder. Its *habitat is declining in quality*. The *habitat is somewhat limited and somewhat vulnerable* (Markow and W. Fertig 2000), (Handley, Heidel et al. 2002), (Ode 2001).

Life History and Demographic Characteristics of the Species:

This species has a high intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include over-collecting, isolation, logging (canopy changes and ground disturbance), grazing, trampling (Markow and W. Fertig 2000), (Handley, Heidel et al. 2002), (Ode 2001).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of higher levels of grazing and associated habitat disturbance.

Alternative F has a predicted high likelihood of persistence because of lower amounts of grazing. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Lomatogonium rotatum, Marsh felwort

Global and State Rankings

G5, S1, Medium (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Northern United States, Canada and Greenland; south to New Mexico (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Snowy Range and Pole Mountain area; *few locations* (Fertig 2000), (Hartman and Nelson 1998.).

Dispersal Capability

It has *very limited dispersal ability* (Fertig 2000), (Handley, Heidel et al. 2002), (Johnston 2002). It is likely the remnant of a previous flora without dispersal mechanisms in the current climate and phtytogeography {Qian 1999}.

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downwards to unknown* (Fertig 2000), (Handley, Heidel et al. 2002), (Johnston 2002).

Habitat, Trend and Vulnerability

Its habitat is moist to wet meadows and willows. Its *habitat is declining in quality*. Habitat is *very limited availability and is very vulnerable* (Fertig 2000), (Handley, Heidel et al. 2002), (Johnston 2002).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include grazing, trampling, hydrologic changes (water levels and water quality) and isolation (Fertig 2000), (Handley, Heidel et al. 2002), (Johnston 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of levels of grazing, localized hydrologic changes from vegetation management and other sources of habitat disturbance. Alternative F has a predicted high likelihood of persistence based on lower levels of grazing and hydrologic changes associated with vegetation management actions. Alternative F has the highest predicted amounts of potential wildfire which may pose a threat. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Packera crocata, Saffron groundsel

Global and State Rankings

G4, S1, Medium (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Montana, Wyoming, Utah, Colorado (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Snowy Range, *few locations* (Fertig 2000), (Hartman and Nelson 1998.).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig 2000), (Heidel, J. Handley et al. 2002), (Coles 2002).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downwards to unknown*. It may be extirpated (Fertig 2000), (Heidel, J. Handley et al. 2002), (Coles 2002).

Habitat, Trend and Vulnerability

Its habitat is wet meadows, streamsides and adjacent slopes. Its *habitat is declining in quality to stable*. The *habitat is somewhat limited and somewhat vulnerable* (Fertig 2000), (Heidel, J. Handley et al. 2002), (Coles 2002).

Life History and Demographic Characteristics of the Species:

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include trampling, grazing, hydrologic changes, riparian associated recreation use, isolation (Fertig 2000), (Heidel, J. Handley et al. 2002), (Coles 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C and D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of lower levels of habitat disturbance associated with grazing (trampling) and lower level of consumption associated with grazing. Alternative F has a predicted high likelihood of persistence based on lower levels of grazing. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Packera pseudaurea var. *flavulus*, Streambank groundsel

Global and State Rankings

G5, T?, S1, Low (NatureServe 2003), (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Idaho, Wyoming, Colorado, New Mexico (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Sierra Madre, Snowy Range and Pole Mountain, *few locations* (Fertig 2000), (Hartman and Nelson 1998.).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downwards to unknown* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Habitat, Trend and Vulnerability

Its habitat is open woods, streamsides and wet meadows. Its *habitat is stable to unknown*. The *habitat is somewhat limited and somewhat vulnerable* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Life History and Demographic Characteristics of the Species:

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include hydrologic changes (water levels and water quality), grazing, recreation use, isolation (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of levels of trampling and habitat disturbance associated with grazing and consumption associated with grazing and localized hydrologic changes from vegetation management actions. Alternative F has a predicted high likelihood of persistence because of lower levels of grazing and lower levels of vegetation management actions and associated hydrologic changes. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Phacelia alba, White scorpion-weed

Global and State Rankings

G4G5, S1, Low (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Wyoming, Utah, Colorado, Arizona, New Mexico (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Sierra Madre, Snowy Range and Pole Mountain, *few locations* (Fertig 2000), (Hartman and Nelson 1998.).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downwards to unknown* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Habitat, Trend and Vulnerability

Its habitat is rocky areas with three-tip sagebrush within meadows, mature aspen, mature spruce/fir and mature lodgepole pine forests. Its *habitat is stable to unknown*. The *habitat is somewhat limited and somewhat vulnerable* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include competition from invasive species, isolation, fire, grazing (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of levels of invasive species and habitat disturbance associated with grazing. Alternative F has a predicted high likelihood of persistence because of reduced levels of habitat disturbance associated with grazing. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Phacelia denticulata, Rocky Mountain phacelia

Global and State Rankings

G3?, S2, Medium (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Wyoming, Colorado, New Mexico (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Snowy Range, Pole Mountain, Laramie Peak Range, *few locations* (Fertig 2000),(Hartman and Nelson 1998.).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig 2000), (Handley, Heidel et al. 2002), (Johnston 2002).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The population trend is *downwards to unknown* (Fertig 2000), (Handley, Heidel et al. 2002), (Johnston 2002).

Habitat, Trend and Vulnerability

Its habitat is foothills, draws, clay-banks. Its *habitat is stable to unknown*. The *habitat is somewhat limited and somewhat vulnerable* (Fertig 2000), (Handley, Heidel et al. 2002), (Johnston 2002).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include mineral development (limestone quarries), grazing, fire, recreation use and isolation (Fertig 2000), (Handley, Heidel et al. 2002), (Johnston 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of levels of grazing, mineral development and other sources of habitat disturbance. Alternative F has a predicted high likelihood of persistence based on lower levels of grazing and Management area allocations with reduced human disturbances. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Potamogeton robbinsii, Flatleaf pondweed

Global and State Rankings

G5, S1, Medium (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

United States and Canada (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Snowy Range, *few locations* (Fertig 2000), (Hartman and Nelson 1998.).

Dispersal Capability

This species has *very limited dispersal ability* (Fertig 2000), (Handley, S. Laursen et al. 2002), (Coles 2002). It is likely the remnant of a previous flora without dispersal mechanisms in the current climate and phtytogeography {Qian 1999}.

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downwards to unknown* (Fertig 2000), (Handley, S. Laursen et al. 2002), (Coles 2002).

Habitat, Trend and Vulnerability

Its habitat is aquatic, streams and lakes. Its *habitat is stable to unknown but may have suffered declines in quality*. Habitat has *very limited availability and is very vulnerable* (Fertig 2000), (Handley, S. Laursen et al. 2002), (Coles 2002).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include lake and lakeside recreation, hydrologic changes (water levels and water quality), isolation (Fertig 2000), (Handley, S. Laursen et al. 2002), (Coles 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS, E and F have a low likelihood of persistence in the long term because of levels of lake and lakeside recreation and hydrologic changes (water level and water quality) and other sources of habitat disturbance. In the short-term (10-15 years), all alternatives have a predicted moderate likelihood of persistence. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Pyrrocoma crocea var. *crocea*, Western goldenweed

Global and State Rankings

G4?, T4?, S1, Low (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Wyoming, Utah, Colorado, New Mexico (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Snowy Range, Laramie Peak Range; *few locations* (Hartman and Nelson 1998.; Fertig 2000).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig 2000), (Coles 2002), (Handley and S. Laursen 2002).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downwards to unknown* (Fertig 2000), (Coles 2002), (Handley and S. Laursen 2002).

Habitat, Trend and Vulnerability

Its habitat is clayey soils in mid-elevation meadows and aspen. Its *habitat is stable to unknown*. The *habitat is somewhat limited and somewhat vulnerable* (Fertig 2000), (Coles 2002), (Handley and S. Laursen 2002).

Life History and Demographic Characteristics of the Species:

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include grazing, road maintenance, isolation (Fertig 2000), (Coles 2002), (Handley and S. Laursen 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a low to moderate likelihood of persistence because of levels of grazing, road maintenance and other sources of habitat disturbance. Alternative F has moderate likelihood of persistence because of moderate amounts of road maintenance and other sources of habitat disturbance. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Symphytotrichum porterii, Porter's aster

Global and State Rankings

G3G4, S1, Low (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Northern and Western United States and Canada (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on Pole Mountain; *few locations*. MBNF has 1 of 2 Wyoming populations (Fertig. W 2000), (Hartman and Nelson 1998.).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig. W 2000), (Heidel and Laursen 2002).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is stable to unknown* (Fertig. W 2000), (Heidel and Laursen 2002).

Habitat, Trend and Vulnerability

Its habitat is granite rubble and granite talus within aspen, shrubs, lodgepole pine, Douglas-fir and limber pine forests. Its *habitat is declining in quality to unknown*. The *habitat is somewhat limited and somewhat vulnerable* (Fertig. W 2000), (Heidel and Laursen 2002).

Life History and Demographic Characteristics of the Species:

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include woody plant encroachment (lack of periodic fire, successional changes), high severity wildfire, and isolation (Fertig. W 2000), (Heidel and Laursen 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, C, D DEIS, D FEIS and E have a high likelihood of persistence because proposed prescribed fire applications should maintain habitat. Alternative F has a moderate likelihood of persistence because of low levels of prescribed fire although in the long term Alternative F has the highest amounts of potential wildfire, which may pose a threat. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Trillium ovatum, Western trillium

Global and State Rankings

G5, S2, Medium (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Western United States and Western Canada (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Snowy Range and Sierra Madre (Proctor 2002), (Proctor 2003); *few locations* (Fertig 2000), (Hartman and Nelson 1998.).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The population trend is *downwards to unknown* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Habitat, Trend and Vulnerability

Its habitat is old growth spruce/fir forests where soils are boggy in early spring. Its *habitat is declining*. This species declines in fragmented forested habitat (Jules 1998). The *habitat is somewhat limited and somewhat vulnerable* (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include canopy changes and fragmentation from logging or fire, grazing, and isolation (Fertig 2000), (USDA Forest Service Rocky Mountain Region 2003a), (USDA Forest Service Rocky Mountain Region 2003b), (Jules 1998).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B and C have a predicted low likelihood of persistence because of levels of logging (canopy changes and ground disturbance) and other sources of habitat disturbance. Alternative D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of lower levels of logging and habitat disturbance. Alternative F has a predicted high likelihood of persistence. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.

Viburnum edule, Squashberry

Global and State Rankings

G5, S1, Low (NatureServe 2003) (Fertig and B Heidel 2002).

Geographic Distribution Outside of the MBNF

Northern United States and Canada (NatureServe 2003).

Geographic Distribution Within the MBNF

It occurs on the Snowy Range and is suspected on Sierra Madre; *few locations*. MBNF has 2 of 6 Wyoming populations (Fertig 1999), (Hartman and Nelson 1998.).

Dispersal Capability

It *disperses only along corridors of suitable habitat* (Fertig 1999), (Ode 2001), (Handley, Heidel et al. 2002).

Abundance and Population Trend on the MBNF

Its abundance is *rare – current abundance is low enough that stochastic and other factors lead to potential imperilment*. The *population trend is downwards to unknown* (Fertig 1999), (Ode 2001), (Handley, Heidel et al. 2002).

Habitat, Trend and Vulnerability

Its habitat is streambanks, aspen and rocky openings in mature spruce/fir forests. *Its habitat is declining*. The *habitat is somewhat limited and somewhat vulnerable* (Fertig 1999), (Ode 2001), (Handley, Heidel et al. 2002).

Life History and Demographic Characteristics of the Species

This species has a moderate intrinsic vulnerability rating from WYNDD. It has a *low reproductive rate or susceptibility to disease, predation, or competition* (Fertig and B Heidel 2002).

Threats from Human Activity

Threats include grazing, logging, fire, isolation (Fertig 1999), (Ode 2001), (Handley, Heidel et al. 2002).

Protection in the Plan

Standard.

Environmental Consequences

Alternatives A, B, and C have predicted low likelihood of persistence because of high levels of disturbance associated with logging. Alternatives D DEIS, D FEIS and E have a predicted moderate likelihood of persistence because of lower levels of logging and other sources of habitat disturbance. Alternative F has a high likelihood of persistence because of lowest levels of disturbance associated with logging. Because it is difficult to predict the viability of small populations, the certainty of persistence findings is low to moderate.