# Appendix D - Biological Diversity Report

This report has been prepared as support for the revision of the 1983 Routt National Forest Land and Resource Management Plan (1983 Plan). Because a forest plan is a programmatic document, 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 programmatic decisions made and corresponding environmental consequences discussed in the Revised Plan and associated Environmental Impact Statement.

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 1992a). 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).

The Forest has adopted a three-part approach to the analysis of biological diversity in support of revising the 1983 Plan. The coarse filter, fine filter, and range of natural variability are each described in individual sections of this document. The first of these, the coarse filter, focuses on the function, composition, and structure of ecosystems. Providing for these parts of the ecosystem as a whole should be adequate to provide for the needs of most species. Thus, the coarse filter is where most species needs are addressed. However, a few species may require special attention due to unique habitat requirements or rarity of species numbers in an area. These species needs will be addressed in the fine filter. Their individual habitat requirements will be analyzed in Chapter 3 of the Final Environmental Impact Statement. Finally, the range of natural variability (RNV) serves to place conditions and management actions in a temporal context; to explain ecosystem dynamics and processes, particularly disturbance processes; and to provide information on conditions which can be maintained (Morgan et al. 1994). The actual RNV for the Forest is described in a separate report (Routt National Forest 1994). That report is summarized here. The RNV Report and summary provide a background for understanding how current forest ecosystems and communities developed and what might be expected in the future.

## Context for Assessment

### Hierarchy of Ecological Units

Central to biological diversity and ecosystem management is the study of landscape spatial and temporal patterns. The hierarchial 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 discreet 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. Table D-1 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<br>Global<br>Continental<br>Regional | Domain<br>Division<br>Province | Broad applicability for modeling and sampling RPA assessment. International planning | 1,000,000s to 10,000s of square miles |
| Subregions | Sections<br>Subsections | RPA planning multi-forest, statewide, and multi-agency analysis and assessment. | 1,000s to 10s of square miles |
| Landscape | Landtype<br>Association | Forest or area-wide planning, and watershed analysis. | 1,000s to 100s of acres |
| Land Unit | Landtype<br>Landtype Phase | Project and management area planning and analysis. | 100s to less than 10 acres |

Table D-2 summarizes the criteria used to differentiate the ecological units used in this report to describe the Forest (ECOMAP 1993).

Figure D-1 shows Ecological Domains, Divisions, and Provinces respectively, in relation to the Routt National Forest. These Ecological Units define a very broad ecological spatial context for the Forest.

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. Increased detail will be provided to describe the Province and Sections in which the Forest resides.

## Domains

Domains are subcontinental areas of broad climate similarity. The Forest resides within the Dry Domain. Figure D-1 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).

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

| Ecological Unit | Principal Map Unit Design Criteria[1/] |
|---|---|
| **Domain** | Broad climatic zones or groups (e.g., dry, humid tropical) |
| **Division** | Regional climatic types (Trewartha 1968)<br>Vegetational affinities (e.g., prairie or forest)<br>Soil order |
| **Province** | Dominant potential natural vegetation (Kuchler 1964)<br>Highland or mountains with complex vertical climate-vegetation-soil zonation |
| **Section** | Geomorphic process, surficial geology, lithology<br>Regional climatic data<br>Phases of soil orders, suborders, or great groups<br>Potential natural vegetation |

| | |
|---|---|
| | Potential natural communities (PNC)[2/] |
| **Subsection** | Geomorphic process, surficial geology, lithology<br>Phases of soil orders, suborders, or great groups<br>Subregional climatic data<br>PNC - formation or series |
| **Landtype Association** | Geomorphic process, geologic formation, surficial geology, and elevation<br>Phases of soil subgroups, families, or series<br>Local climate<br>PNC - series, subseries, plant associations |
| **Landtype** | Landform and topography (elevation, aspect, slope gradient, and position)<br>Rock type, geomorphic process<br>Phases of soil subgroups, families, or series<br>PNC - plant associations |
| **Landtype Phase** | Phases of soil families or series<br>Landform and slope position<br>PNC - plant associations or phases |

1/ 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.

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

## Divisions

Domains are further partitioned into Divisions. Divisions are determined by isolating areas of differing vegetation, broad soil categories, and regional climates. The Forest resides within the Temperate Steppe Division (Figure D-1). 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 (1964). The Forest resides within the Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow Province (M331). Figure D-1 shows the spatial relationship of the Forest and the Province mentioned above. Figure D-2 shows this in greater detail for Province M331. The following is the map unit descriptions for Province M331 (Bailey 1994).

### M331 Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow Province

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 7,000 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.

**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 (1964). The Forest resides within two Sections: M331H (North-central Highlands and Rocky Mountain) and M331I (Northern Parks and Ranges). Figure D-3 shows the spatial relationship of the Forest and the two sections mentioned above.

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

### Section M331H - 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.

**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 M331I - 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.

## Part I Coarse Filter

## Province

Location and Area

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

Cover Types

The USDA Forest Service mapped the forested land as a part of the Resources Planning Act (RPA) 1992 assessment update (Powell et al. 1993). Applying this information to the Province, the broad cover types and acreages are as shown in Table D-3.

**Table D-3. 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 |

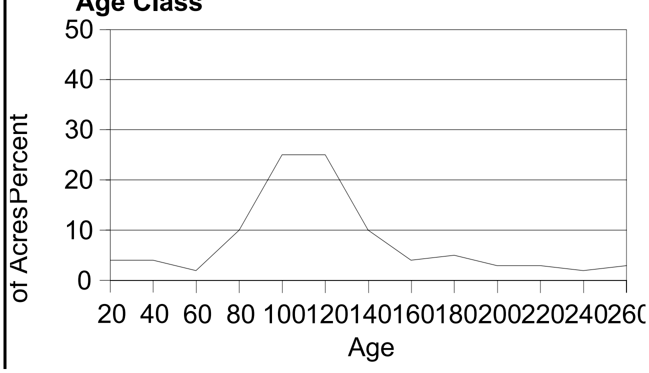
*Source: (Powell et al. 1993)*

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

<u>Age of Forested Cover Types</u>

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 major forested communities are lodgepole pine, ponderosa pine, Douglas-fir, spruce/fir, aspen, and pinyon/juniper. The majority of these forests are older forests in excess of 100 years (USDA Forest Service 1992a). Age classes for each dominant forested cover type are presented below. The data is from the Rocky Mountain Region, but it should be representative of the Province.

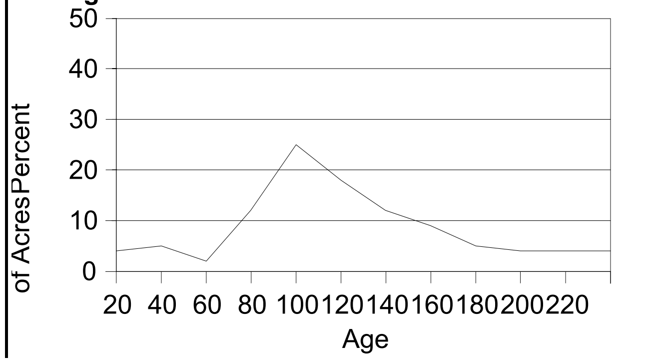
**Figure D-4. Lodgepole Pine Cover Type by Age Class**




Approximately 70% of the lodgepole pine cover type is between 80-180 years old. Stands of lodgepole pine at lower elevations start becoming high risk for bark beetles beyond the age of 80. The younger stands that are present are a result of past timber harvests and fires. Figure D-4 shows the lodgepole pine cover type age-class distribution.

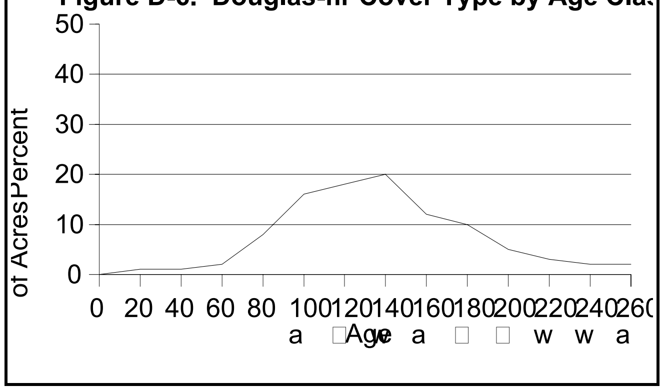
Approximately 70% of the ponderosa pine cover type is between 60-140 years old. Ponderosa pine can live to be 600 years old and usually does not slow down in growth until 150-225 years of age. About 10% is considered to be mature or older. Like lodgepole pine, the younger stands of ponderosa pine are a result of past timber harvests and fires. The open stands of ponderosa pine provide an understory of vegetation that is used by livestock and wildlife. Figure D-5 shows the ponderosa pine cover type age-class distribution.

**Figure D-5. Ponderosa Pine Cover Type by Age Class**



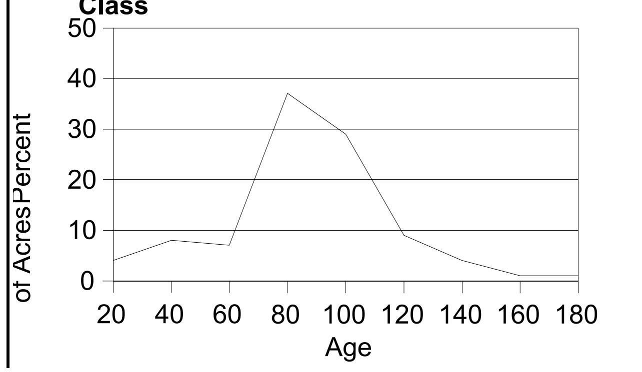

Approximately 75% of the Douglas-fir stands are between the ages of 80-180 years of age. In the northern and central Rockies, this community normally slows in growth at approximately 200 years old. Only a small percent is beyond 200-220 years of age. Figure D-6 shows the Douglas-fir cover type age-class distribution.

**Figure D-6. Douglas-fir Cover Type by Age Clas**



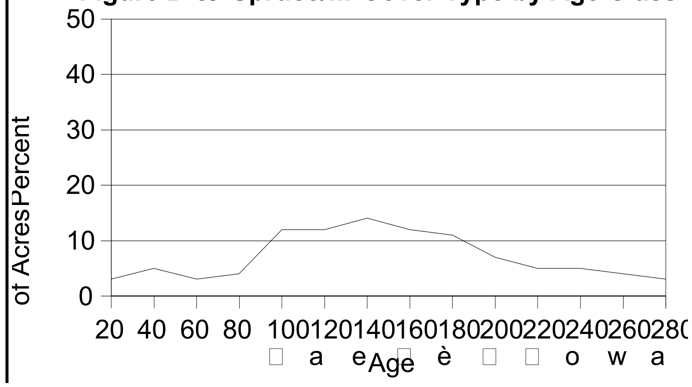

Aspen typically lives 80-90 years before pathogens start causing death. Seventy-eight percent of the aspen stands are between 60 and 120 years old. About 44% are beyond age 80. The amount of aspen is expected to decline as disease-causing organisms, insects, diseases, and the invasion of conifer trees affect the older stands. The aspen communities produce high yields of shrubs, forbs, and grasses which are available to livestock and wildlife. Figure D-7 shows the aspen cover type age-class distribution.

**Figure D-7. Aspen Cover Type by Age Class**



Roughly 77% of the spruce/fir in the Region is between 80-220 years old. Some spruce forests can reach an age of 500 years. The spruce/fir community is the most diverse of the cover types in terms of different ages represented. The younger forests present are primarily a result of past timber harvesting. Figure D-8 shows the spruce/fir cover type age-class distribution:

**Figure D-8. Spruce/fir Cover Type by Age Class**




There is not as much information available for pinyon/juniper communities.

Insects and Disease

According to the Biological Diversity Assessment done for this Region (USDA Forest Service 1992a), 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 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 Table D-4.

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 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-4. Selected Province Cover Types, Acres, and Percent of Total**

| 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 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 this habitat is suitable and occupied, there is potentially a significant amount of habitat associated with older forests present. The likelihood of all this 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.

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. They were also a more open forest, not the dense, multi-layered forest that people tend to describe when discussing old-growth forests in general.

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 1992a). However, this includes the National Grasslands, which are not within the Province proper. Thus, the 40% figure would actually be somewhat lower.

Rare Species

Nationwide, the threatened and endangered species list contains 944 species: 433 animals and 511 plants (USDI Fish and Wildlife Service 1995). Flather, et al. (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.

Potential for severe air pollution problems is determined by weather and topography. Weather that allows for accumulation of pollutants is common over large areas of the Western U.S. The potential for problems is probably greater than for the Eastern U.S. Most areas in the West, and in this Province, have low population densities, and pollution emissions are a fraction of what they are in the East. As the Western population grows, the frequency and severity of air pollution episodes is expected to increase (Binkley et al. 1991). From 1980 to 2030, sulfur dioxide ($SO_2$) and nitrogen oxide ($NO_x$) emissions in this Province are projected to increase by 42% and 142%, respectively (NAPAP Interim Assessment 1987).

Ozone is the pollutant of greatest concern in the West, mainly due to personal motor vehicles. In the Colorado Rockies, ozone concentrations reach levels of concern during summer months. Forests close to large urban and industrial complexes are more likely to receive higher air pollution exposure than forests further from pollution sources. However, large areas of the West lack data which could refute this conclusion (Binkley et al. 1991).

The Province contains portions of almost all the airsheds identified in the Region 2 air quality assessment (Blett et al. 1993). Major pollution sources whose impacts are increasing include oil and gas activities (increases in nitrogen oxides - NOx, sulfur dioxide - SO2, and carbon monoxide - CO), power plants (increase in NOx, SO2, and particulate matter - PM), mineral developments (increasing dust), and ski-area emissions (increase in PM and volatile organic compounds).

Fifteen counties in Colorado and one county in Wyoming are experiencing violations of national air quality standards. Counties in Colorado are: Archuleta, San Miguel, Prowers*, Fremont, Pitkin, Routt, Boulder, Adams*, Arapaho*, Denver*, Douglas, Jefferson, El Paso, Larimer, and Weld*. The county in Wyoming is Sheridan. The counties marked with an asterisk (*) are outside the Province.

<u>Water</u>

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. See Figure D-9.

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 Colorado 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.

## Section

<u>Location and Area</u>

The two sections in which the Forest resides, M331H - North-central Highlands and Rocky Mountains, and M331I - Northern Parks and Ranges, have been grouped together for this analysis. This two-section area includes portions of Colorado and Wyoming, but the majority of the acreage is in Colorado.

<u>Cover Types</u>

Using the vegetation/land cover data (based on LANDSAT satellite data) from the Colorado GAP Analysis Project and the Wyoming GAP Analysis Project (Wyoming GAP Analysis 1996), information was summarized for the two-section area. This information is presented in Table D-5.

**Table D-5. Cover Types, Acres, and Percent of Total for Sections M331H and M331I**

| 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), Colorado and Wyoming GAP Analysis Projects landcover layers 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.

<u>Age of Forested Cover Types</u>

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.

<u>Insects and Disease</u>

According to the Biological Diversity Assessment done for this Region (USDA Forest Service, 1992a), 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 M331H (Laramie Peak area) recently experienced an epidemic outbreak of mountain pine beetle (*Dendroctonus ponderosae*) in ponderosa pine.

<u>Timber Resource</u>

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 Table D-6.

**Table D-6. Selected Cover Types, Acres, and Percent of Total for Sections M331H and M33I1**

| 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 and Wyoming GAP Analysis Project*

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 all of this habitat is suitable and occupied, there is a large amount of habitat associated with older forests present. The likelihood of all this 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 Forest, the Medicine Bow-Routt National Forest, and the White River National Forest are all included in the two sections M331H and M331I. Parts of the Pike/San Isabel and the Grand Mesa/Uncompahgre/Gunnison National Forests are included. Threatened, endangered, and sensitive species lists for those forests were combined to form Table D-7 which lists the threatened, endangered, and sensitive species that potentially occur within the two-section area (USDA Forest Service 1994d).

Because the area being considered overlaps state boundaries, the state of Colorado's rare species have not been included. Table D-18 in the Fine Filter section of this appendix lists the threatened, endangered, and species of special concern for the state of Colorado thought to occur on or near the Routt National Forest.

**Table D-7. Rare Species for Sections M331H and M331I**

| Common Name | Scientific Name | Threatened, Endangered, or |
|---|---|---|

| | | Sensitive |
|---|---|---|
| **Mammals:** | | |
| Black-footed Ferret | *Mustela nigripes* | En |
| Rocky Mountain Gray Wolf | *Canis lupus irremotus* | En |
| Grizzly Bear | *Ursus arctos horriblis* | Th |
| Dwarf Shrew | *Sorex nanus* | R2S |
| Pygmy Shrew | *Microsorex hoyi montanus* | R2S |
| Fringed-tailed Myotis | *Myotis thysanodes pahasapensis* | R2S |
| Spotted Bat | *Eudema maculatum* | R2S |
| Townsend's Big-eared Bat | *Plecotus townsendii* | R2S |
| Wet Mountains Yellow-bellied Marmot | *Marmota flaviventris notioros* | R2S |
| Wyoming Pocket Gopher | *Thomomys fuscus* | R2S |
| Water Vole | *Microtis richardsoni* | R2S |
| Preble's Meadow Jumping Mouse | *Zapus hudsonius preblei* | R2S |
| Swift Fox | *Vulpes velox* | R2S |
| Ringtail | *Bassariscus astutus* | R2S |
| Marten | *Martes americana* | R2S |
| Fisher | *Martes pannanti* | R2S |
| North American Wolverine | *Gulo gulo luscus* | R2S |
| Colorado Hognosed Skunk | *Conepatus mesoleucus figginsi* | R2S |
| North American Lynx | *Felis lynx canadensis* | R2S |
| **Birds:** | | |
| American Peregrine Falcon | *Falco peregrinus anatum* | En |
| Bald Eagle | *Haliaeetus leucocephalus* | En |
| Eskimo Curlew | *Numenius borealis* | En |
| Least Tern | *Sterna antillarum* | En |
| Piping Plover | *Charadrius melodus* | En |
| Whooping Crane | *Grus americana* | En |
| Mexican Spotted Owl | *Strix occidentalis lucida* | Th |
| Common Loon | *Gavia immer* | R2S |
| Harlequin Duck | *Histrionicus histrionicus* | R2S |
| Northern Goshawk | *Accipiter gentilis* | R2S |
| Ferruginous Hawk | *Buteo regalis* | R2S |
| Osprey | *Pandion haliaetus* | R2S |
| Merlin | *Falco columbarius* | R2S |
| Columbian Sharp-tailed Grouse | *Tympanuchus phasianellus columbianus* | R2S |
| American Bittern | *Botaurus lentiginosus* | R2S |
| White-faced Ibis | *Plegadis chihi* | R2S |
| Greater Sandhill Crane | *Grus canadensis tabida* | R2S |

**Table D-7. Rare Species for Sections M331H and M331I (continued)**

| Common Name | Scientific Name | Threatened, Endangered, or |
|---|---|---|

| | | Sensitive |
|---|---|---|
| Mountain Plover | *Charadrius montanus* | R2S |
| Long-billed Curlew | *Numenius americanus* | R2S |
| Upland Sand Piper | *Bartramia longicauda* | R2S |
| Black Tern | *Chlidonias niger* | R2S |
| Western Yellow-billed Cuckoo | *Coccyzus americanus occidentalis* | R2S |
| Burrowing Owl | *Athene cunicularia* | R2S |
| Boreal Owl | *Aegolius funereus* | R2S |
| Flammulated Owl | *Otus flammeolus* | R2S |
| Black Swift | *Cypseloides niger* | R2S |
| Lewis Woodpecker | *Melanerpes lewis* | R2S |
| Black-backed Woodpecker | *Picoides arcticus* | R2S |
| Northern Three-toed Woodpecker | *Picoides triactylus* | R2S |
| Olive-sided Flycatcher | *Contopus borealis* | R2S |
| Purple Martin | *Progne subis* | R2S |
| Pygmy Nuthatch | *Sitta pygmaea* | R2S |
| Golden-crowned Kinglet | *Regulus satrapa* | R2S |
| Loggerhead Shrike | *Lanius ludovicianus* | R2S |
| Baird's Sparrow | *Ammodramus bairdii* | R2S |
| **Amphibians:** | | |
| Tiger Salamander | *Ambystoma tigrinum* | R2S |
| Boreal Toad | *Bufo boreas boreas* | R2S |
| Northern Leopard Frog | *Rana pipiens* | R2S |
| Wood Frog | *Rana Sylvatica* | R2S |
| Yellow Mud Turtle | *Kinosternon flavescens flavescens* | R2S |
| **Reptiles:** | | |
| Texas Horned Lizard | *Phrynosoma cornutum* | R2S |
| Black Hills Redbellied Snake | *Storeria occipitomeoculatae pahasapae* | R2S |
| Kansas Glossy Snake | *Arizona elegans blanchardi* | R2S |
| Lined Snake | *Tropidoclonion lineatum* | R2S |
| Milk Snake | *Lampropeltis triangulum* | R2S |
| Prairie Ringneck Snake | *Diadophis punctatus arnyi* | R2S |
| Texas Blind Snake | *Leptotyphlops dulcis* | R2S |
| Texas Longnosed Snake | *Rhinocheilus lecontei tessellatus* | R2S |
| **Fish:** | | |
| Bonytail Chub | *Gila elegans* | En |
| Colorado Squawfish | *Ptychocheilus lucius* | En |
| Humpback Chub | *Gila cypha* | En |
| Razorback Sucker | *Xyrauchen texanus* | En |
| Greenback Cutthroat Trout | *Oncorhynchus clarki stomias* | Th |
| **Table D-7. Rare Species for Sections M331H and M331I (continued)** | | |
| **Common Name** | **Scientific Name** | **Threatened, Endangered, or Sensitive** |

| | | |
|---|---|---|
| Colorado River Cutthroat Trout | *Oncorhynchus clarki pleuriticus* | R2S |
| Rio Grande Cutthroat Trout | *Oncorhynchus clarki virginalis* | R2S |
| Yellowstone Cutthroat Trout | *Oncorhynchus clarki bouveri* | R2S |
| Arkansas River Shiner | *Notropis girardi* | R2S |
| Arkansas River Speckled Chub | *Hybopsis aestivalis tetranemus* | R2S |
| Flathead Chub | *Hybopsis gracilis* | R2S |
| Southern Redbelly Dace | *Phoxinus erythrogaster* | R2S |
| Plains Topminnow | *Fundulus sciadicus* | R2S |
| Banded Killfish | *Fundulus diaphanus* | R2S |
| Arkansas Darter | *Etheostoma cragini* | R2S |
| **Invertebrates:** | | |
| American Burying Beetle | *Nicrophorus americanus* | En |
| Uncompahgre Fritillary Butterfly | *Boloria acrocnema* | En |
| Pawnee Montane Skipper | *Hesperia leonardus montana* | Th |
| Rocky Mountain Capshell Snail | *Acroloxus coloradensis* | R2S |
| Regal Fritillary Butterfly | *Speyenia idalia* | R2S |
| Albarufan Dagger Moth | *Acronicta albarufa* | R2S |
| Lost Ethmiid Moth | *Ethmia monachella* | R2S |
| Steven's tortricid Moth | *Decodes stevensi* | R2S |
| **Plants:** | | |
| Osterhout Milkvetch | *Astragalus osterhoutii* | En |
| Penland Beardtongue | *Penstemon penlandii* | En |
| North Park Phacelia | *Phacelia formosula* | En |
| Penland Alpine Fen Mustard | *Eutrema penlandii* | Th |
| Unita Basin Hookless Cactus | *Sclerocactus glaucus* | Th |
| Ute Ladies'-tresses | *Spiranthes diluvialis* | Th |
| Southern Maiden-hair Fern | *Adiantum capillus-veneris* | R2S |
| Larimer Aletes | *Aletes humilis* | R2S |
| Laramie Columbine | *Aquilegia laramiensis* | R2S |
| Sea Pink | *Armeria maritima ssp. sibirica* | R2S |
| Dwarf Milkweed | *Asclepias uncialis* | R2S |
| Gunnison Milkvetch | *Astragalus anisus* | R2S |
| Leadville Milkvetch | *Astragalus molybdenus* | R2S |
| Reflected Moonwort | *Botrychium echo* | R2S |
| Narrow-leaved Moonwort | *Botrychium lineare* | R2S |
| Pale Moonwart | *Botrychium pallidum* | R2S |
| Arctic Braya | *Braya glabella* | R2S |
| Rollands Bulrush | *Scripus rollandii* | R2S |
| Laramie False Sagebrush | *Sphaeromeria simplex* | R2S |

**Table D-7. Rare Species for Sections M331H and M331I (continued)**

| Common Name | Scientific Name | Threatened, Endangered or Sensitive |
|---|---|---|
| Hapeman's Sullivantia (Wyoming) | *Sullivantia hapemanii var. hapemanii* | R2S |

| | | |
|---|---|---|
| Handing Garden Sullivantia (Colorado) | *Sullivantia hapemanii var. purpusii* | R2S |
| Selkirk Violet | *Viola selkirkii* | R2S |
| Livid Sedge | *Carex livida* | R2S |
| Sandhill Goosefoot | *Chenopodium cycloides* | R2S |
| Purple Lady's-Slipper | *Cypripedium fasciculatum* | R2S |
| Smith's Whitlow-Grass | *Draba smithii* | R2S |
| Roundleaf Sundew | *Drosera rotundifolia* | R2S |
| Giant Helleborine | *Epipactis gigantea* | R2S |
| Woolly Fleabane | *Erigeron lanatus* | R2S |
| Brandegee's Wild-buckwheat | *Eriogonum brandegei* | R2S |
| Altai Cottongrass | *Eriophorum altaicum var. neogaeum* | R2S |
| Hall Fescue | *Festuca hallii* | R2S |
| Black Canyon Gilia | *Gilia pentstemonoides* | R2S |
| Rabbit Ears Gilia | *Ipomopsis aggregata spp. weberi* | R2S |
| Globe Gilia | *Ipomopsis globularis* | R2S |
| Kirkpatrick's Ipomopsis | *Ipomopsis spicata spp. robruthii* | R2S |
| Colorado Tansy-aster | *Machaeranthera coloradoensis* | R2S |
| White adder's-mouth | *Malaxis monophyllos spp. brachypoda* | R2S |
| Weber Monkey-flower | *Mimulus gemmiparus* | R2S |
| Marsh Muhly | *Muhlenbergia glomerata* | R2S |
| Rock-loving Aletes | *Aletes lithophilus* | R2S |
| Wyoming Feverfew | *Bolophyta alpina* | R2S |
| Degener Penstemon | *Penstemon degeneri* | R2S |
| Harrington Beardstongue | *Penstemon harringtonii* | R2S |
| DeBeque phacelia | *Phacelia submutica* | R2S |
| Rocky Mountain Cinquefoil | *Potentilla rupincola* | R2S |
| Greenland Primrose | *Primula egaliksensis* | R2S |
| Porten feathergrass | *Ptilagrostis porteri* | R2S |
| Nagoon Berry | *Cylactis arctica spp. acaulis* | R2S |
| Lime-loving Willow | *Salix lanata ssp. calciola* | R2S |
| Low blueberry Willow | *Salix myrtillifolia* | R2S |
| Autumn Willow | *Salix serissima* | R2S |

*Source: (USDA Forest Service 1994d and Spackman et al. 1997)*

## Air Quality

At the section level, the Forest has portions of three airsheds identified in the Forest Service Rocky Mountain Region air quality assessment. Major pollution sources whose impacts are increasing include power plants (sulphur dioxide - $SO_2$ and nitrogen oxides - $NO_x$) and oil/gas activities ($SO_2$, $NO_x$, particulate matter - PM and carbon monoxide - CO). Presently, Routt County is experiencing violation of national air quality standards.

## Water

Water pollution sources off-forest are related primarily to mining and agriculture. Although surface water on the Forest is good overall, there are four stream reaches which are on the state of Colorado Impairment List. These four reaches are on the impairment list for historic mining or off-forest mining. Also on the impairment list are reaches of the Michigan and Illinois Rivers in Jackson County and the Yampa River through Steamboat Springs in Routt County. These streams are impaired due to sedimentation, metals, and other causes.

## Current Conditions - Routt National Forest

Cover Types

The Forest contains about 2% of the acreage in the M331 Province. Overall, the Forest has 1,100,567 acres (including oak brush) of forest land. This is 2.6% of the total forest land in the Province. Moving down to the Section level in the hierarchy, the Forest is 7.0% of the two-section area (M331H and M331I). The forested lands comprise 8.9% of the total forest land in the two sections. Table D-8 shows the Forest contribution to the makeup of cover types in the two sections.

**Table D-8. Routt National Forest Cover Types in Sections M331H and M331I**

| Cover Type | Acres | Percent of Forest Total | Percent of Cover Type in Sections |
|---|---|---|---|
| Spruce/fir | 453,977 | 33.4 | 18 |
| Lodgepole pine | 379,097 | 27.9 | 13 |
| Aspen | 260,364 | 19.2 | 11 |
| Oak brush (Chaparral) | 1,793 | 5.1 | .2 |
| Douglas-fir | 5,336 | .4 | 1 |
| Nonforested | 256,204 | 14.0 | 4 |

*Source: DWRIS GIS*

As the table above shows, most of the Forest, (61.8%) is covered with conifer forest. Aspen and oak brush also account for a large percent of the total land at 19.3%. These figures represent 9.2% of the total conifer in the two-section area and 7.9% of the aspen and chaparral (hardwood) component in the same area. Although oak brush is very important at the Section level, with 63% of the oak in the Province found there, the Forest contains only 0.2% of the two-section total. The largest percentage contribution made by the Forest for the two sections is spruce/fir at 18%. Based on these figures, the Forest does not contribute any disproportionately large percentages to any of the cover types analyzed. However, because oak brush in the two sections constitutes such a large portion at the Province level, the oak brush managed by the Forest may be more important than the 0.2% contribution indicates.

Age of Forested Cover Types

Actual age data for the forested land on the Forest is limited. About 37% of the Forest has age data. However, structural stage data is available for the entire Forest and can serve as a substitute for age. Table D-9 shows that 61% of the forest land is in a mature structural stage. Structural stages 4b, 4c, and 5 have been lumped together and classified as late successional forest (see FEIS, Chapter 3, Vegetation section for a complete explanation of structural stages). Almost half of the forested land on the Forest is classified as late successional.

**Table D-9. Percent of Habitat Structural Stage on Forested Lands**

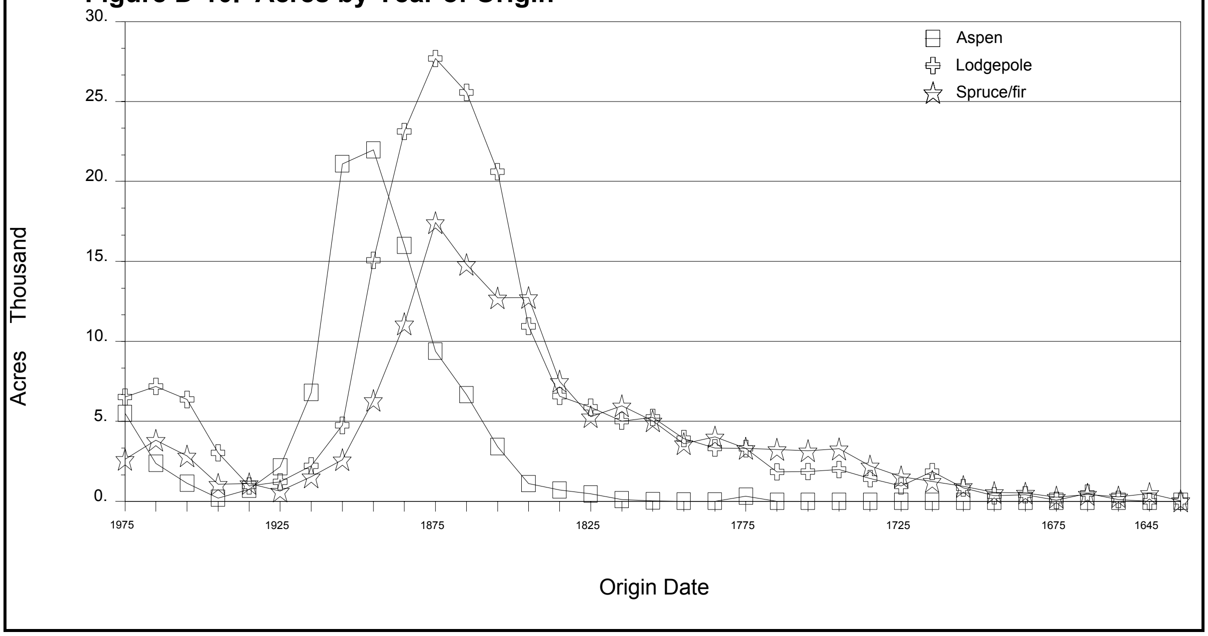
| Structural Stage | Acres | Percent of Total |
|---|---|---|
| 1 - Grass/Forb | 14,480 | 1 |
| 2 - Seed/Sap | 27,017 | 3 |
| 3 - Pole | 388,532 | 35 |
| 4 - Mature | 668,745 | 61 |

| | | |
|---|---|---|
| 4b/4c - Late Successional | 539,004 | 49 |

*Source for D-9 and D-10: DWRIS GIS*

Figure D-10 shows an age distribution diagram for the Forest. The diagram represents only the 37% of the Forest with age data. Nevertheless, this diagram has particular implications when interpreting the Range of Natural Variability (RNV) report for the Forest. The large peak centered at about age 112 (in 1885) roughly coincides with the period of settlement in the area of the Forest. The period between 1850-1910 accounts for most of the area under the curve. In 1910 approximately, the Forest Service began in earnest to suppress wildfires on the Forest. As stated in the RNV report, many large fires burned on the Forest in the late 1800s. The large percentage of the Forest dating from the 1850-1910 period probably regenerated as a result of these fires. This same period also coincides with the period of settlement and several large-scale droughts across the western U.S. (Routt National Forest 1994). Most of the acres from this period now qualify as late successional forest.

**Figure D-10. Acres by Year of Origin**



*Source: DWRIS GIS*

## Disturbance Processes

The ecosystems and associated vegetation of the Forest are very dynamic. The processes of succession and associated disturbance patterns have produced the current vegetative conditions. These processes will continue to produce changes in the future. Disturbance events such as fire, wind storms, landslides, and insect and disease outbreaks are generally more difficult to predict than the changes associated with succession. However, such disturbance events will occur throughout the Forest and are a necessary part of the ecosystem. Explanations of some of these events and their influence on, and role in, the ecosystem are presented in this section.

## Insects and Disease - Background

The information in this section was supplied by David Johnson, Supervisory Plant Pathologist and Center Leader for the Lakewood Service Center of Forest Health Management, Region 2, USDA Forest Service.

## Spruce beetle

The tree-killing potential of the spruce beetle, *Dendroctonus rufipennis*, has been well-documented during the last 100 years. This insect infests all species of spruce in North America. On the Forest, Engelmann spruce is the principal host. Spruce beetles generally prefer to attack green windthrown or other recently downed spruce. As a result, endemic beetle populations are always present, breeding in scattered down material, in the spruce-fir forest type. Outbreaks begin after a major forest disturbance (e.g., a large windthrow) creates an abundance of suitable breeding material. Beetle populations rapidly increase in the down material and then readily attack standing spruce. Outbreaks may persist until suitable host material is depleted. The susceptibility of a stand to spruce beetle outbreaks is dependent on:

- The physiographic location of the stand.
- The average diameter of the spruce in the stand.
- The basal area of the stand.
- The proportion of spruce in the canopy.

In general, spruce stands on well-drained creek bottoms are susceptible to outbreaks if the following are present: large diameter spruce, high basal areas, and high proportions of spruce in the canopy (Schmid and Frye 1976).

<u>History</u>

Tree ring evidence suggests that the earliest known spruce beetle outbreak on the White River Plateau occurred in the early 1700s (Miller 1970; Veblen 1993). In the mid 1870s, Sudworth (1900) found that 10% to 25% of the mature spruce on the White River Plateau and the Grand Mesa were dead. Hopkins (1909) later confirmed that the spruce beetle was the cause of this mortality. Photographic and tree-ring analysis by Baker and Veblen (1990) suggest that the mortality observed by Sudworth and Hopkins occurred between the 1850s and 1880s and affected forests from central New Mexico to north-central Colorado.

In the 1940s, the White River, Arapaho, Grand Mesa, Routt, San Juan, and the Uncompahgre National Forests were the sites of the most damaging spruce beetle outbreak ever recorded (Massey and Wygant 1954). In the White River National Forest, more than 700,000 acres were devastated by the beetle (Hinds et al. 1965). This outbreak was triggered in 1939 when a violent windstorm blew down extensive patches of subalpine forests in western Colorado (Hinds et al. 1965). The White River Plateau suffered the greatest spruce losses during this outbreak, with most of the spruce mortality occurring between 1943 and 1946 (Hinds et al. 1965). By the time the outbreak subsided in 1952, nearly all spruce eight inches in diameter and larger on the plateau (an estimated 3.8 billion board feet of timber) were killed (Massey and Wygant 1954; Hinds et al. 1965). Today, many of the spruce killed during this outbreak remain standing, and the severity of the outbreak is still evident.

Although the major spruce beetle outbreaks listed above have caused significant changes in stand structure over extensive areas, not all epidemics create these extreme effects. More common are epidemics of lesser magnitude which may kill 10% to 20% of the stand or only the largest diameter trees within the stand (Frye and Flake 1972).

<u>Impacts of Spruce Beetle on Resources</u>

The most significant forest response to the 1940s outbreak was the shift in species composition (from 90% spruce and 10% fir to 20% spruce and 80% fir) and the release of previously suppressed fir and spruce (Schmid and Hinds 1974; Veblen et al. 1991). If the outbreak favored establishment of new spruce and fir seedlings, this effect was not evident approximately 40 years later (Veblen et al. 1991). Because fir is more abundant than spruce in the understory, more of the former species can be expected to grow into the larger size classes following an outbreak (Peet 1981; Veblen 1986). However, given the greater longevity of spruce, stands that have experienced a spruce beetle outbreak will continue to be co-dominated by both tree species.

Spruce beetle outbreaks may have long-term effects on ungulate populations. Yeager and Riordan (1953) found that the killing of the stands initially improves the summer forage for deer and elk. However, increasing numbers of fallen dead trees may inhibit the movement of ungulates for many decades following the outbreak. Hinds et al. (1965) found that 25% of the beetle-killed trees were windthrown 20 years after an outbreak.

Beetle-killed spruce become hazards for recreationists because trees decay and fall or become windthrown before decaying. The increased windthrow is also a concern to recreation managers who must contend with increased trail and campground maintenance costs.

Spruce beetle outbreaks create a large fuel source for fires. Much of the area affected by the 1940s outbreak has greater than 100 tons of dead fuel per acre (Leighty 1993). Decomposition of the dead trees is slow because of the slow rate at which the trees fall and the fact that many of the trees fall atop each other and do not contact the ground for several decades. Although heavy fuel loading means that fires in this area would be catastrophic and difficult to control, natural ignitions in the spruce-fir forests of the White River Plateau are rare due to the generally moist environment during much of the fire season.

## Mountain Pine Beetle

The mountain pine beetle (*Dendroctonus ponderosae*) is a native bark beetle. This beetle has a persistent outbreak history in the mature and over-mature lodgepole pine stands on the Forest. The large scale mountain pine beetle epidemics of the 1970s and 1980s provide an example of natural forces causing large-scale changes in spacing and eventual age classes of tree species and accumulations of dead biomass (McGregor et al. 1985).

The mountain pine beetle usually infests standing live trees larger than eight inches in diameter but may attack smaller trees when intermixed with the larger trees. During epidemics, trees are usually killed in small groups of three to ten trees, but such groups may coalesce into one large group of more than 100 dead trees. Endemic populations are usually associated with single trees which are diseased or stressed by any number of agents or causes. The susceptibility of lodgepole pine stands to outbreaks can be estimated by average tree diameter, average tree age, and location by elevation and latitude (Amman et al. 1977).

The mountain pine beetle influences stand structure in pure pine stands. It kills greater portions of large diameter trees, so the average stand diameter decreases during epidemics. Depending on the extent of tree mortality within the stand, small to large openings may be created in the canopy. Under extreme epidemics, entire stands may be killed thus converting the site to a younger age class of pine or to another seral stage.

Mountain pine beetle epidemics also influence herbage production, wildlife populations, and fire hazard. The growth of forbs and grasses increases in beetle-killed areas. Wild ungulates may benefit from the increased herbaceous production, and the standing beetle-killed trees may provide habitat for cavity nesting birds. In general, the influence of mountain pine beetle epidemics will vary depending on the needs of the particular species. Fire hazard is increased for several years following mountain pine beetle mortality due to the dead needles remaining on the trees and because the probability of higher intensity fires may be increased for a number of years as the dead trees fall to the ground and add to the surface fuel loading.

The frequency of mountain pine beetle epidemics in a given area may range from 20 to 40 years, depending how rapidly some trees grow into large diameter categories. However, for a given stand, the frequency between epidemics may range from 50 to 100 years, depending on how much of the original stand was beetle-killed. Mountain pine beetle populations are currently in endemic status on the Forest.

### Dwarf mistletoe

The dwarf mistletoe is a parasitic seed plant that affects most conifers in the western United States. Dwarf mistletoe and western conifers have existed together for centuries. Today, the dwarf mistletoe is one of the most widespread and damaging groups of forest diseases in the West. Fires normally change forest composition and sanitize infested stands by killing the parasite when the host tree is killed. Where large fires occurred, the new replacement forests are essentially free of mistletoe. Thus, suppression of large fires over the last 50 years has played a critical role in shaping western forests.

In the absence of fire and management, the status of dwarf mistletoe does not change markedly from year to year. Mistletoe spreads slowly, at a rate that averages one to two feet per year in even-aged stands. Past management practices have, in some situations, increased the rate of spread by the perpetuating uneven-aged stands which accentuate the spread of dwarf mistletoe from overstory to understory trees. The incomplete removal of infected trees, usually nonmerchantable in timber sale areas, has led to increased spread of the disease. The retention of infected trees along visual corridors and for wildlife habitat has resulted in subsequent spread to adjacent uninfested stands. The limitations on the size of harvest units in recent years has also had an impact. In stands of at least 20 acres, it is most effective to cut all infected trees to minimize reinfection from the edges of the stand. Small harvest units can aggravate and intensify the rate of infection. The lack of market for smaller trees that occurs in heavily infested, low volume stands has also prevented treatment of many diseased stands.

Silvicultural practices to control dwarf mistletoe have been advocated since the early part of the century; however, these efforts were limited to removing only the large, merchantable overstory trees during the course of harvesting operations. This type of partial cutting actually increased the amount of infection in residual stands. Leaving infected trees of no commercial value in regeneration areas also intensified the problem.

Forest roads and timber markets began improving in the 1950s. Improved access and markets, coupled with more specific guidelines from research, made it possible for managers to take more effective action against the dwarf mistletoe.

In the past two decades, dwarf mistletoe control programs have been more consistent. In addition, thousands of acres are treated each year through scheduled stand improvement and timber harvesting operations. Despite these efforts, our ability to substantially improve the health of the forest is limited by markets and politics.

Impacts of Dwarf Mistletoe on the Resource

The most important effect of dwarf mistletoe is volume reduction. When trees are heavily infested, dwarf mistletoe reduces both height and diameter growth and increases mortality. The extent of loss depends upon several factors, including host and mistletoe species, intensity of infection, site index, stand density, and stand structure. Infestation levels vary greatly from stand to stand, dependent primarily upon fire history of the stand and past management practices. If stands are infected early in their development and if no suppression measures are taken to reduce spread and intensity of the disease, significant reduction in yield occurs

The first symptom of infection on an individual tree is a swelling of host tissues. Later, the swellings enlarge and produce dense masses of distorted branches called "witch's broom." As the parasite spreads through the tree crown, tree growth is gradually reduced. Eventually the top weakens and dies, diameter growth ceases, and the entire tree dies. Insects, particularly bark beetles, may cause an earlier death by attacking weakened, heavily infected trees (Johnson et al. 1976). Other pests, such as decay fungi, enter wounds and swellings created by the mistletoe.

Dwarf mistletoe not only causes losses in timber values, but also adversely affect recreation values by killing trees in campgrounds, picnic areas, etc. In addition, the decay and canker fungi associated with dwarf mistletoe infections kill or weaken branches so that they are more susceptible to wind breakage, thus increasing the hazard to recreationists.

Although the debilitating effects of the mistletoe on tree growth and forest productivity are well-documented, their effects on noncommodity Forest values have not been fully assessed. The effects on wildlife, for example, may be positive or negative depending upon the particular ecological needs of the wildlife species. Dead trees provide nesting sites for snag-dependent bird species. Witch's brooms also provide cover and nesting sites for many birds and mammals. Large areas infested with mistletoe have a more irregular, open forest canopy which favors certain bird and mammal species. Greater vegetation diversity will occur as the openings regenerate to either the same tree species or other tree species and brush. This results in profound changes in both stand structure and species composition. The mistletoe plants themselves provide a food source for some mammals, birds, and insects.

The impacts of dwarf mistletoe on visual quality would generally be considered negative due to reduced tree vigor, increased mortality, increased fuel accumulations, and susceptibility to fire. Effects on other resource values are, for the most part, unknown.

## Armillaria Root Disease

Root diseases are one of the most damaging classes of forest tree diseases in the western United States. These diseases cause economic loss by killing trees, slowing growth, decaying wood, predisposing trees to other harmful pests, causing trees to fail and fall over, preventing reforestation, and reducing stocking levels on regeneration sites.

In an assessment of losses caused by root disease for the western U.S., Smith (1984) estimated average annual volume loss in commercial forest lands at nearly 240 million cubic feet. This loss is approximately 18% of the total softwood mortality reported for the West.

Investigations of root disease losses in the Rocky Mountain Region are in their infancy (Johnson 1984), therefore, no data is available on volume loss. Although study plots have been established throughout the Region to monitor disease development in various host types, no loss estimates have been generated from this data.

Specific surveys for root diseases have not been conducted on the Forest, but observations indicate that Armillaria root disease is the most common and widespread species (James and Gillman 1980). Tree species susceptibility varies by host species, tree vigor, age, and habitat type. The fungus is commonly observed on lodgepole pine, ponderosa pine, and subalpine fir. The fungus has also been recorded on pinyon pine, Engelmann spruce, white fir, aspen, Rocky Mountain juniper, and cottonwoods.

In forest types where fire has been an important natural factor in determining species composition and stand characteristics, fire suppression may interact with silvicultural management to promote root disease by allowing regeneration of species which are more susceptible to armillaria. Fire control associated with selective logging in some of the drier forests in western North America has favored regeneration of Douglas-fir and true fir in stands formerly composed predominantly of ponderosa pine, western white pine, and western larch, species apparently less susceptible or more tolerant to root disease. Factors that increase stress in trees, such as drought and defoliation by insects, may also increase the amount of root disease.

Armillaria is a natural component of the mycroflora of many forests worldwide. It commonly lives as a saprophyte on dead organic material such as old stumps left from logging. It also kills living tissues and then utilizes them as a nutrient source. As a consequence of parasitic activity or disturbance such as logging, windthrow, or fire, armillaria may infect large quantities of roots, stumps and other debris on the ground. From stumps it can spread to living hosts by root contacts and rhizomorphs. The rhizomorphs are red-brown or black cords of fungus mycelium similar to shoestrings (15 mm in diameter), hence the common name shoestring root rot. Rhizomorphs can grow through the soil from the food base to the roots of living trees. The fungus then spreads from the roots to the root collar and can parasitize and girdle the tree. During wet periods in late summer, the fungus produces mushrooms which are found in clumps near the base of infected trees or stumps. Spores released from the mushrooms infect butt and root wounds.

This root disease is relatively easy to identify. Affected trees show declining growth (especially height), yellowing foliage, and stress crops of cones. Small trees often die in groups (a characteristic of all root diseases). An exudate of resin is found on the trunk near the soil line and often is mixed with the soil at the root collar. Thick, white mycelial fans occur under the bark of roots and around the root collar. Mushrooms may or may not be present, depending upon the time of year and microsite conditions.

Armillaria root disease occurs commonly in association with trees that have been attacked or killed by bark beetle and woodborer. A study conducted in the Colorado Front Range showed that 62% of ponderosa pine killed by mountain pine beetle were also infected by armillaria (Fuller 1983).

Armillaria is also common in cutover lodgepole pine stands that have regenerated naturally (Sharon 1988). An evaluation of a 31-year old stand on the Poudre Ranger District showed that 12% of the cumulative mortality was attributed to this fungus (Johnson and Hawksworth 1977).

No disease centers were large enough to result in understocking of the stand. Annual loss of trees over a period of 18 years showed a reduction in tree mortality from nearly 2% per annum to less than 0.5%.

Surveys of naturally regenerated seedling-sapling stands indicate up to 11% of trees infected or killed by Armillaria. Disease incidence is not uniform throughout stands. Most diseased trees are located near stumps, which probably served as infection sources.

### Comandra Blister Rust

Comandra blister rust causes stem and branch cankers on several species of pines, including ponderosa pine and lodgepole pine (Johnson 1979; Johnson 1986). It occurs throughout North America and is a serious cause of loss in many lodgepole pine stands in the central Rocky Mountains. For example, on the Shoshone National Forest, Wind River Ranger District, more than half of lodgepole pine basal area is in infected trees (Geils and Jacobi 1984).

Comandra blister rust has a complex life cycle. It has five different spore stages produced alternately on two hosts: a hard pine and the perennial herb for which the fungus is named, pale comandra (*Comandra umbellata*). The spores that infect the pine are produced only on the comandra plants. These plants occur in sagebrush communities at various distances from the pine stands. The delicate rust spores are wind-dispersed from the comandra plants to pines during rainy days in summer. Infection occurs through needles and young shoots. The fungus spreads into the inner bark. One to three years later, the first evidence of the disease on pine appears; small drops of thick, sticky, reddish-orange liquid on the diseased bark. These drops contain spores. During the following spring and summer, pustules form on these cankered areas. These pustules soon rupture and release another spore stage, which infects the alternate host, comandras. Infection of comandras results in yellow, blister-like spots on the leaves which, in turn, produce spores that infect other comandra plants.

In late summer or early fall, brown, hairlike structures develop on the underside of infected leaves. During mild, wet weather, these structures produce another spore that infects pines, thus completing the life cycle.

The rust attacks pines of all sizes and ages. Seedlings are the most susceptible and are usually killed within a few years by stem cankers. Infection of pole and sawtimber-size trees results in growth loss and mortality that prevents those trees from becoming merchantable.

The number of years it takes the fungus to girdle the main stem equals twice its diameter, in inches, at the spot where the canker occurs.

Trunk infections in mature and overmature trees are accompanied by diagnostic crown symptoms. The first crown symptoms are dead branches in a narrow zone around the branch where the fungus entered the main stem. Above this zone, the crown thins and eventually dies, forming characteristic spike tops. These tops are resistant to decay and remain intact for many years.

A detailed study on the Laramie Ranger District showed that rust incidence was highest in stands older than 40 years along forest edges adjacent to comandra habitat, but pine stands as far as eight miles from comandra plants can be seriously infected. Spore dispersal from comandra plants to pines seems to be associated with easterly winds during long rainy periods. Disease incidence also increases with average tree height or diameter (Jacobi et al. 1993).

### Summary

The current and projected future conditions on the Forest indicate that insects and diseases will continue to play significant roles in the successional and disturbance processes at work. Most major forest vegetation types have the largest percentage of their structural stage acreage in the mature class. These areas are conducive to outbreaks of the more important (in terms of potential damage) insect and disease agents (Table D-10). Growth loss and mortality will continue to occur, particularly where access, topography, or other resource restraints preclude silvicultural treatment of stands.

We can influence the outcome of insect and disease outbreaks at the stand level on a project level basis. The use of risk rating systems exist for most of the important insect and disease organisms and both forest stand and pest models can be helpful in projecting future scenarios and determining management options.

**Table D-10. Forest Conditions with the Greatest Potential to Incur Significant Loss to the Major Insect and Disease Organisms**

| Organism | Stands with greatest potential to incur significant losses |
|---|---|
| Spruce beetle | Spruce stands located in well-drained creek bottoms having large diameter spruce, high basal areas, and high proportions of spruce in the overstory. Also extensive spruce stands where large amounts of windthrown trees have occurred. |
| Mountain pine beetle | Dense, clumpy ponderosa pine stands (stands with basal areas of 150 square feet or greater per acre measured around any individual trees); stands of low vigor lodgepole pine that are usually dense and 80 years old or older. |
| Dwarf mistletoes | Multi-storied host stands with infected overstories. Pure stands that are already infected. Young stands adjacent to infected stands of the same species. |
| Armillaria root disease | Differs by area, but generally more severe in stands with major true fir components; may be favored by factors that stress trees such as defoliating insects, weather extremes, drought, etc. |
| Comandra blister rust | Pine stands adjacent to sagebrush habitats containing the alternate host plant, Comandra. Marginally stocked stands with a high incidence of disease. |

## Insects and Disease - Current Status and Risk Assessment

Dwarf Mistletoe

Dwarf mistletoe surveys in lodgepole pine have been completed for 182,590 acres on the Forest. This amounts to 13% of the Forest and 48% of the lodgepole pine cover type. Results of these surveys are displayed in Table D-11. These ratings are based on Hawksworth (1979). Given the slow rate of spread for dwarf mistletoe and the fact that 86% of the acres surveyed have a rating of 2 or less, the risk from this disease is not great. However, these data represent only 48% of the lodgepole pine cover type and local conditions can present higher risk situations. Data on dwarf mistletoe in other conifer species is not available.

**Table D-11. Acres and Percentages of Hawksworth Dwarf Mistletoe Ratings in Lodgepole Pine**

| Hawksworth Dwarf Mistletoe Rating | Acres | Percent of Surveyed Acres | Percent of Lodgepole Cover type |
|---|---|---|---|
| 0 (no visible infection) | 92,273 | 51 | 24 |
| 1 | 41,697 | 23 | 11 |
| 2 | 21,607 | 12 | 6 |
| 3 | 13,437 | 7 | 4 |
| 4 | 7,686 | 4 | 2 |
| 5 | 4,165 | 2 | 1 |

| | | | |
|---|---|---|---|
| 6 (most severe) | 1,725 | 1 | <1 |

*Source: Rocky Mountain Resource Information System database, 1995*

### Spruce Beetle

A spruce beetle rating has been computed for 141,743 acres on the Forest. This amounts to 10% of the Forest and 31% of the spruce/fir cover type. Results of these computations are displayed in Table D-12. These ratings are based on physiographic location, the number and size of trees in the stand, and the percentage of spruce in the stand as discussed in Schmid and Frye (1976). As the spruce/fir stands on the forest continue to grow, the percentage of area in the higher risk categories will increase.

**Table D-12. Acres and Percentages of Spruce Beetle Ratings**

| Spruce Beetle Rating | Acres | Percent of Computed Acres | Percent of Spruce/fir Cover type |
|---|---|---|---|
| 1 - Low | 21,752 | 15 | 5 |
| 2 - Medium Low | 16,933 | 12 | 4 |
| 3 - Medium | 88,735 | 63 | 20 |
| 4 - Medium High | 12,387 | 9 | 3 |
| 5 - High | 1,936 | 1 | <1 |

*Source: Rocky Mountain Resource Information System database, 1995*

### Mountain pine beetle

A rating system has also been developed for mountain pine beetle in lodgepole pine (Amman, McGregor, Cahill, and Klein 1977). The rating from this system is based on elevation and latitude, average stand age and average stand diameter. Using this system, an actual mountain pine beetle risk rating has been computed for 107,465 acres on the Forest. This amounts to 8% of the Forest and 28% of the lodgepole pine cover type. Results of these computations are displayed in Table D-13.

**Table D-13. Acres and Percentages of Mountain Pine Beetle Ratings in Lodgepole Pine**

| Mountain Pine Beetle Rating | Acres | Percent of Computed Acres | Percent of Lodgepole Cover type |
|---|---|---|---|
| 1 - Low | 6,920 | 6 | 2 |
| 3 - Medium | 72,615 | 68 | 19 |
| 5 - High | 27,930 | 26 | 7 |

*Source: Rocky Mountain Resource Information System database, 1995*

In addition to the actual computed rating described above, GIS was used to develop an estimated rating for the remaining lodgepole pine on the Forest. The estimated rating is also based on elevation and latitude, average stand age, and average stand diameter as specified by Amman, et al. (1977). Elevation for each lodgepole stand is described in the Routt National Forest RIS database. Each stand can also be assigned to broad 15 minute latitude bands. Using the elevation information and latitude bands, a risk factor was developed for each lodgepole pine stand according to Amman, et al. (1977). Table D-14 shows these bands.

**Table D-14. Mountain Pine Beetle Risk Factors by Latitude and Elevation**

| Latitude (deg. min. sec.) | Elevation (feet) | Risk Factor/1 |
|---|---|---|
| 41 00 00 - 40 45 00 | >9750 | 1 |
| | 9750-8700 | 2 |
| | <8700 | 3 |

| | | |
|---|---|---|
| 40 45 00 - 40 30 00 | >9850<br>9850-8800<br><8800 | 1<br>2<br>3 |
| 40 30 00 - 40 15 00 | >9950<br>9950-8900<br><8900 | 1<br>2<br>3 |
| 40 15 00 - 40 00 00 | >10050<br>10050-9000<br><9000 | 1<br>2<br>3 |
| 40 00 00 - 39 45 00 | >10150<br>10150-9100<br><9100 | 1<br>2<br>3 |
| 39 45 00 - 39 30 00 | >10250<br>10250-9200<br><9200 | 1<br>2<br>3 |

**/1** 1 - Low, 2 - Medium, 3 - High
*Source: GIS (ARC/Info), vegetation layer*

Next, an average size risk factor was developed for each lodgepole pine stand. This was based on structural stage. By definition, all structural stage 1 or 2 stands are less than seven inches average diameter. All structural stage 4 or 5 stands are greater than eight inches average diameter.

However, structural stage 3 stands range from one to nine inches average diameter. According to available data in the RIS database, 18% of structural stage 3 stands were less than seven inches average diameter, 53% of structural stage 3 stands were between seven and eight inches average diameter, and 29% of structural stage 3 stands were greater than eight inches average diameter. These percentages were then applied forestwide to the lodgepole pine structural stage 3 stands. The size risk ratings applied were:

- Diameter < 7 inches, risk rating = 1.
- Diameter between 7 inches and 8 inches, risk rating = 2.
- Diameter > 8 inches, risk rating = 3.

Accordingly, all structural stage 1 and 2 stands were assigned a size risk rating of 1; all structural stage 4 and 5 stands were assigned a size risk rating of 3; and 18% of structural stage 3 stands were assigned 1, 53% were assigned 2, and 29% were assigned a size risk rating of 3 (Amman et al. 1977).

The final factor to be taken into account was stand age. The age risk ratings applied were:

- Age < 60 years old, risk rating = 1.
- Age between 60 and 80 years old, risk rating = 2.
- Age > 80 years old, risk rating = 3.

Structural stage was again used as the basis for this rating. All structural stage 1 and 2 stands were assumed to be less than 60 years old and so received a rating of 1. According to the RIS database, 8% of the structural stage 3 stands are less than 60 years old; 5% are between 60 and 80 years old; and 87% are greater than 80 years old. So these percentages received age risk ratings of 1, 2, and 3 respectfully. Again, from the RIS database, 1% of the structural stage

4/5 stands are less than 60 years old; 1% are between 60 and 80 years old; and 98% are greater than 80 years old. Age risk ratings were assigned accordingly.

Each of the three rating factors were then multiplied together to provide an overall risk rating for each lodgepole pine stand. The estimation techniques outlined above and the actual mountain pine beetle computed risk ratings from Table D-13 were then combined and are presented in Table D-15 as GIS-computed acres. The GIS acres (developed using the estimation techniques outlined above) vary slightly from the actual acreage due to computational differences. The last column in Table D-15 shows the percent of total for each risk rating.

**Table D-15. Estimated Total Acres and Percentages of Mountain Pine Beetle Ratings in Lodgepole Pine**

| Mountain Pine Beetle Rating | GIS Computed Acres | Percent of GIS Lodgepole Acres |
|---|---|---|
| Low | 107,099 | 28 |
| Medium | 216,389 | 56 |
| High | 60,793 | 16 |

*Source: GIS (ARC/Info), Rocky Mountain Resource Information System database, 1995*

Using the analysis outlined above, location of areas subject to overall high risk from mountain pine beetle can be identified. Overall risk factors are grouped as follows (Amman, et al. 1977):

Overall Risk 1-9 = Low Risk

Overall Risk 12-18 = Moderate Risk

Overall Risk 27 = High Risk

The three separate factors are multiplied together to arrive at an overall risk factor. For example, where elevation/latitude is 2, age is 3, and diameter is 3; the overall risk factor is 18 (2x3x3=18) or moderate. Therefore, in order to reach an overall high risk category, each of the separate risk factors (elevation/latitude, age, diameter) must themselves be at a high risk level. It then follows that only those low elevation areas, as defined in Table D-14, will be subject to high risk from mountain pine beetle. Lodgepole pine stands falling into these low elevation-high risk areas are displayed in Figure D-11. Of the three risk factors used, only diameter and stand age can be influenced by management activities. The elevation/latitude factor is not subject to management action but is physically controlled.

## Fire

The role of fire on the Routt National Forest is discussed in the Range of Natural Variation Report (Routt National Forest 1994) and in Chapter 3 of the FEIS. In general terms, the Forest is in a low-frequence/high-intensity fire regime. Accordingly, we expect low numbers of actual fires. Those fires that do start have the potential to become very large fires depending on conditions. In fact, large portions of the forest did burn between 1870 and 1910 coinciding with the period of settlement and a period of drought.

On the Routt National Forest, fire frequency varies with cover type. See Table D-16. The stand turnover interval is the mean length of time required for fire to revisit a stand. The fire return interval is the length of time required for fire to revisit an area.

**Table D-16. Fire Return Information**

| Cover type | Stand Turnover Interval | Fire Return Interval |
|---|---|---|
| Spruce/fir | 500 | 200 |
| Lodgepole pine | 300 | 200 |
| Aspen | 200 | 70-100 |

*Source: Routt National Forest RNV Report 1994.*

Table D-17 shows the history of fire on the Forest since 1909 and Table D-18 show averages for the same period. Time periods are used to display the information because different reporting techniques were used for the periods shown. For the most recent period, which probably has the most reliable data, the Forest has averaged about 8 lightning fires and 10 human-caused fires annually over about 1.3 million acres. These fires have burned, on average, 134 acres per year. Although not shown, the average fire size over the 25-year period from 1970-1995 was 7.45 acres. The largest fire was 1,104 acres.

**Table D-17. Fire Total by Period**

| | Cause | | | |
|---|---|---|---|---|
| **Period** | **Lightning** | **Man** | **Total No. Fires** | **Total Acres Burned** |
| 1909 - 1939 | 35 | 156 | 191 | 1,437 |
| 1940 - 1969 | 101 | 216 | 317 | 1,640 |
| 1970 - 1994 | 194 | 257 | 451 | 3,355 |

**Table D-18. Averages by Period**

| | Cause | | | |
|---|---|---|---|---|
| **Period** | **Lightning** | **Man** | **Total No. Fires** | **Total Acres Burned** |
| 1909 - 1939 | 1.1 | 5.0 | 6.2 | 46.4 |
| 1940 - 1969 | 3.4 | 7.2 | 10.6 | 54.7 |
| 1970 - 1994 | 7.8 | 10.3 | 18.0 | 134.2 |

*Source for both D-17 and D-18: Routt National Forest Fire Records.*

In order to place the fire situation on the Routt in perspective, Table D-19 shows the lightning fires/million acres statistics for selected Region 3 and Region 1 National Forests (Barrows et al. 1976 and Barrows 1978). The annual fire occurrence figures for the Routt translate into 6.2 fires/million acres. The forests shown from Region 3 and some of those from Region 1 are in a high-frequence/low-intensity fire regime. Numbers for the Beaverhead and Gallatin National Forests are similar to those for the Routt. These figures illustrate the contrast between different fire regimes and provide some insight into the effect of past fire suppression management strategies. One would expect fire suppression to have a much greater influence on the vegetation in areas with a high frequency/low intensity fire regime.

Table D-20 shows the relative ranking of Colorado National Forests based on annual lightning fires/million acres (Ryan 1976). Although not shown on the table, those forests with large areas of ponderosa pine are also those ranking highest in lightning fire occurrence (Ryan 1976). As Table D-8 shows, the ponderosa pine cover type is not represented on the Routt.

**Table D-19. Average Annual Lightning Fires/Million Acres for Selected National Forests**

| Region/State | National Forest | Lightning Fires/Million Acres |
|---|---|---|
| 3/Arizona | Coconino | 163 |
| 3/New Mexico | Gila | 125 |
| 3/New Mexico | Santa Fe | 56 |
| 3/Arizona | Coronado | 77 |
| 1/Montana | Gallatin | 10 |
| 1/Montana | Beaverhead | 9 |
| 1/Idaho | Clearwater | 67 |
| 1/Montana | Lolo | 53 |

Period 1960-1974 for Region 3 Forests and Period 1946-1973 for Region 1 Forests.
*Source: Barrows et al. 1976 and Barrows 1978.*

**Table D-20. Ranking of Colorado National Forests Annual Lightning Fires/Million Acres 1960-1973**

| Forest | Number of Lightning Fires/Million Acres | Rank |
|---|---|---|
| San Juan | 30.7 | 1 |
| Pike | 29.4 | 2 |
| Roosevelt | 15.1 | 3 |
| Grand Mesa/Uncompahgre | 10.3 | 4 |
| San Isabel | 8.5 | 5 |
| Rio Grande | 4.3 | 6 |
| Routt | 3.9 | 7 |
| Arapaho | 3.7 | 8 |
| White River | 3.6 | 9 |
| Gunnison | 3.0 | 10 |

*Source: Ryan 1976.*

## Late Successional Forests

Late successional forests are defined in the FEIS Chapter 3 - Vegetation section. They are composed of structural stages 4b, 4c, and 5. The Routt does not have a complete inventory of old growth. Agreed-to definitions of old growth are elusive, as stated in Rebertus et al. (1992). Nevertheless, old growth descriptions for the Rocky Mountain Region have been established by Mehl (1992). Using these descriptions and input from Mel Mehl, attempts were made to determine how well the RMRIS (USDA Forest Service 1994a) database could be used to verify old growth. Determination was made that RMRIS information by itself did not consistently evaluate old growth stand characteristics. This being the case, a cost-effective parameter to assess late successional or "old growth" characteristics across the Forest was needed. The parameter also needed to meet some reasonable definition or description. Structural stage information is available for the entire forest and is the best available information the Forest Service has to address the issue.

Although there is not a direct correspondence between the late successional forests and the old growth forests described by Mehl (1992), any of the late successional forest could qualify as old growth. Mehl (1992) used minimum levels of attributes, while the late successional definition is built on averages. For example, the lodgepole pine old growth description lists a minimum of 10 trees per acre with a minimum diameter of 10 inches. A lodgepole pine stand with an average diameter of 9 inches (habitat structural stage 4) could qualify as old growth based on this diameter criteria. This of course depends on the actual diameter distribution in the stand. For spruce/fir, the minimum is 10 trees with a minimum diameter of 16 inches. There are a number of other criteria used by Mehl (1992), some quantifiable and some qualitative. The nature of the descriptions used by Mehl (1992) would require a site visit to determine if a stand matches the description.

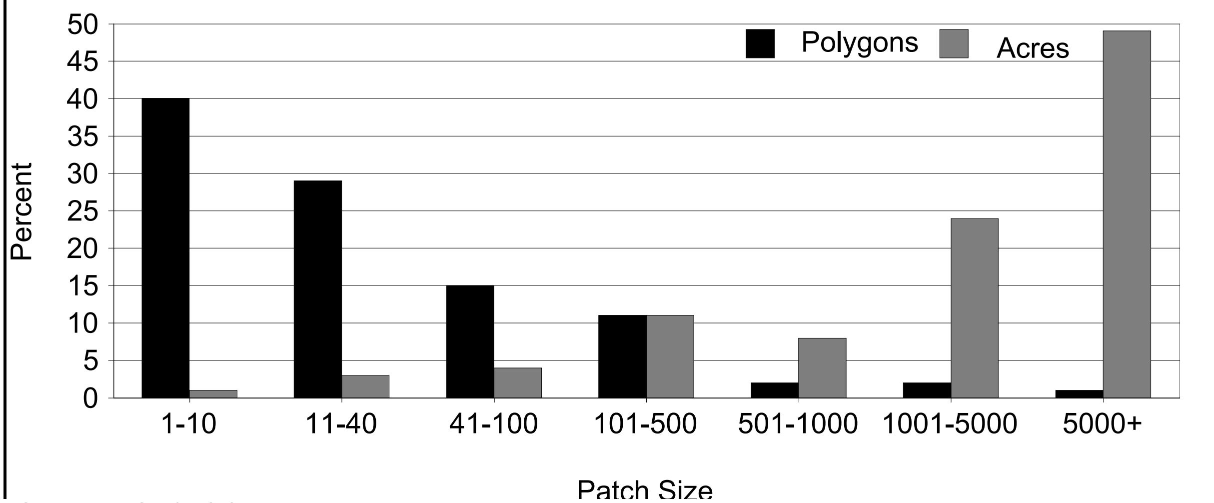
Of the forested acres on the Routt, about 49% can be considered as late successional forests. These are composed of structural stages 4b, 4c, and 5. When considering habitat structural stage 4 as late successional, the interdisciplinary team focused on structural stages 4b and 4c. With a crown cover potentially as low as 11%, structural stage 4a stands were too open to be late successional. The 49% figure represents a current inventory only. It will change in the future as younger forests mature and move into the late successional structural stages and as natural and human-caused disturbance events move some of these late successional forests into younger structural stages.

### Distribution of and Patch Statistics for Late Successional Forests

Although almost half of the forested portion of the Routt is considered late successional forest, distribution of that vegetation is also an important consideration. Figure D-12 depicts late successional forest distribution across the landscape. As the map shows, they are well-distributed.

Late successional forest patch size was analyzed using GIS. Late successional forest patches are defined as connected late successional forest stands of all cover types. However, in order for individual stands or groups of stands to be considered connected, the connection between them had to be at least 50 meters in width, based on work by Vaillancourt (1995). A buffering technique was used to separate patches joined by areas less than 50 meters wide. The results of this analysis are displayed in Figure D-13 and Table D-21.

**Figure D-13. Late Successional Forest Patches - Forest Totals**




*Source: ARC/Info, GIS*

**Table D-21. Late Successional Forest Patch Size Statistics - Forest Totals**

| Average | Median | Mode | Percent in patches over 500 acres | Percent in patches over 5,000 acres |
|---|---|---|---|---|
| 213.7 | 17 | 3 | 81 | 49 |

*Source: ARC/Info, GIS*

The data shows that there are many more small patches than large patches, but the vast majority of the late successional acreage is in large patches (>500 acres). In fact 49% of the acreage is in patches greater than 5,000 acres.

For Alternative C, further analysis broke out the areas allocated to timber production (Management Areas 5.11 and 5.13) and downhill ski areas (Management Area 8.22). Management Areas 5.11 and 5.13 are the only allocations in Alternative C where vegetation is managed for the production of wood products. Although vegetation management can occur in other management areas for a variety of reasons, these cases would be of limited size and occurrence. Natural disturbance events may occur, but it is generally not possible to predict them. Therefore, the greatest effect on late successional forests will take place in the timber management and ski area allocations (5.11, 5.13, 8.22). Tables D-22 and D-23 show the results of this analysis.

**Table D-22. Late Successional Forest Patch Size Statistics Non-timber Allocations**

| Average | Median | Mode | Percent in patches over 500 acres | Percent in patches over 5000 acres |
|---|---|---|---|---|
| 181.9 | 14 | 1 | 78 | 37 |

*Source: ARC/Info, GIS*

**Table D-23. Late Successional Forest Patch Size Statistics Timber/Ski Allocations (5.11, 5.13, 8.22)**

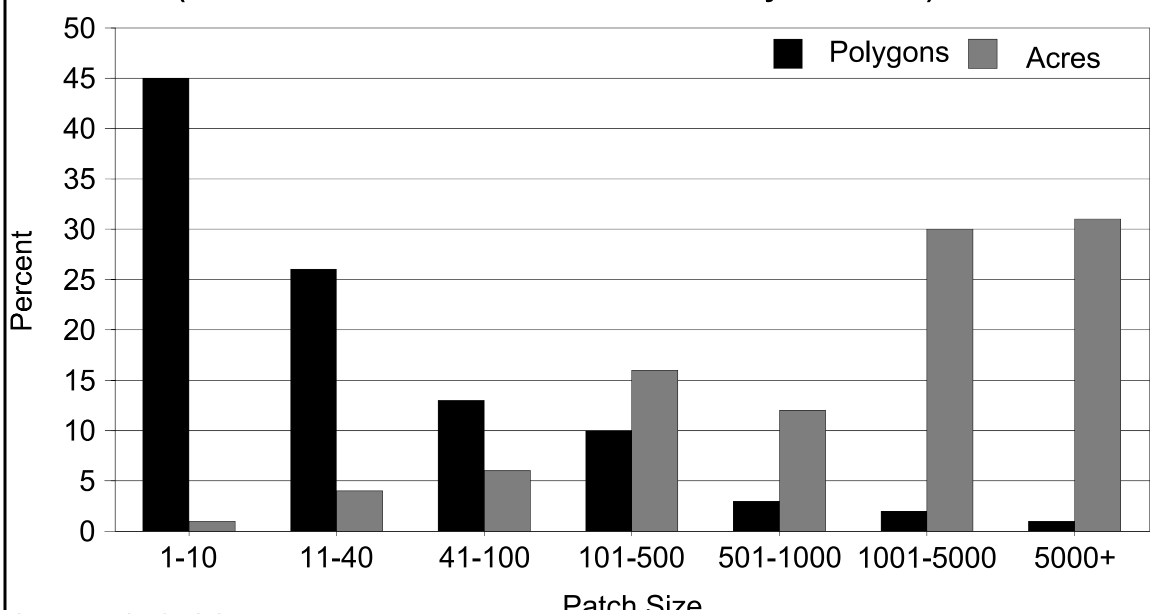
| Average | Median | Mode | Percent in patches over 500 acres | Percent in patches over 5000 acres |
|---|---|---|---|---|
| 133.8 | 15 | 3 | 69 | 12 |

*Source: ARC/Info, GIS*

Barring natural disturbance events such as large scale fires, most of the effects to existing late successional forest structure will occur from timber harvest (vegetation management for the production of wood products). In Alternative C allocations where timber management will occur (Management Areas 5.11 and 5.13, plus the Ski Area allocations 8.22), a decrease in overall patch size is seen. This is probably due to two factors: 1) contiguous patches along the allocation boundaries would have been split to do the analysis, and 2) past timber management practices in these same areas have caused a decrease in patch size. Many of the Management Area 5.13 areas have had past timber management activity. Point 1 will also account for the decrease in patch size associated with the non-timber allocations. Point 2 is supported by work done by Reed et al. (1996a).

The effects of unrestricted motorized travelways (open roads and motorized trails) on late successional patch size was investigated using a similar technique. In addition to the analysis described above, each travelway was buffered out 50 meters on each side (100 meters total). This served to separate late successional forest patches. Results of this analysis are displayed in Tables D-24 through D-26. Figure D-14 displays the Forest totals graphically.

**Figure D-14. Late Successional Forest Patches - Forest Totals (Effect of Unrestricted Motorized Travelways Included)**




*Source: ARC/Info, GIS*

**Table D-24. Late Successional Forest Patch Size Statistics - Forest Totals Effect of Unrestricted Motorized Travelways Included**

| Average | Median | Mode | Percent in | Percent in |
|---|---|---|---|---|

| | | | Patches over 500 Acres | Patches over 5000 acres |
|---|---|---|---|---|
| 138.5 | 13 | 1 | 72 | 31 |

**Table D-25. Late Successional Forest Patch Size Statistics - Non-timber Allocations Effect of Unrestricted Motorized Travelways Included**

| Average | Median | Mode | Percent in Patches over 500 Acres | Percent in Patches over 5000 Acres |
|---|---|---|---|---|
| 142.2 | 11 | 1 | 73 | 29 |

**Table D-26. Late Successional Forest Patch Size Statistics Timber/Ski Allocations (5.11 5.13, 8.22) Effect of Unrestricted Motorized Travelways Included**

| Average | Median | Mode | Percent in Patches over 500 Acres | Percent in Patches over 5000 Acres |
|---|---|---|---|---|
| 84.7 | 12 | 1 | 54 | 0 |

*Sources for D-24, D-25 and D-26: ARC/Info, GIS*

As the data shows, the inclusion of unrestricted motorized travelways produces more small patches and decreases the percentage of acreage in large patches. Overall, acreage in patches over 5,000 acres dropped from 49% to 31%. This decrease in patch size with the inclusion of unrestricted motorized travelways was also shown by Reed et al. (1996b). Removing the travelways and the 100-foot buffer associated with them resulted in an overall decrease in late successional forest structure of 4.5%. Separating the timber/ski allocations from the remainder of the forest shows the same pattern found before including the travelways. However, the inclusion of these travelways has eliminated all patches over 5,000 acres in the timber/ski allocations. This decrease is consistent with expectations given that road building is closely associated with past logging and many of the 5.13 allocation areas have had past timber management activity.

## Management Impacts

In each of the alternatives that use management area allocations 5.13 and 5.21 (Water Yield used in Alternative A only), overall patch size will decrease, as will the percentage of late successional forest structure. In Management Area 5.11 late successional forest structure will be maintained through the use of long rotation ages (200 years). Management Area 5.11 also has direction to match natural patch size and patterns in harvest unit design. Table D-27 shows the percentage of current late successional forest structure allocated to Management Areas 5.13 and 5.21. In Alternative C (the selected alternative), patch size and percentages of late successional forest structure should be expected to decrease in 16% of the current late successional forests. However, by the end of the first decade, at the experienced budget level, overall forestwide late successional forest acreage is projected to increase by 13.9 %. (see FEIS Chapter 3 - Vegetation - Cumulative Effects Section)

**Table D-27. Percent of Late Successional Forests in Management Areas 5.13, 5.21**

| Alternatives | | | | | | |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| 26 | 0 | 16 | 18 | 27 | 0 | 24 |

*Source: ARC/Info, GIS*

The effect of timber harvest on the distribution of late successional forests was investigated using GIS (ARC/Info). We asked the following questions, "Will our management actions isolate any late successional forest areas and will a well-distributed system remain intact?" Each stand qualifying as late successional forest was plotted. Each of the alternatives were analyzed. Management areas allocated for timber management (5.11, 5.13, 5.21) were plotted along with the previously plotted late successional forests. It was assumed that each of the late successional areas suited for timber production within Management Area Prescriptions 5.11, 5.13, and 5.21 could be harvested. Accordingly, these areas were coded as if they were not late successional. Next, areas of late successional forest in watersheds of concern were added back to the map, but in a different color, since levels of harvest in these areas is modified over a fifty year planning horizon. After this analysis was complete, maps showing current late successional forest areas for each alternative were created. These areas of late successional forests were analyzed for distribution and connections. Eleven areas of concern were identified. Figure D-15 shows the location of these areas. Table D-28 lists the alternatives and their areas of concern.

**Table D-28. Late Successional Forest Areas of Concern by Alternative**

| Area | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 1 | X | X | X | | | | X |
| 2 | X | | X | X | X | | X |
| 3 | X | | X | X | X | | X |
| 4 | X | X | X | X | X | X | X |
| 5 | | | | | | | X |
| 6 | X | | X | | X | | X |
| 7 | X | X | X | | X | | X |
| 8 | X | | | | X | | X |
| 9 | X | X | X | X | X | | X |
| 10 | X | X | X | X | X | X | X |
| 11 | X | X | X | X | X | | X |

Based on this analysis, a guideline was developed for application at the Geographic Area level. This guideline was designed to ensure well-distributed late successional forest structure. Late successional forest structure is provided in the 5.11 allocation through the use of extended rotation ages and natural patch/patterns. In areas allocated to Management Area 5.13, the following guideline will be applied in the listed geographic areas. These geographic areas correspond to the areas of concern listed for Alternative C in Table D-28.

1. Guideline - In Management Areas 5.13, late successional habitats should be provided and well-distributed so that individuals of species requiring those habitats can interact with others in the planning area.

Geographic Areas:

- Encampment River
- Little Snake
- Slater Creek
- Sand Mountain
- Willow Creek
- Upper Elk River
- Gore
- Arapaho Creek
- Red Dirt
- Corral Peaks
- Pinkham Mountain
- Owl Mountain

### Fragmentation of Late Successional Forests

Fragmentation is defined in the glossary to the FEIS as the breaking up of contiguous areas into progressively smaller patches of increasing degrees of isolation. It should be noted that this definition does not address temporal scale. That is to say, over what time periods do these isolations occur, and how long do they last. This is an important consideration and one that has been discussed in the literature (Hagan et al. 1996, Faaborg et al. 1995, Schieck et al. 1995). Much of the research on fragmentation has been in areas where habitat changes are associated with agriculture or urban development (Hagan et al. 1996). These changes are long-term in nature. The vast majority of habitat alterations related to timber management on National Forest land are temporary. Research investigating the temporal and spatial patterns needed by native species is needed (Hansen et al. 1991).

Reed et al. (1996a and 1996b) as well as Baker (1994) have demonstrated the effects of timber harvest on landscape structure in the Rocky Mountains. Each of these studies has demonstrated a change in landscape metrics. Landscape metrics in general provide a powerful tool to quantify changes over time and with differing management scenarios (Diaz 1996). However, research is needed to establish the relationship of these metrics to individual species habitat requirements in the Central/Southern Rocky Mountains (personal communication with W.L. Baker 1997). Beauvais (1997) did address the relationship of some of these metrics to mammal distributions in the Big Horn Mountains. Although the establishment and design of these studies is problematic, the information is needed before landscape metrics can be used to assess individual species habitats needs in a management context.

Some work has been done in the Central/Southern Rocky Mountains investigating the influence on wildlife of patches created through timber harvest (Scott et al. 1982, Scott and Crouch 1987, Raphael 1988, Keller and Anderson 1992, Beauvais 1997). For the most part, these studies address distributions associated with forest habitat changes. However, Keller and Anderson (1992) also investigated distribution in relation to forest interior and edge, while Beauvais (1997) also looked at macrohabitat components which included edges and certain patch characteristics. Keller and Anderson (1992) state "the response to fragmentation did not appear to result from simple preference or avoidance of forest edges or interiors." They found the effects of fragmentation related more to the loss of habitat and associated resources. Beauvais (1997) found that species distributions did not vary with his macrohabitat component 1, which included landscape diversity, forest cover, patch density, and edge density. But the positioning of the clearcut boundaries relative to certain cover types did effect distributions.

Schieck et al. (1995) bring up several pertinent points in regard to fragmentation. First species abundance is not the same as species viability. Second, the degree of natural heterogeneity may have a strong influence on the effects of fragmentation. Third, the degree of contrast between the patches and matrix may be important. These points are important considerations given the management situation on the Routt.

The first point concerns viability. The presence or absence of a species in any of the cited studies does not necessarily reflect on the viability of that species. Population viability questions, as directed at 36 CFR 219.19, are to be addressed at the planning area level; in this case, the 1.3 million acres considered in this forest plan revision effort. Ultimately fragmentation is a question of population viability and not one of species abundance.

Ecosystems in the Rocky Mountains are different from those in the Pacific Northwest and those further to the east (Beauvais 1997, McNab and Avers 1994) where much of the work on fragmentation has been done. Forests in the Central/Southern Rocky Mountains have a certain degree of natural heterogeneity. Large-scale disturbance events are part of the natural history in this region as well. Vast contiguous acreages of late successional forest have not existed on the Routt for the past 150 or so years. Large acreages on the Routt (possibly up to 60%) have been in early successional stages within the past 100-200 years (Routt National Forest 1994).

Beauvais (1997), Hagan et al. (1996), and Keller and Anderson (1992) all discuss or mention the concept or idea of initial fragmentation. Initial fragmentation refers to the composition of the majority of the habitat compared to the composition of the minority. This is best explained by illustration. For example, a forested habitat surrounded by agricultural land is a different situation than a clearcut surrounded by late successional forest. These might both be different than a case of a late successional patch surrounded by saplings. Each of these produces a different degree of edge, among other factors. Changes in habitat associated with management on National Forest lands are generally temporary in nature. This further complicates the question by adding a temporal component. Currently 49% of the forested acres on the Routt are in late successional condition. This percentage is projected to increase under all alternatives.

The effects of habitat change on species distributions and populations is very complex. Several of the components of this complex topic are discussed above. A better understanding is dependent on future research. However as the above discussion shows, enough information is available to indicate that caution must be used in applying research results from other regions to the Rocky Mountains. For example, conclusions about community dynamics in the Pacific Northwest, will not likely apply to this region (Beauvais 1997).

To summarize, most of the research done to date on fragmentation has been in ecosystems or management situations very different from those found in the Rocky Mountains. Research completed in the Rocky Mountains has not shown simple forest edge or forest interior to be a significant factor in species' distributions. Research done in the Rocky Mountains has demonstrated a change in landscape structure associated with timber harvest. The literature does discuss certain factors which are present in Rocky Mountain forests and can influence fragmentation effects. These factors are: temporal scales and level of management, ecosystem dynamics, species viability scale issues, and the need for further research.

In conclusion, 16% of the current late successional forest would be subject to the smaller patch size associated with timber harvest in Management Area 5.13. As stated in the literature, the minimum size of forest blocks that must be maintained for wildlife is not yet well-defined (Patton 1992). However, it is agreed that habitat must be well-distributed over a broad geographic area to allow breeding individuals to interact within and among populations spatially and among generations temporally (Morrison et al. 1992). A well-distributed network of late successional forests will be provided through the use of long rotation ages in Management Area 5.11 and a guideline addressing late successional distribution in Management Area 5.13. The overall acreage of late successional forest structure is projected to increase throughout the planning period. The distribution of late successional habitat would provide adequate connectivity or habitat linkages for those species associated with this habitat complex (see the Biological Evaluation and the Wildlife section of the FEIS for a list of associated species) and ensure that these species would not be isolated or restricted to parts of the Forest. This in turn would provide habitats to help sustain viable populations across the Forest or planning area.

## Aquatic Ecosystems

Aquatic ecosystems have structure and function. The primary goal must be ecosystem integrity. For aquatic systems, the integrity of the watershed should be maintained. To facilitate this, planning must be on an ecosystem or a watershed basis. Management should consider ecosystem processes. In aquatic ecosystems, management activities should consider natural processes such as energy, waterflow and nutrients. These processes formed the current aquatic systems and must be allowed to operate.

The physical and chemical features of an ecosystem provides the structure within which an ecosystem develops. The productivity of a stream is largely due to temperature and nutrient types and availability. The stream's physical habitat is determined mainly by adjacent hill slopes and riparian vegetation. Factors that control channel morphology are discharge, sediment load and physical features in the channel (large wood and rocks, bank characteristics, etc.). The flowing water works within the surrounding landscape to form amounts and types of aquatic habitats. Under normal conditions, stream channels are in a state of dynamic equilibrium, where the amount of sediment recruited into the channel is equal to the amount of sediment transported out of the system.

Human activities can affect natural processes and the frequency, magnitude and duration of major catastrophic events. The effects of these processes on habitat quality and productivity depend on the intensity and timing of disrupting events. Some events occur on a regular basis and are generally easy to predict (seasonal and annual precipitation, moderate streamflows, etc.). Other events occur less frequently, are more sporadic, and thus more difficult to predict. These largely unpredictable events are usually triggered by major storms and large scale vegetation disturbance, such as fire, windthrow, and insects and disease. All of these events can alter watershed processes, local channel configuration and aquatic biota.

Watershed sensitivity, to both minor and major disturbances, is subject to a broad range of variability. Some watersheds are highly sensitive to disturbance because of steep slopes and highly erodible soils. Other watersheds are more resilient and capable of accommodating extreme climatic events or more intense ground-disturbing activities. Watersheds of concern were identified based upon their inherent stability and the amount and type of management activities. A detailed discussion of the analysis approach is in the water/riparian section of this document.

The Forest has been delineated into 143 prescription watersheds using a standardized numbering system code developed and coordinated with other federal agencies to facilitate data reporting and management. These watersheds range in size from approximately 1,000 acres to 20,000 acres. Watersheds are mostly 6th-level watersheds (as described in the IRI handbook).

**Table D-29. Number of Prescription Watersheds by River Basin**

| Colorado | Yampa | Platte |
|---|---|---|
| 32 | 68 | 43 |

The existing condition of watersheds (watershed health) on the Forest varies from watershed to watershed, depending upon amount of disturbance found within that watershed and the degree of natural integrity of the system. Disturbances such as timber management, road construction, livestock grazing, recreation, and special uses (e.g. ski areas) can adversely affect a watershed's potential.

Past land management activities have been concentrated in some watersheds more than others. These watersheds which have been entered more frequently tend to have a higher risk of reduced watershed potential due to the altering of natural functions within the watershed. The Watershed Health Risk Assessment table in Appendix I shows levels of disturbance for each watershed, and is used to assess watershed health risk and geologic hazard ratings.

For this Revised Plan, levels, types, and timing of disturbance have been analyzed along with soils/disturbance relationships to determine a Disturbance Risk Potential (Low, Moderate, High) for each prescription watershed (See Table I-2 in Appendix I). These disturbance ratings are not to be confused with Class I, II or III conditions as described in FSM 2521.1. The disturbance ratings in this analysis are used to show susceptibility to disturbance. Types of disturbance include timber harvest (total acres harvested), equivalent clearcut acres (total acres harvested converted into clearcut acres which takes into account hydrologic recovery), roads (total miles, acres, number of stream crossings and road locations near streams), and ski areas. The concept is that a watershed which has had more overall disturbance over time is at higher risk for degradation than a watershed with less overall disturbance.

In 1987, a forest-wide "watersheds of concern" list was compiled from photo interpretation of orthophoto quads, from a soil/watershed computer modeling program, and from personal knowledge of existing and planned timber sale activities. This list was updated in 1994. These watersheds are sensitive to further increases in water yield and sediment but are not necessarily over threshold levels as determined by the HYSED model ref. [The HYSED model incorporates a WRENSS (Water Resource Evaluation Non-point Source Pollution Silviculture 1980) type analysis and has been used extensively at the project planning level as dictated in the current 1983 Plan]. The major benefit of this watersheds of concern list has been to identify that watershed and water-related resources need to be studied in more detail. More precise modeling (HYSED and Road Impact Index) are part of the analysis procedure which uses the most current data on size of harvest units, date when harvested, type of harvest prescription, location within the watershed, and total road miles by surface type. Using the most current information available gives the existing conditions of the watershed at that point in time. This existing condition information is then compared with the proposed action alternatives in the Environmental Assessment to determine the potential effects of the proposed management activities on not only the soil and water resources, but fisheries, wildlife, and visuals resources as well.

Watersheds that have been identified as "watersheds of concern, due to past management activities are high priority areas for remedial work. Projects will focus on restoring the natural drainage pattern of a watershed by reducing the "connected disturbed area" resulting from past land management. In addition to the project implementation, monitoring will follow to assure that the remedial work is effective.

## Part 2 Fine Filter

The Routt National Forest cooperated with the Colorado Natural Heritage Program (CNHP) to collect occurrence information on threatened, endangered, sensitive and other species of concern found on the Forest. A series of interviews was conducted with individuals knowledgeable about these species in order to collect occurrence information. A list of these species is found in Table D-30. Using information from the interviews and data already held on the Forest and in the CNHP database, 265 species occurrence records were found. Not all of the species on the list, however, are represented by the species occurrence records. Detailed information abstracts on each of the Federally listed threatened, endangered or Forest Service sensitive species may be found in the planning record. More Fine Filter information is contained in Appendix J - Biological Assessment and Biological Evaluation.

**Table D-30. Routt National Forest Fine Filter Species**

| Common Name | Scientific Name | Federal Status* | Routt Status** | State Status*** |
|---|---|---|---|---|
| **Amphibians:** | | | | |
| Western Boreal Toad | *Bufo boreas boreas* | R2S, C | X | En |
| Wood Frog | *Rana sylvatica* | R2S | X | Th |
| Northern Leopard Frog | *Rana pipiens* | R2S | X | SC |
| Tiger Salamander | *Ambystoma tigrinum* | R2S | X | |
| **Birds:** | | | | |
| Whooping Crane | *Grus americana* | En | X | En |
| American White Pelican | *Pelecanus erythrorhynchos* | | | SC |
| American Peregrine Falcon | *Falco peregrinus anatum* | En | X | Th |
| Mountain Plover | *Charadrius montanus* | R2S, C | X | SC |
| Bald Eagle | *Haliaeetus leucocephalus* | En | X | Th |
| Black Swift | *Cypseloides niger* | R2S | X | |
| Loggerhead Shrike | *Lanius ludovicianus* | R2S, C | X | |
| Ferruginous Hawk | *Buteo regalis* | R2S, C | X | SC |
| Northern Goshawk | *Accipiter gentilis* | R2S, C | X | |
| American Bittern | *Botaurus lentiginosus* | R2S | X | |
| Columbian Sharp-tailed Grouse | *Tympanuchus phasianellus columbianus* | R2S, C | X | SC |
| Long-billed Curlew | *Numenius americanus* | R2S, C | X | SC |
| White-faced Ibis | *Plegadis chihi* | R2S, C | X | |
| Harlequin Duck | *Histrionicus histrionicus* | R2S | X | |
| Merlin | *Falco columbarius* | R2S | X | |
| Boreal Owl | *Aegolius funereus* | R2S | X | |
| Purple Martin | *Progne subis* | R2S | X | |
| Upland Sandpiper | *Bartramia longicauda* | R2S | X | |
| Three-toed Woodpecker | *Picoides tridactylus* | R2S | X | |
| Black Tern | *Childonias niger* | R2S, C | X | |
| Black-backed Woodpecker | *Picoides arcticus* | R2S | X | |
| Osprey | *Pandion haliaetus* | R2S | X | |

**Table D-30. Routt National Forest Fine Filter Species (continued)**

| Common Name | Scientific Name | Federal Status* | Routt Status** | State Status*** |
|---|---|---|---|---|
| Burrowing Owl | *Athene cunicularia* | R2S, C | X | |
| Western Yellow-billed Cuckoo | *Coccyzus americanus* | R2S | X | |
| Greater Sandhill Crane | *Grus canadensis* | R2S | X | Th |
| Common Loon | *Gavia immer* | R2S | X | |
| Flammulated Owl | *Otus flammeolus* | R2S | X | |
| Lewis' Woodpecker | *Melanerpes lewis* | R2S | X | |
| Olive-sided Flycatcher | *Contopus borealis* | R2S, C | X | |
| Pygmy Nuthatch | *Sitta pygmaea* | R2S | X | |
| Golden Crowned Kinglet | *Regulus satrapa* | R2S | X | |
| Fox Sparrow | *Passerella iliaca* | R2S | X | |
| **Fish:** | | | | |
| Humpback Chub | *Gila cypha* | En | X | En |
| Bonytail Chub | *Gila elegans* | En | X | En |
| Colorado Squawfish | *Ptychocheilus lucius* | En | X | En |
| Razorback Sucher | *Xyrauchen texanus* | En | X | En |
| Roundtail Chub | *Gila robusta* | | | SC |
| Plains Topminnow | *Fundulus sciadicus* | R2S | | SC |
| Colorado River Cutthroat Trout | *Oncorhynchus clarki pleuriticus* | R2S, C | X | SC |
| Greenback Cutthroat Trout | *Oncorhynchus clarki stomias* | Th | | Th |
| Flannelmouth Sucker | *Catostomus latipinnis* | | | SC |
| Yellowfin Cutthroat Trout | *Oncorhynchus clarki macdonaldi pleuriticus* | | | |
| **Mammals:** | | | | |
| Black-footed Ferret | *Mustela nigripes* | En | X | En |
| Rocky Mountain Gray Wolf | *Canis lupus irremotus* | En | X | |
| Grizzly Bear | *Ursus arctos horriblis* | Th | X | En |
| Wyoming Pocket Gopher | *Thomomys fuscus* | R2S | X | |
| Water Vole | *Microtis richrdsoni* | R2S | X | |
| Preble's Meadow Jumping Mouse | *Zapus hudsonius preblei* | R2S | X | SC |
| Swift Fox | *Vulpes velox* | R2S | X | |
| Fisher | *Martes pennanti* | R2S | X | |
| Spotted Bat | *Euderma maculatum* | R2S | X | |
| North American Lynx | *Felis lynx canadensis* | R2S | X | En |
| Fringe-tailed Myotis | *Myotis thysanodes pahasapensis* | R2S | X | |
| North American Wolverine | *Gulo gulo luscus* | R2S | X | En |
| Pygmy Shrew | *Sorex hoyi montanus* | R2S | X | |
| Dwarf Shrew | *Sorex nanus* | R2S | X | |

**Table D-30. Routt National Forest Fine Filter Species (continued)**

| Common Name | Scientific Name | Federal Status* | Routt Status** | State Status*** |
|---|---|---|---|---|
| Townsend's big-eared Bat | *Plecotus townsendii* | R2S, C | X | |
| Marten | *Martes americana* | R2S | X | |
| Ringtail | *Bassariscus astutus* | R2S | X | |
| **Reptiles:** | | | | |
| Smooth Green Snake | *Opheodrys vernalis* | | | |
| Western Yellowbelly Snake | *Coluber constrictormormon* | | | |
| **Mollusks:** | | | | |
| Rocky Mountain Capshell Snail | *Acroloxus coloradensis* | R2S | X | SC |
| Cockerll's Striate Disc Snail | *Discus shimeki concerellii* | R2S | | |
| **Plants:** | | | | |
| Harrington Beardtongue | *Penstemon harringtonii* | R2S | | |
| Purple Lady's Slipper | *Cypridedium fasciculatum* | R2S | X | |
| Rabbit Ears Gilia | *Ipomopsis aggregata ssp. weberi* | R2S | X | |
| Hanging Garden Sullivantia | *Sullivantia hapemanii var. purpusii* | R2S | | |
| Roundleaf Sundew | *Drosera rotundifolia* | R2S | X | |
| Ute Ladies'-Tresses | *Spiranthes diluvialis* | Th | | |
| Hamilton Milkvetch | *Astragalus lonchocarpus var. hamiltonii* | | | |
| Gibben's Beardtongue | *Penstemon gibbensii* | | | |
| Livid Sedge | *Carex livida* | R2S | X | |
| North Park Phacelia | *Phacelia formosula* | En | | |
| Osterhout Milkvetch | *Astragalus osterhoutii* | En | | |
| Penland Beardtongue | *Penstemon pendlandii* | En | | |
| Dudley Bluffs Bladderpod | *Lesquerella congesta* | Th | | |
| Wilken Fleabane | *Erigeron wilkenii* | | | |
| Alcove Bog Orchid | *Platanthera zothecina* | | | |
| Graham Beardtongue | *Penstemon grahamii* | C | | |
| Narrow-leaf Evening Primrose | *Denothera acutissima* | | | |
| Alcove Death Camas | *Antichea vaginata* | | | |
| Reflected Moonwort | *Botrychium echo* | R2S | | |
| Gray's Peak Whitlow-grass | *Draba grayana* | | | |
| Weber Monkey-flower | *Mimulus gemmiparus* | R2S | | |
| Piceance Twinpod | *Physaria obcordata* | Th | | |
| Sun-loving Meadowrue | *Thalictrum heliophilum* | | | |
| Rocky Mountain Columbine | *Aquilegia saximontana* | | | |
| Duchesne Milkvetch | *Astragalus duchesnensis* | | | |
| Dog Parsley | *Lomatium nuttallii* | | | |
| Utah Gentian | *Gentianella tortuosa* | | | |

| Table D-30. Routt National Forest Fine Filter Species (continued) | | | | |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **Federal Status*** | **Routt Status**** | **State Status***** |
| Ephedra Buckwheat | *Eriogonium viridulum* | | | |
| Narrow-stem Gilia | *Gilia stenothyrsa* | | | |
| Uinta Basin Spring-parsley | *Cymopterus duchesnensis* | | | |
| Ligulate Feverfew | *Bolophyta ligulata* | | | |
| Tufted Cryptanth | *Oreocarya caespitosa* | | | |
| Debris Milkvetch | *Astragalus detritalis* | | | |
| Wetherill Milkvetch | *Astragalus wetherillii* | | | |
| Woodside Buckwheat | *Eriogonum tumulosum* | | | |
| Pale Blue-eyed Grass | *Sisyrinchium pallidum* | | | |
| Clawless Draba | *Draba exunguiculata* | | | |
| Ownbey Thistle | *Cirsium ownbeyi* | | | |
| Yampa Beardtongue | *Penstemon yampaensis* | | | |
| Piceance Bladderpod | *Lesquerella parviflora* | | | |
| Shale Columbine | *Aquilegia barnebyi* | | | |
| Utah Fescue | *Festuca dasyclada* | | | |
| Hoary Phacelia | *Phacelia incana* | | | |
| Park Rockcress | *Boechera fernaldiana var. fernaldiana* | | | |
| Short-flower Cryptanth | *Oreocanya breviflora* | | | |
| Rollins Cryptanth | *Oreocanya rollinsii* | | | |
| White River Penstemon | *Penstemon scariosus var. albifluvis* | C | | |
| Autumn Willow | *Salix serissima* | R2S | | |
| Giant Helleborine | *Epipactis gigantea* | R2S | | |
| Nagoon Berry | *Cylactis arctica spp. acaulis* | R2S | | |

***Federal Status**

R2S = Region 2 Sensitive, En = Endangered, Th = Threatened

C = The US Fish and Wildlife Service issued a Notice of Review in the February 28 Federal Register for plant and animal species that are "Candidates" for listing as endangered or threatened under the Endangered Species Act.  The revised candidate list replaces an old system that listed many more species under three categories: C1, C2, and C3.

****Routt Status**

X = Species currently or historically occurred on NFS lands.

*****State Status**

En = Endangered, Th = Threatened, SC = Colorado Species of Special Concern

Not applicable to plants

## Colorado River Cutthroat Trout

The Colorado River cutthroat trout has been identified in Goal 1 of the Revised Plan as a species to receive special attention. Table D-31 identifies waters on the Routt National Forest containing this fish. The information has been included in the Unique Features section of the appropriate Geographic Area. Data is taken from Young et al. (1996).

**Table D-31. Colorado River Cutthroat Trout - Status on the Routt National Forest**

| Water* | Drainage* | Genetic Purity* | Water#* | Routt National Forest Geographic Area |
|---|---|---|---|---|
| Willow Creek | Little Snake | p | 184 | Slater Creek |
| Roaring Fork Slater Creek | Slater Creek | u | 185 | Slater Creek |
| South Fork Slater Creek | Slater Creek | u | 186 | Slater Creek |
| West Prong South Fork | Slater Creek | u | 187 | Slater Creek |
| Johnson Creek | South Fork Little Snake | h | 189 | Slater Creek |
| Oliver Creek | South Fork Little Snake | h | 190 | Slater Creek |
| Lopez Creek | South Fork Little Snake | u | 191 | Slater Creek |
| Summit Creek | Independence Creek | u | 192 | Little Snake |
| Beaver Creek | South Fork Williams Fork | u | 193 | Pagoda |
| Indian Run | Beaver Creek | u | 194 | Pagoda |
| Poose Creek | East Fork Willams Fork | h | 195 | Pagoda |
| Cyclone Creek | Poose Creek | u | 196 | Pagoda |
| Rough Creek | Poose Creek | u | 197 | Pagoda |
| Baldy Creek | East Fork Williams Fork | u | 198 | Pyramid |
| Black Mountain Creek | East Fork Williams Fork | u | 199 | Pyramid |
| Little Cottonwood Creek | Fortification Creek | u | 200 | Elkhead Mountain |
| Freeman Reservoir | Little Cottonwood Cr | u | 201 | Elkhead Mountain |
| South Fork Fortification Creek | Fortification Creek | u | 202 | Elkhead Mountain |
| First Creek | Elkhead Creek | h | 203 | Elkhead Mountain |
| Armstrong Creek | Elkhead Creek | u | 204 | Elkhead Mountain |
| Porcupine Lake | South Fork Mad Creek | h | 205 | Lower Elk River |
| Luna Lake | North Fork Mad Creek | h | 206 | Lower Elk River |
| Lake of the Crags | North Fork Mad Creek | h | 207 | Lower Elk River |
| Smith Creek | Deep Creek | u | 208 | Sand Mountain |
| Sand Creek | Elk River | u | 210 | Sand Mountain |
| Beaver Creek | Willow Creek | u | 211 | Sand Mountain |

| Table D-31. Colorado River Cutthroat Trout - Status on the Routt National Forest (continued) | | | | |
|---|---|---|---|---|
| **Water*** | **Drainage*** | **Genetic Purity*** | **Water#*** | **Routt National Forest Geographic Area** |
| Lost Dog Creek | North Fork Elk River | h | 212 | Upper Elk River |
| Lake Diana | North Fork Elk River | h | 213 | Upper Elk River |
| West Coal Creek | Coal Creek | u | 214 | Bear River |
| Dome Creek | Bear River | u | 215 | Bear River |
| Mandall Creek | Bear River | h | 216 | Bear River |
| Egeria Creek | Harper Reservoir | u | 266 | Bear River |
| Big Park Creek | Blacktail Creek | h | 268 | Gore |
| Antelope Creek | Muddy Creek | u | 269 | Chimney Rock |
| Lindsey Creek | Muddy Creek | u | 270 | Chimney Rock |
| Frantz Creek | Muddy Creek | u | 271 | Red Dirt |
| Little Green Creek | Muddy Creek | h | 272 | Red Dirt |
| North Little Green Creek | Muddy Creek | p | 273 | Red Dirt **(Conservation Population*)** |
| Long Draw | Haystack Creek | u | 283 | Troublesome |
| Paradise Creek | East Fork Troublesome | p | 284 | Troublesome |
| Timber Creek | East Fork Troublesome | p | 285 | Troublesome |
| Rabbit Ears Creek | Troublesome Creek | u | 286 | Chimney Rock |
| Steelman Creek | Williams Fork | p | 287 | Upper Williams Fork |
| McQueary Creek | Williams Fork | u | 288 | Upper Williams Fork |
| Bobtail Creek | Williams Fork | p | 289 | Upper Williams Fork |

*u = unknown, p = pure, h = hybridized
*Source: Young et al. 1996*

In addition, CNHP mapped land areas identified as important to the existence of ecological processes that support one or a suite of species of the list in Table D-30. Generally these areas reflect the associated habitats around the species occurrence locations. The areas identified by CNHP are called preliminary conservation planning areas. They represent areas of special or unique habitats which may not have been "caught" in the coarse filter. A total of 71 areas were identified that included over 119,000 acres, 62,000 acres on the Forest. Table D-32 identifies these areas, their size, acres of Forest Service administered land included, and the number of TE&S and CNHP species (separate species not occurrences) found in the conservation area.

| Table D-32. Colorado Natural Heritage Program Preliminary Conservation Planning Areas | | | | |
|---|---|---|---|---|
| **CNHP Conservation Site Name** | **Total Acres** | **Net NFS Acres** | **Total TE&S Species** | **Total CNHP Species** |
| Big Creek Lakes Mac | 13,664 | 13,294 | 7 | 9 |
| Elk River | 29,943 | 26 | 0 | 0 |
| Slater Park | 16,605 | 7,876 | 2 | 4 |
| Baldy Peak Stock Pond | 29 | 29 | 1 | 0 |
| Bear Park Reservoir | 13 | 13 | 1 | 0 |
| Bear River at Moore Park | 127 | 127 | 0 | 1 |
| Beaver Creek Ponds | 417 | 301 | 1 | 0 |
| Beaver Flat Tops East | 68 | 68 | 1 | 0 |
| Beeler Gulch | 10 | 10 | 0 | 1 |
| Big Canyon Creek | 305 | 305 | 1 | 0 |
| Big Creek Lakes | 2,317 | 2,317 | 6 | 1 |
| Buffalo Park | 777 | 777 | 0 | 0 |
| California Park | 11,875 | 10,634 | 5 | 2 |
| Cameron Pass | 81 | 37 | 2 | 2 |
| Chedsey Creek | 40 | 40 | 1 | 0 |
| Christina SWA Site | 117 | 9 | 0 | 0 |
| Circle Bar Basin | 294 | 294 | 1 | 0 |
| Crane Park | 30 | 30 | 0 | 2 |
| Dennis Hump South | 113 | 113 | 0 | 1 |
| Dumont Lake | 75 | 75 | 1 | 0 |
| Elkhead Creek | 657 | 1 | 0 | 0 |
| Elkhorn Mountain | 46 | 43 | 1 | 0 |
| Encampment River | 93 | 93 | 0 | 0 |
| Freeman Reservoir | 304 | 120 | 1 | 1 |
| Harrison Creek | 32 | 32 | 0 | 1 |
| High Rock Creek | 526 | 526 | 0 | 4 |
| Horse Park | 227 | 227 | 0 | 2 |
| Independence Creek | 1,960 | 769 | 1 | 1 |
| Lake Diana | 35 | 35 | 1 | 0 |
| Little Red Park | 559 | 559 | 0 | 1 |
| Livingston Park | 502 | 459 | 1 | 1 |
| Lone Pine Creek | 23 | 23 | 0 | 1 |
| Lower Beaver Ponds | 674 | 674 | 1 | 0 |
| Luna Lake | 122 | 122 | 1 | 0 |
| Mandall Creek | 165 | 165 | 0 | 0 |
| Middle Fork Elk River | 3,307 | 3,166 | 2 | 3 |
| Middle Fork Little Snake | 53 | 53 | 1 | 0 |
| Milk Creek Reservoir | 189 | 41 | 1 | 0 |
| Moon Hill | 81 | 50 | 0 | 0 |
| Table D-32. Colorado Natural Heritage Program Preliminary Conservation Planning Areas | | | | |

**(continued)**

| CNHP Conservation Site Name | Total Acres | Net NFS Acres | Total TE&S Species | Total CNHP Species |
|---|---|---|---|---|
| Morrison Creek | 20 | 65 | 0 | 0 |
| Morrison Creek Ponds | 171 | 171 | 0 | 2 |
| Muddy Pass Lake | 65 | 65 | 1 | 0 |
| North Fork Elkhead Creek | 40 | 40 | 0 | 2 |
| Pond Lily Lakes | 770 | 71 | 1 | 0 |
| Poose Creek | 81 | 81 | 1 | 1 |
| Porcupine Creek | 315 | 315 | 1 | 0 |
| Reed Creek | 243 | 119 | 1 | 0 |
| Sawmill Creek | 293 | 293 | 0 | 1 |
| Service Creek | 121 | 121 | 1 | 1 |
| Service Creek Rocks | 519 | 519 | 0 | 0 |
| Service Creek Trail | 203 | 203 | 1 | 0 |
| Sheriff Reservoir | 15 | 15 | 0 | 0 |
| Slide Lake | 80 | 80 | 1 | 0 |
| Soda Creek | 252 | 236 | 0 | 2 |
| South Fork Elk River | 471 | 471 | 0 | 1 |
| South Fork Michigan River | 503 | 503 | 1 | 0 |
| South Fork Park | 6,636 | 2,025 | 1 | 0 |
| South Fork Williams Fork | 196 | 196 | 0 | 1 |
| South Summit Creek | 51 | 51 | 1 | 1 |
| Steamboat Lake Site | 14,859 | 2,994 | 1 | 0 |
| Steelman Creek | 51 | 51 | 1 | 1 |
| Teal Lake | 151 | 151 | 2 | 0 |
| Tributary to Walton Creek | 185 | 185 | 0 | 1 |
| Upper Beaver Ponds | 484 | 484 | 1 | 0 |
| Upper East Fork Williams Fork | 584 | 496 | 0 | 1 |
| Upper Muddy Creek | 198 | 198 | 0 | 0 |
| Upper Oak Creek | 1,420 | 1,309 | 0 | 3 |
| Walton Creek | 50 | 34 | 0 | 1 |
| West Fork | 76 | 76 | 1 | 0 |
| White Slide | 33 | 33 | 1 | 0 |
| Willow Creek Canyon | 110 | 110 | 0 | 1 |
| Willow Creek Lake East | 35 | 35 | 1 | 0 |
| Willow Creek Lake West | 26 | 26 | 1 | 0 |
| Willow Park | 441 | 274 | 1 | 0 |

*Source: ARC/Info, GIS*

These areas vary in size of National Forest acreage involved from 1 to over 13,000 acres. They are preliminary based on desk top references only, not field verified and are not based on a complete inventory of the Forest.

The database accompanying each conservation planning area contains several pieces of information which serve to describe and evaluate these areas. The Colorado Natural Diversity

Database recommended three of these field be used to evaluate the areas. "Biodiversity significance" rank is a measure of the rarity and quality of the species or community found within the preliminary conservation planning area. The "protection urgency" rank describes the urgency to take protective action at the site. The CNHP "management urgency" rank identifies the time period during which management action should be taken.

CNHP recommended that the Forest Plan revision effort should focus on a "biodiversity significance" rank of 3 or better. "Protection urgency" and "management urgency" are best dealt with at the site specific level as they deal more directly with aspects of actually implementing the plan. Since the areas are not delineated based on field verification and not based on a complete forest inventory, they will be described in the unique features section of their respective Geographic Areas. This highlights the importance of each area allowing for later site specific analysis.

Table D-33 displays each of the Preliminary Conservation Planning Areas with a "biodiversity significance" rank of 3 or better. As the table show, there were no rank 1 areas on the Forest.

**Table D-33. Preliminary Conservation Planning Areas - Biodiversity Significance Rank >=3**

| Preliminary Conservation Planning Area Name | Biodiversity Significance Rank | Geographic Area Name |
|---|---|---|
| Service Creek Trail | 2 | Sarvis |
| Upper Muddy Creek | 2 | Red Dirt |
| Upper East Fork of Williams Fork | 2 | Pyramid |
| Soda Creek | 2 | Middle Yampa |
| Middle Fork of Elk River | 2 | Upper Elk River |
| Beeler Gulch | 2 | Little Snake |
| Sawmill Creek | 2 | Elkhead Mountain |
| Big Creek Lakes (Micro and Macro Sites) | 2 | Big Creek/Red Canyon |
| Steelman Creek | 2 | Upper Williams Fork |
| North Fork of Elkhead Creek | 2 | Elkhead Mountain |
| Morrison Creek Ponds | 2 | Morrison |
| Elk River (Macrosite) | 2 | Lower Elk River/Upper Elk River |
| Slater Park (Macrosite) | 2 | Slater Creek |
| High Rock Creek | 3 | Gore |
| Tributary to Walton Creek | 3 | Middle Yampa |
| South Fork Michigan River | 3 | Owl Mountain |
| Cameron Pass | 3 | Owl Mountain |

| Table D-33. Preliminary Conservation Planning Areas - Biodiversity Significance Rank >=3 (continued) | | |
|---|---|---|
| **Preliminary Conservation Planning Area Name** | **Biodiversity Significance Rank** | **Geographic Area Name** |
| * Luna Lake | 3 | Lower Elk River |
| South Fork Elk River | 3 | Upper Elk River |
| Little Red Park | 3 | Little Snake |
| Crane Park | 3 | Little Snake |
| Independence Creek | 3 | Little Snake |
| Upper Oak Creek | 3 | Dunckley |
| Poose Creek | 3 | Pagoda |
| * Mandall Creek | 3 | Bear River |
| Bear River at Moore Park | 3 | Bear River |

* Later evaluation resulted in different recommendation
*Source: ARC/Info, GIS*

Both the Luna Lake and Mandall Creek areas were intended to conserve habitat for Colorado River cutthroat trout. However, later information (Young et al. 1996) indicate that the populations in these areas are in fact hybridized. Therefore, after consultation with the CNHP, it was decided not to place these areas in the unique features section of their respective Geographic Areas. This example serves to indicate the preliminary nature of these areas.

## Part III Range Of Natural Variability Summary

Forest ecosystems are dynamic with changes in composition, structure and function occurring over periods from years to centuries. The range of these changes over time is known as the range of natural variability (RNV). Understanding this range helps to better understand the dynamic nature of the ecosystems on the Forest. In addition, it places current forest conditions and management decisions affecting those conditions in context. The temporal scale, or period of time that the RNV report focuses on, is mid-1800s to present. The mid-1800s was the period of European exploration and settlement of northwestern Colorado. Some of the natural resources in the area were documented for the first time. This historic text provided the comparison of what was here then, to what is here now.

The RNV report itself (Routt National Forest 1994) focused on the following seven parameters:

**Forest Communities -** composition (tree species/types), structure (age classes), and patterns.

**Insects and Diseases -** composition (primary insects and disease) and their effect on the major forest types, their change in structure (age classes) and pattern. Insects and disease disturbance intervals.

**Fire Regimes -** fire frequency, fire size, of the different vegetative communities (composition).

**Non-forest Communities -** shrub and grassland composition and their structure.

**Wildlife and Fish -** composition (species of wildlife and fish) and, population estimates (structure).

**Riparian Environments -** plant composition and structure (and processes altering riparian environments).

**Human Use and Occupation -** population composition, population changes (structure) over time and human-induced changes on the environment.

## The Setting

## Geology

The Forest is located in north central Colorado astride the Continental Divide. The Divide follows the north-south oriented Park Range from the Wyoming border to Rabbit Ears Pass, where it veers to the east along the Rabbits Ears Range en route to Rocky Mountain National Park. The Continental Divide separates the Forest generally into three distinct geographic areas: the Upper Yampa River drainage (Yampa, Steamboat Springs); North Platte River drainage (North Park); and the Main Stem Colorado River drainage (Middle Park).

In addition to the Continental Divide, portions of other mountains and ranges are found in the Forest, including the Elkhead Range north of Craig, the Flat Top Mountains west of Yampa, the Williams Fork Mountains south of Kremmling, and the Medicine Bow Range east of Walden. Generally, National Forest System land is found at the higher elevation on the slopes of these mountains (7,000 feet and up), while the lower land in the Yampa Valley, North Park and Middle Park are in private or other government ownership.

## Geomorphology

The Forest occupies parts of three physiographic provinces. They are Southern Rocky Mountains, Wyoming Basin and Colorado Plateau provinces.

The Southern Rocky Mountain Province consists of complex mountains of various types, and intervening basins. This province consists mostly of broad, elevated, north-south trending mountains of dominantly granitic rocks.

Topography of the Forest area is typical of glaciated mountain regions. Elevation ranges from about 7,000 feet in the valleys to over 13,000 feet at the highest peaks. The area is characterized by steep, glaciated mountains with barren, knife-edged ridges and peaks. Valleys are steep and U-shaped. Other parts have been glaciated by broad sheets of ice that did not follow drainages. These areas are made up of rolling terrain and deep valleys cut by streams. There are many rock outcrops and other features of glaciation exhibited.

The Wyoming Basin Province in northwest Colorado consists of sedimentary deposits that have been intruded by Tertiary Volcanics. They are composed of sandstones and shales of late Cretaceous and Tertiary age; the ridges and peaks being capped by resistant volcanics which have preserved the entire area as a high standing mass. There are two main groups of peaks. One has a general east-west trend, and extends from the Park Range into the Washakie Basin. The other group trends slightly west of north, parallel to the Park Range. From the main ridge, the mountains slope gradually into the basins without sharp breaks in structure of the sediments.

The high country is characterized by bare talus-covered domes of igneous peaks with the foothills (pediments) extending from the peaks. This overall topography exhibits smooth rounded slopes with landslides common throughout the area.

The southwest part of the Forest is in the Colorado Plateau province. The plateaus are deeply incised by streams and form steep-walled canyons. Sideslopes exhibit landslide topography with the hummocks and interrupted or nonexistent drainage patterns.

The end of the Pleistocene (the period concluding the last great Ice Age) about 10,000 Before Present (B.P.) was characterized by climatic and ecologic change. Although the continental ice sheets did not extend down into the state, the mountains around this area received a great deal of alpine glaciation during the Pleistocene. This shaped many of the features in the present day mountains. The late Holocene period (roughly 2,000 B.P. to the present) is characterized by a period of relative climatic stability with climate comparable to today. This would be the starting point as plants and animals began to assume their current composition.

### Climate

The climate on the Forest can be summarized briefly by the statement "long, snowy winters and short, cool summers." Most of the precipitation comes as snow, although some years have wet summers also. Summer thundershowers are common, although their extent is localized. The south end of the Gore Range, the west end of the Elkhead Mountains, and the north, south and east fringes of North Park are the driest portions of the Forest. The country between the Continental Divide and California Park is the wettest.

Drought cycles on the Forest could have affected the fire frequency and intensity, but there is no conclusive data to support this assumption.

### Paleoecology

For the last 10,600 years the White River Plateau area has been a consistent forest community type; spruce fir. This implies that this spruce fir community, on this site, did not go through earlier successional stages like lodgepole or aspen over that length of time.

There have been four major environmental/climatic periods within the past 10,600 years in the area around the Bear River Corridor, north of the Flat Tops Wilderness. Climate conditions changed from cool and moist to a more warm and dry environment which would increase stress and spruce bark beetle infestations and reduce number of spruce in favor of fir.

### The Parameters

### Forest Communities

Spruce/fir

Generally, individual, dominant Engelmann spruce trees are often 250- 450 years old and trees 500 -600 years old are not uncommon throughout its range in the western United States. Subalpine fir trees older than 250 years are not uncommon although they often become highly susceptible to death from beetles and root disease at about 125 -175 years

Engelmann spruce maintains its abundance over subalpine fir in the spruce/fir ecosystems by its increased longevity.

Although spruce can live up to 600 years, the susceptibility of large old trees to windthrow, spruce beetle attack and fire limits the development of extensive stands of old growth for several generations.

Spruce/fir stands go through four developmental phases: stand initiation following a major stand replacement event (usually fire); the spruce exclusion phase (125 -200 years); the spruce (and fir) re-initiation phase (225- 400 years) when the canopy starts to break apart; and the when the stand develops into a multi-aged old-growth stand.

Complete removal of spruce/fir stands by fire or logging can change the species composition to lodgepole pine, quaking aspen and/or shrub or grass communities.

A large number of snags can be expected to remain standing up to fifty years following a major stand-replacing fire in a mixed species stand of spruce, subalpine fir and lodgepole pine. Sometime after this period, there will be increase reduction in the total number of snags.

On the Forest over the last several hundred years, the principal disturbance agents of Engelmann spruce have been wind, spruce bark beetle and wildfire, while the principal disturbance agents of subalpine fir have been root rots, bark beetles and wildfire.

Lodgepole Pine

Lodgepole pine composition on the Forest is usually attributed to wildfires. Crown fires are widely assumed to be the selective factor favoring the serotinous trait of lodgepole pine cones; cooler ground fire would favor open-coned characteristics.

Where lodgepole pine is a minor seral species, in the absence of wildfire and mountain pine beetle epidemics, it will usually be replaced in 50 -100 years by more tolerant species. Where it is a dominant seral species within the stand, replacement usually requires 100 -200 years. Data from Idaho to Wyoming shows that pure stands of lodgepole pine persist for varying lengths of time and may start breaking up anywhere from 80 to 400 years.

Past harvesting on the Forest has often removed the lodgepole where it was a seral species in favor of the longer living Engelmann spruce.

Without fire, lodgepole pine would be replaced by forests dominated by Engelmann spruce and subalpine fir. Lodgepole pine rarely reached climax conditions in presettlement times because of frequent disturbances; however, in some areas, lodgepole pine is climax or at least a long-lived subclimax species due to edaphic and local site conditions.

The principal disturbance agents of lodgepole pine over the last several hundred years, have been the mountain pine beetle, wildfire and lodgepole pine dwarf mistletoe.

Aspen

Aspen has a pathological rotation of 110 -120 years although stands as old as 200 years exist within its range throughout the United States.

In seral aspen stands on the Forest, the tree canopy usually consists almost exclusively of aspen for 50-150 years, until the slower growing conifers are able to penetrate the aspen canopy. In many aspen stands, there is little evidence of a trend of aspen to be replaced by conifers.

Fire is probably responsible for most even-aged aspen stands that exist in the west and on the Forest, whether or not the aspen type is climax on the site. Although aspen is often initiated by fire, an aspen forest does not burn readily and over time, is often replaced by grasses, forbs, shrubs or conifers.

There has been a great reduction in aspen fire rejuvenation throughout the west and on the Forest. This has resulted in an increase in the overall age of the aspen stands. There are more late seral and climax aspen stands now than existed prior to the creation of the Forest Reserves.

In some areas on the Forest, aspen dominates sites where fires have destroyed coniferous forests. Over time, conifers will gradually replace aspen. In other areas, aspen forests appear to be climax without evidence of conifer invasion.

Complete conversion of aspen stands to coniferous climax forest may require more than 1,000 fire-free years in western Colorado where aspen reaches its optimum development.

The principal disturbance agents of quaking aspen over the last several hundred years on the Forest, have been wildfire and decay fungi.

Ponderosa Pine and Douglas-fir

Ponderosa pine and Douglas-fir are not widespread on the Forest. The presence of ponderosa pine and Douglas-fir may be indicative of much drier conditions on the Forest in the past.

## Forest Composition Structure and Pattern

Many forested areas within the current Forest boundaries were burned by fire prior to 1900. Based on historical estimates between 1888 -1904, an estimate of the amount of forested area destroyed by fire before 1900 is between 20%- 60% depending on the location.

In Engelmann spruce-subalpine fir stands in 1898 on the White River Reserve that had not been damaged by fire, the Engelmann spruce often comprised 75% to 90% of the species composition and had a maximum diameter at breast height of 40 inches although large trees usually ranged from 19 to 24 inches. The large spruce trees ranged from 200 to 290 years old.

Much of the lodgepole pine on the White River Reserve in 1898 had been killed by fire. In its best development within the Reserve, it ranged from 8 to 20 inches diameter at breast height.

An analysis of the southwestern portion of the Forest, comparing current vegetative cover to that which existed in 1898, indicates that forested species composition and total tree cover today is similar to conditions in 1898.

Based on historical accounts since the Forest Reserves were created, the percent species composition on the Forest of the major forested types ranged from 30% to 40% for spruce/fir, 35% to 45% for lodgepole pine and 20% to 25% for aspen.

Spruce/fir forested composition is at the high end of its historical range; lodgepole pine is at the low end of its historical range; and aspen is relatively stable based on its historical range.

Estimates and surveys of the amount of volume of dead timber between 1908 -1920 ranged from 21% to 27%.

There is a higher percentage of "mature" spruce/fir, lodgepole pine and aspen forests today then there was in 1900.

## Potential Natural Vegetation

Significant acreage of potential spruce/fir, based on past soil development, are being maintained in a mid-seral condition. About 54% of spruce/fir soils are currently supporting other species, primarily lodgepole pine and aspen. This suggests that fire is the probable agent of disturbance. Insects would not cause a long term type change, although in some cases insects set up the fire stand replacement event.

The majority of lodgepole pine sites on the Forest are being maintained in lodgepole pine through various disturbance events, primarily wildfire and insects.

There is a large percentage of conifer on aspen soils due to lack of disturbance. However, there is a larger percentage of aspen on conifer soils due to past disturbances. About 55% of the current aspen acreage exists on sites that have been aspen for long periods of time.

In natural ecological cycles, the longer the period of time between major disturbances, primarily fire, the higher the percentage of spruce/fir composition across the forested landscapes and the lower the percentage of lodgepole pine and aspen composition across the forested landscapes.

The potential for a stand replacement event is increasing with time in all of the cover types due to the lack of significant fire within the last 100 years. This is most likely the normal interval for this area. However, the probability of fire events that would mimic early conditions are remote since agricultural uses in the lower valley areas and social acceptance of large free running fire have and will continue to influence wildfire suppression.

Grassland soils are supporting a high percentage of shrubs and tree species. Only about 30% of grassland soils are supporting grassland communities. This suggests that disturbance, possibly grazing and lack of fire, is allowing an increase in some of the woody species such as snowberry, big sage and aspen. A high percentage of oak on grassland and aspen soils indicates disturbance such as grazing and lack of fire may be responsible.

## Landscape Pattern

Historical data on patch size and pattern is lacking. These patch size and pattern conclusions are based on analysis of roadless areas. These roadless areas are the Forest's best examples of ecosystems unaltered by management.

The landscape following a stand-replacing fire disturbance(s) is dominated primarily by a few large patches. As these patches revegetate they progressively move from structural stage 1 to 4. Over long periods of time and after many other landscape disturbances from weather, insects, diseases and small fires, the landscape is broken into a mosaic of patches of different sizes and patterns.

There are more individual smaller patches than larger patches across all forested cover types on the Forest, with the majority of these patches less than 40 acres.

There is more total acreage across the landscape of large forested patches than smaller patches. The majority of acreage in structural stages 3 and 4 is in patches greater than 100 acres across all forested cover types.

There are few aspen patches over 300 acres on the east side and there are few lodgepole pine patches over 1000 acres on the west side.

There are fewer patches greater than 300 acres in structural stages 1 and 2 than there are in structural stages 3 and 4.

## Insects and Disease

<u>Spruce Beetle</u>

Spruce beetle, an insect native to North America, has been the most significant insect pest on the Forest in its effect on stand structure and species composition in the Engelmann spruce-subalpine fir ecosystem. This beetle has had as much effect as fire in the development of the Forest's spruce/fir forests. Spruce beetles attack and kill the largest spruce trees (greater than 16 inches DBH) first. As the beetle populations grow they will attack and kill trees greater than ten inches.

Epidemics populations of spruce beetle:

- ♦ Originate from stand disturbances. Blowdown and logging residue are ideal locations for the build-up of spruce beetle populations.
- ♦ Alter species composition and stand structure.
- ♦ Have varied from light to heavy on the Forest.
- ♦ That remove less than 40% of the spruce overstory will not have as great an impact on stand composition and structure.

A spruce/fir stand developing after a beetle infestation would be all-aged compared with a stand developing after a wildfire which would tend to be more even-aged. From 70% to 84% of the dead spruce trees will still be standing 20 -25 years later. Current literature suggests that the loss of trees after this period will continue to be gradual for a number of years.

Based on current regional literature, a conservative turnover period for Engelmann spruce/subalpine fir stands, due to spruce beetle epidemics, will average about 259 years, with an insect return interval of about 110- 120 years.

<u>Balsam Bark Beetle</u>

Western balsam bark beetle is native to North America. On the Forest it kills thousands of individual subalpine fir trees in association with shoestring root rot, other bark beetles, and/or drought.

In Engelmann spruce-subalpine fir ecosystems, the western balsam bark beetle is one of the agents that assists in the removal of the old (125 -175+ years) subalpine fir and increases the proportion of spruce in the stand.

No documented extensive epidemics of western balsam bark beetle are known to have occurred on the Forest.

<u>Western Spruce Budworm</u>

Western spruce budworm, an insect species native to North America, has not played a significant role in the structure and composition of the Engelmann spruce/subalpine fir ecosystems on the Forest in the last 150 years.

<u>Mountain Pine Beetle</u>

Mountain pine beetle, an insect native to North America, has been the most significant insect pest on the Routt National Forest in its effect on stand structure and species composition in the lodgepole pine ecosystem. Mountain pine beetle is believed to have coexisted with lodgepole pine since the trees earliest existence.

Epidemic populations of mountain pine beetle:

- Have varied from light to heavy on the Forest.
- Attack injured or weaken trees but generally attack the largest diametered, healthiest trees first. In pure stands of lodgepole pine, trees down to five inches DBH may be killed.
- Last between 5- 7 years and range from 20 to 40 years.
- Alter stand structure by removing a percentage of the lodgepole pine overstory. The percentage of trees killed that are four inches in diameter at breast height and larger may range from 10% to 50%, with greater mortality in larger diametered trees.
- Increase in risk as the stand reaches 80 years of age and the average diameter at breast height of trees 5 inches and larger is 8 inches or greater.

Mountain pine beetles can create multi-storied lodgepole pine stands by removing a portion of the overstory trees and allowing establishment of younger-aged lodgepole pine trees or by releasing spruce and fir understory trees.

About 30 years after a mountain pine beetle infestation lodgepole pine snags become uncommon.

Mountain pine beetles on the Forest are currently in an endemic status. If the last major epidemic period on the Forest was in the early 1970s then, based on the regional average outbreak period of 20 to 40 years, another outbreak period can be expected within the next 20 years somewhere on the forest.

The suppression of wildfires since the turn of the century has strongly influenced the current status of many insect and disease populations and the risk factor for future epidemic outbreaks. With higher percentages of mature lodgepole pine stands and with stands becoming more homogenous the risk of future outbreaks of the mountain pine beetle has increased.

Pandora Moth

A pandora moth outbreak occurred on the North Park District in 1961. Despite this small outbreak, the pandora moth has not been a major player in shaping species composition or stand structure in lodgepole pine on the Forest.

Lodgepole Pine Dwarf Mistletoe

Lodgepole pine dwarf mistletoe is an active native parasite that has caused considerable loss of lodgepole pine growth on the Forest.

Wildfires have been most important in controlling the distribution of mistletoe. Large hot fires kill both the lodgepole host and the dwarf mistletoe plant.

The increase in late seral lodgepole pine stands and the reduction in large stand replacing wildfires has allowed mistletoe to spread further into uninfected stands.

Aspen Stem Cankers

With the absence of stand regenerating fires and/or major disturbances, and with the increased overall stand age of the aspen, there is a good probability that stem cankers are more prevalent now then they were before the turn of century.

Shoestring Root Rot

Shoestring root rot, a disease native to North America, is the most common root disease on the Forest. It kills all species of trees on the Forest although it seems most aggressive on the subalpine fir.

In Engelmann spruce\subalpine fir ecosystems, shoestring root rot is one of the agents that assists in the removal of the old (125 - 175+ years) subalpine fir and increases the proportion of spruce in the stand.

When combined with a drought and heavy bark beetle activity, mortality of trees in the overstory and understory from shoestring root rot can increase.

### Fire Regimes

The fire frequency on the Forest can be classified as infrequent with fires greater than 10 years apart, and high intensity which is greater than 1200 BTU/ft/sec. These are severe fires when they occur but they don't burn that frequently. The ecosystems on the Forest have developed under this fire regime.

Major tree cover types typically have long fire return intervals:

- Spruce/fir stand turn over 500 years, average fire return interval 200 years.
- Lodgepole turn over 300 years, average fire return interval 200 years.
- Aspen turn over 200 years, return interval of 70- 100 years.

Cooler creeping ground fire will cause mortality in all the major tree cover types, and will have a significant effect on the stand structure.

Within the three major drought cycles in the last 140 years affecting the Forest, most large fire occurred in the 1870 -1895 time period. A large number were human-caused.

Livestock grazing, farming and development in the valley have reduced the potential for high intensity fire to spread to the uplands. Low elevation oak and aspen are becoming decadent and sage is increasing due to the reduced fire frequency.

Between 1850 -1900, fire was used by humans to expose mineralized areas, clear for agriculture, create timber harvesting opportunities, and to some extent, as a tool used in battle.

Mortality pattern following high intensity fire is greatly influenced by aspect and slope position. Live trees are often left on the sheltered north slopes and moist valley bottoms.

### Forest Disturbance in General

Nearly all forested stands on the Forest are in some stage of recovery from disturbances.

The forested communities as they exist today on the Forest are the result of interactions between weather, fire, insects, disease, browsing ungulate and humans.

Disturbance is the key factor in determining community structure and patchiness. The resultant patchiness is a key factor in determining the extent and magnitude of future disturbances.

The Forest landscapes are composed of vegetative mosaics of different seral stages based on past disturbances.

Biological diversity increases through the process of disturbance and recruitment of new vegetation.

No major stand replacing fires have occurred since the Park Range Forest Reserve and National Forest were designated at the turn of the century. Therefore, fire has not been a major factor in shaping the majority of the Forest's stand composition and structure since 1900.

The reduction of large acreage burned on the Forest since the late 1890s has led to an increase in the density of conifers, most notably of shade-tolerant subalpine fir.

Under a natural disturbance regime, Engelmann spruce/subalpine fir forests were probably characterized by a mosaic of stands in various stages of recovery from disturbance.

The amount of windthrow in spruce/fir stands steadily increases after 300 years of stand development. This rise in windthrow increases the probability of another stand-initiating fire or extensive spruce beetle outbreak.

The current spruce/fir landscape on the Forest is perhaps more homogeneous (in terms of stand age) than in the presettlement era, due to the synchronizing effect of very extensive, regional fire and insect disturbances over the last 150 years and the subsequent lack of major fire disturbances over the last 95 years.

Since 1900, spruce bark beetle and mountain pine beetle have played the dominant role in changing the relative abundance of species and the structure of spruce/fir and lodgepole pine ecosystems, respectively.

## Non-forest Communities

### Shrub Communities

Approximately 90% of the shrub species identified almost 100 years ago are still present, but their relative abundance is uncertain. Birch and grease wood were documented (historically) as occurring on the Forest but are currently only on adjacent private land. This is probably due to administrative boundary changes, not to past or present land management.

Oak brush communities that are over 80 years old and have had some fire suppression activities may be outside their range of natural variability and normal fire return interval. This may result in a decrease in the abundance and viability of the community.

### Grassland Communities

Early livestock use of the Forest has contributed to the early seral condition of some of the grass and shrublands on the Forest.

Grazing reduces fine fuels that in turn reduces fire intensity and rate of spread and has contributed to the reduced fire frequency in the oak and aspen types.

Fire is needed to rejuvenate old bunchgrass types on a return interval of 8- 10 years.

## Wildlife and Fish

The native bison or American buffalo that once roamed northwest Colorado were extirpated nearly a century ago. The mountain sheep populations that once inhabited this area have remained low compared to the reports of the "abundant" status in the mid-to-late 1800s.

It has been over 70 years since a wolf was reported and confirmed for this part of Colorado. Wolves are considered extirpated from this area and are classified as a state and federal endangered species.

Two state endangered species, lynx and wolverine, are on the fringe of their native range and were never very abundant historically. There have been occasional reports of sightings for both species over the last several decades but few have been confirmed.

Few wildlife species extirpated from Colorado because of excessive hunting or trapping in the 1800s have returned to the state, except river otter.

The river otter has staged a comeback and could potentially increase in numbers, provided riparian habitat is managed in a mid-to-late seral condition and water quality remains high.

The only significant documented change in bird species composition, from historic to present, is in the turkey and ruffed grouse records of the early 1900s. There was no explanation found in old records to indicate why these species disappeared in the latter part of the 1900s. Peregrine falcons are still infrequently sighted on the Forest, which may be the same as historic numbers due to the limitation in available nesting habitat.

The greater sandhill crane population is on a slow but steady rise in numbers and, provided nesting habitat is maintained, this trend should continue.

Monitoring for wildlife species population numbers or their habitat was not performed historically. What little monitoring was done was based on the "presence or absence" approach to inventory and for only a few species. We can't tell today what populations have increased or decreased.

The stocking of non-native trout species, which began in the late 1800s, is considered a primary cause of the decline of the Colorado River cutthroat trout in northwest Colorado and the Routt National Forest. The synergistic effect of increases in non-native trout populations and altered habitat has adversely impacted Colorado River cutthroat populations. The ability of Colorado River cutthroat to hybridize with rainbow trout and other sub-species of non-native cutthroat trout and the effects of competition with brook trout are major factors in the decline in northwest Colorado and the Forest.

All native fish species in the Colorado River and North Platte Basin have been impacted by the introduction of non-native fish, whether they are salmonids, or warm water species such as northern pike and white suckers.

There are currently game fish occupying habitats that historically were devoid of fish due to natural barriers. Most high mountain lakes in the wilderness which were not connected to perennial streams were barren. Indiscriminate stocking has introduced salmonids into all available habitat on the Forest.

Habitat alterations have reduced Colorado River cutthroat populations. These alterations include adverse impacts to riparian vegetation and stream channel stability; water development with concomitant flow deletions during critical time periods; and water quality degradation. However, habitat alteration which has occurred on the Forest is considered a secondary cause in the decline of Colorado River cutthroat trout.

Increased road and trail access has resulted in more angling pressure on the highly susceptible Colorado River cutthroat. There is no "pure" strain of Colorado River cutthroat trout in the gene pool for stocking and reintroduction. Even those currently being used for this purpose have had some degree of hybridization.

The majority of fisheries research has focused on the salmonid "game" species. Much less is known about the status of the nongame indigenous species on the Forest.

The RNV of the Colorado River cutthroat population before European settlement was relatively static. The population fluctuated in individual streams, mainly from natural disturbance events such as landslides, large wildfires and the distribution of beaver. The cutthroat population is currently outside the RNV. The current population of cutthroat on the Forest occupies only 3% of its available habitat.

Currently, 21 species of native, naturalized and introduced fish species are known or suspected to occur in the waters of the Forest because of stocking programs and incidental introductions from bait buckets.

### Riparian Environment

Within the riparian environment, the willow species type occupies the most acres.

The extent of riparian areas on low gradient streams, less than 2%, is directly correlated with the existing and historical beaver population. When a stream is dammed by beavers, the resulting rising of the water table expands the riparian areas. When beaver no longer occupy these streams and the dams have washed out, the riparian acreage diminishes. This fluctuation is within the RNV.

No unusual riparian communities have been identified on the Forest by the Colorado Natural Heritage Program classification project. Therefore, the riparian plant communities on the Forest are common with other riparian areas within the Region.

The Colorado Natural Heritage Program ranked 75% of the riparian plots on the Forest as being in a good condition in regard to population size, productivity and vigor.

### Human Use and Occupation

Prehistoric human use and occupation of the area in and surrounding the Forest has been dated to 11,000 years ago. Native American Indians, predominately the Ute Indian tribes, have occupied the area for at least 300-400 years. European exploration began with the Spanish in the late 1700s and continued with fur traders in the early 1800s. Mining, ranching and farming brought permanent settlers into the area in the late 1800s. Many of the area's communities were established at this time. The arrival of the railroad in the early 1900s, and later, freight roads brought both visitor and more settlers into the area. Skiing came to Steamboat Springs by 1920s. The future holds projections of continued growth and population increases for communities in the west.