Appendix E

Hierarchy of ecological units

Introduction An understanding of spatial and temporal patterns found in landscapes is central to ecosystem management and the conservation of biodiversity. This understanding is aided by describing ecosystems in terms of a hierarchical structure, which allows them to be characterized at different scales and provides a physical and biological context for Forest Service decision-making. **Table A-68** describes the National Hierarchy of Ecological Units (ECOMAP 1993) in terms of its general applications.

Table A-68
National Hierarchy of Ecological Units

Planning and analysis scale	Ecological units	Purpose, objectives, and general use	General size and range
Ecoregions Global Continental Regional	Domain Division Province	Broad applicability for modeling and sampling RPA assessment International planning	Millions to tens of thousands of square miles
Subregions	Sections Subsections	RPA planning multi-forest, statewide; multi-agency analysis and assessment	Thousands to tens of square miles
Landscape	Landtype association	Forest or area-wide planning; watershed analysis	Thousands to hundreds of acres
Land unit	Landtype Landtype phase	Project and management area planning and analysis	Hundreds to less than 10 acres

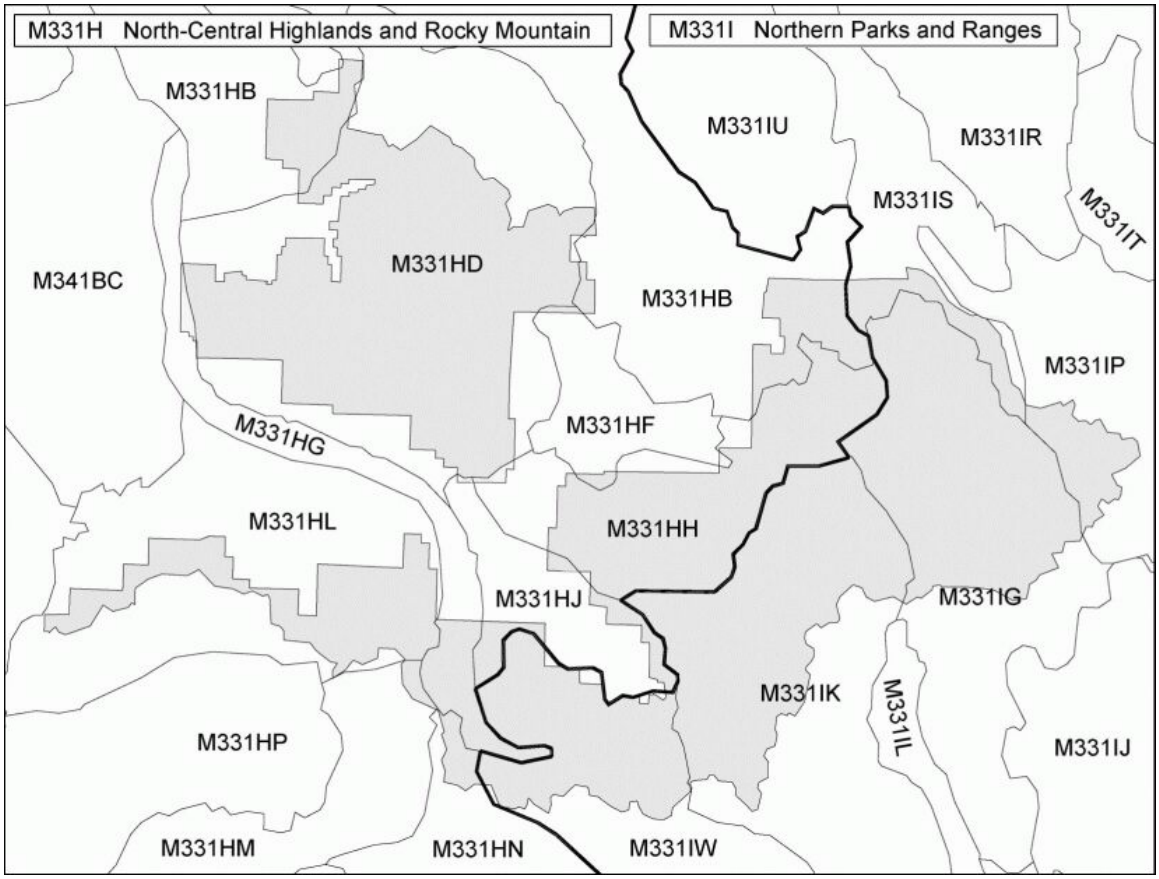
For a particular project, the ecological unit of interest is determined by the purpose of the project.

Figure A-6 illustrates the sections and subsections the White River National Forest occupies. These units define the ecological spatial context for the forest, in which the management situation for the forest is described mainly at the province and section levels.

Domains Domains are sub-continental areas of broad climate similarity. The forest resides within the *Dry Domain*, which is characterized by a relatively dry climate in which annual water losses (through evaporation at the earth's surface) exceed annual water gains from precipitation (Bailey 1998).

Divisions Domains are further partitioned into divisions, which are determined by isolating areas of differing vegetation, broad soil categories, and regional climates. The forest resides within the *temperate steppe division.*

Figure A-6
Location of the White River National Forest in the ecological hierarchy



Provinces Divisions are further subdivided into provinces, which are determined by broad vegetation regions that primarily are controlled by the length and timing of dry seasons and the duration of cold temperatures. Provinces also are 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).

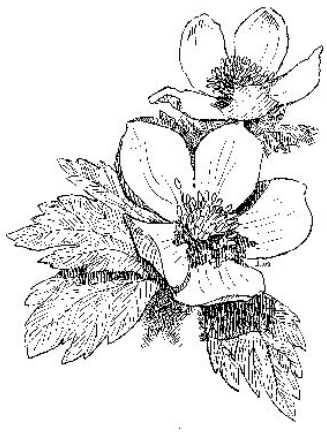


Table A-69 shows the criteria used to differentiate the ecological units.

Table A-69
Principal map unit design criteria of ecological units

Ecological unit	Design criteria[1]
Domain	Broad climatic zones or groups (e.g., dry or humid tropical)
Division	Regional climatic types (Trewartha 1968) Vegetational affinities (e.g., prairie or forest) Soil order
Province	Dominant potential natural vegetation (Kuchler 1964) Highland or mountains with complex vertical climate-vegetation-soil zones
Section	Geomorphic process, surficial geology, lithology Regional climatic data Phases of soil orders, suborders, or great groups Potential natural vegetation Potential natural communities[2]
Subsection	Geomorphic process, surficial geology, lithology Phases of soil orders, suborders, or great groups Sub-regional climatic data Potential natural communities -- formation or series
Landtype association	Geomorphic process, geologic formation, surficial geology and elevation Phases of soil subgroups, families, or series Local climate Potential natural communities – series, sub-series, plant associations
Landtype	Landform and topography (elevation, aspect, slope gradient and position) Rock type, geomorphic process Phases of soil subgroups, families, or series PNC - plant associations
Landtype phase	Phases of soil families or series Landform and slope position Potential natural communities – plant associations or phases

Notes:

[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]Vegetation that would develop if all successional sequences were completed under present site conditions.

THE PROVINCE

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

Cover types

As part of the Resources Planning Act (RPA) 1992 assessment update (Powell et al. 1993), the Forest Service mapped the forested lands of the province. Its forest vegetation cover types and acreages are as shown in **Table A-70.**

Much of the province is non-forested. The major forested cover type is lodgepole pine. Spruce-fir and piñon-juniper also are important cover types in terms of the acreage they cover. Forested cover types comprise roughly 65 percent of the land area.

Table A-70
Province cover types and acreages

Cover type	Acres	% 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
Piñon-juniper	8,115,900	12.3
Hardwoods (predominantly aspen)	5,045,400	7.7
Non-forested	23,316,900	35.4
Water	241,600	0.4
Total	**65,851,200**	**100.0**

Age of forested cover types

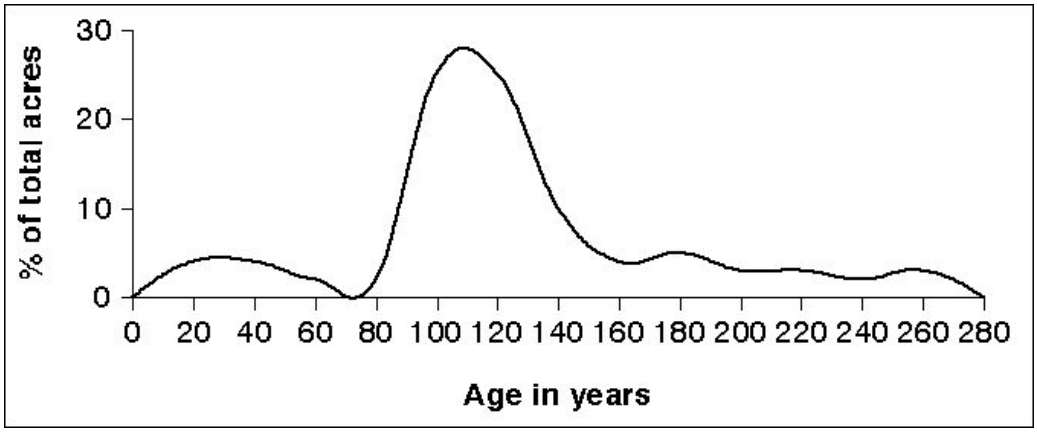
Data is not specifically available for the province, but there is information available for the Region 2 of the Forest Service, which includes Colorado, most of Wyoming and small portions of South Dakota, Nebraska, and Kansas. The Colorado and Wyoming portions of the region, where most of its National Forest System lands occur, roughly correspond to the province (except for a segment of the province located in northern Utah).

According to the biological diversity assessment done for Region 2, the major forested communities are lodgepole pine, ponderosa pine, Douglas fir, spruce/fir, aspen, and piñon-juniper. The majority of these forests are older stands that exceed 100 years of age (USDA Forest Service 1992a). Age classes for each dominant forested cover type are presented as follows:

Lodgepole pine

About 70 percent of the lodgepole pine cover type is between 80 and 180 years old. Beyond the age of 80, stands of lodgepole pine at lower elevations increasingly are at risk for outbreaks of bark beetles. The younger stands that are present are a result of past timber harvests and fires.

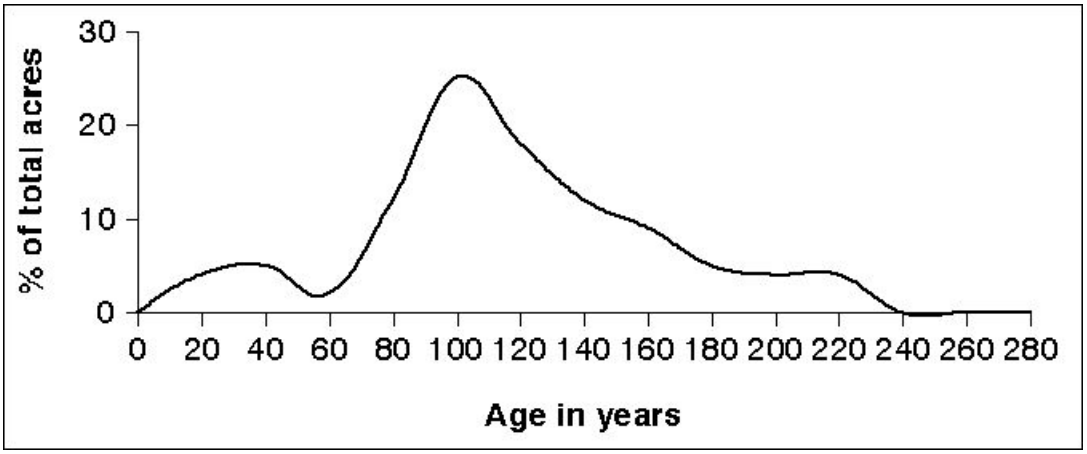
Figure A-7
Age-class distribution of lodgepole pine stands in Region 2



Ponderosa pine

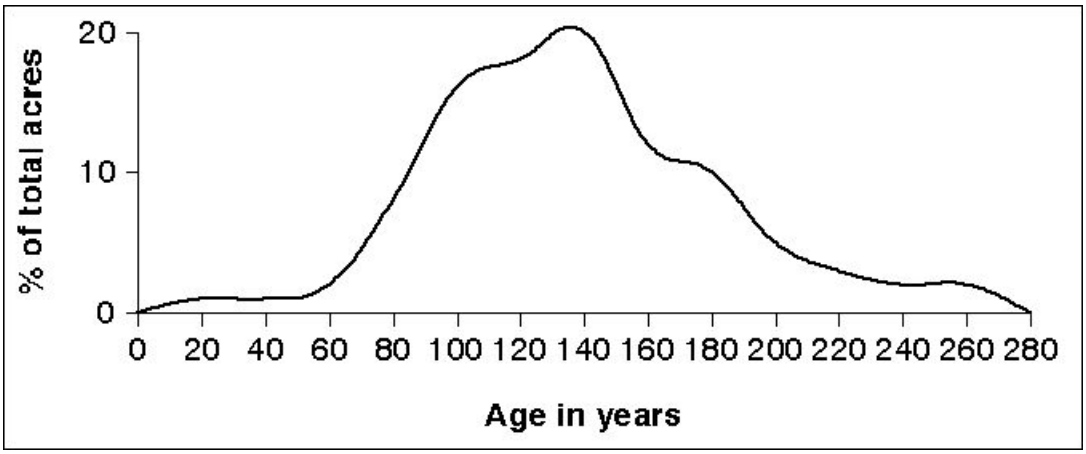
About 70 percent of the ponderosa pine cover type is between 60 and 140 years old. Ponderosa pine can live 600 years and its growth usually does not slow until 150-225 years of age. About 10 percent is considered to be mature or older. Like lodgepole pine, younger stands of ponderosa pine are a result of past timber harvests and fires. Open stands of ponderosa pine provide an understory of vegetation that is used by livestock and wildlife.

Figure A-8
Age-class distribution of ponderosa pine stands in Region 2



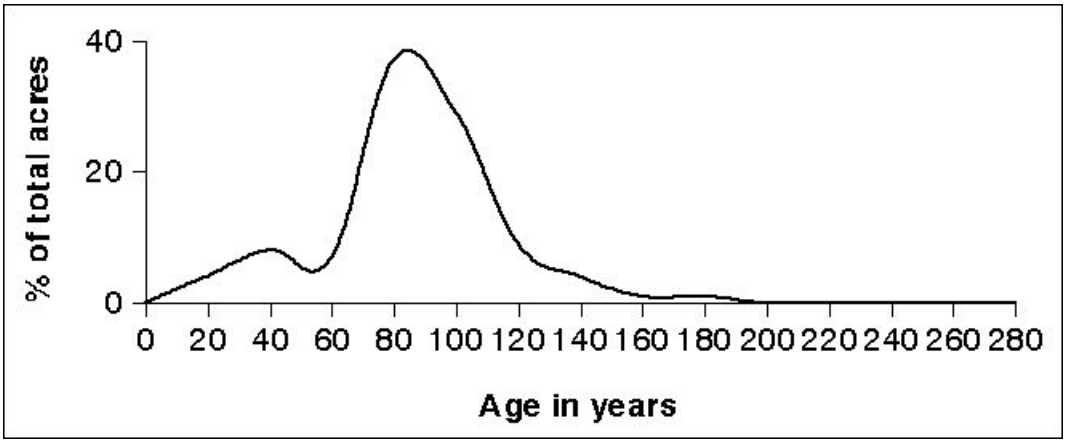
Douglas fir About 75 percent of Douglas fir stands are between 80 and 180 years old. In the northern and central Rockies, this community normally slows in growth at approximately 200 years of age. Only a small percentage is older than 200-220 years.

Figure A-9
Age-class distribution of Douglas fir stands in Region 2



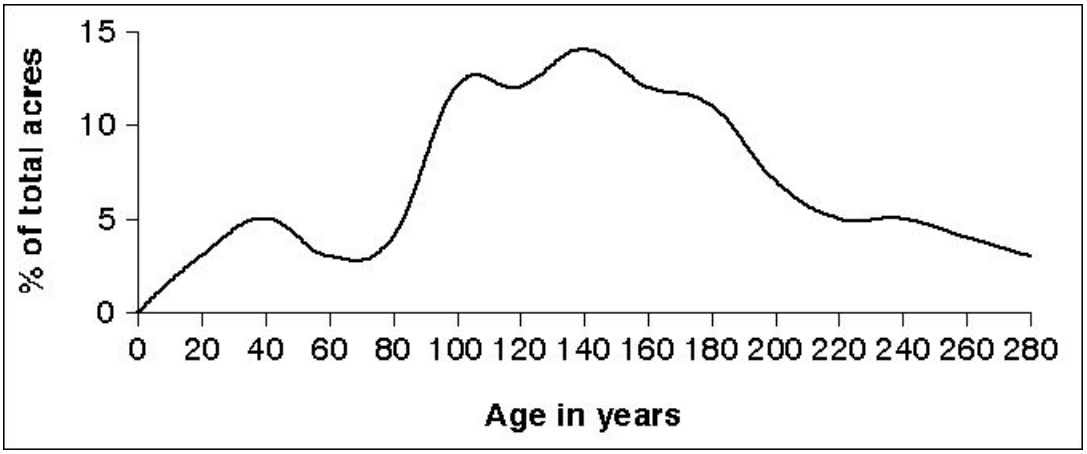
Aspen Aspen typically lives 80 to 90 years before pathogens start bringing about mortality. About 78 percent of aspen stands in Region 2 are between 60 and 120 years old. About 44 percent are older than 80 years. The amount of aspen is expected to decline as disease-causing organisms, insects, diseases, and the invasion of conifer trees affect older stands. The aspen communities produce high yields of shrubs, forbs, and grasses that are available to livestock and wildlife.

Figure A-10
Age-class distribution of aspen stands in Region 2



Spruce-fir Roughly 77 percent of the spruce-fir in Region 2 is between 80 and 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 A-11
Age-class distribution of spruce-fir stands in Region 2



Piñon-juniper There is not much information available to show age classes in piñon-juniper communities.

Insects and disease According to the biological diversity assessment done for Region 2, the risk of insect epidemics in the region as a whole is moderate-to-high because of the large percentage of older trees. Insect epidemics currently are 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 Colorado Front Range. In areas suffering from drought conditions, outbreaks can be expected in the near future because trees are stressed and more susceptible to attack.

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 71.**

Table 71
Acres of forested lands in the province by cover type

Cover type	Acres	% 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**

Not all of these forested lands are available for timber management, or the cutting and thinning of trees for the production of wood fiber. According to Forest Service forest plans, Bureau of Land Management programs, state programs, and activities on private land, approximately 6,133,600 acres are available. This represents 22 percent of the forested lands in the province, or about 9 percent of the entire province.

Not all lands identified as available for timber management are treated in any given year or even in longer periods. In any one decade, an estimated 2 to 5 percent of these lands may be affected by some kind of timber harvest. At the 5 percent level, 200 years would be needed to alter the entire 6.1 million acres available for management. The remaining 78 percent of the province's forested lands would change through natural disturbance processes and succession.

These forest cover types provide habitat for many species of wildlife associated with older forests. Although it cannot be said that this entire habitat is suitable and occupied, a significant amount of habitat potentially is associated with older forests. The likelihood is low that much of this older forest component will be altered by timber harvest. 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. Studies of the historic range of variability for Rocky Mountain ecosystems indicate that older ponderosa pine forests were not widespread or abundant in the Southern Rocky Mountains. In addition, they have been present in relatively open stands, not as 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 Region 2 of the Forest Service, approximately 40 percent of the National Forest System land base supports livestock grazing (USDA Forest Service 1992a). However, this figure includes the national grasslands, which are not within the province proper.

Rare species

Nationwide, the threatened and endangered species list contains 944 species—433 animals and 511 plants (U.S. 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 in which a high number of threatened and endangered species are found relative to the size of the land area. Florida, Southern Appalachia, and the arid southwest stand out for featuring an especially high number of threatened and endangered species. In comparison, the Southern Rocky Mountain province 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. The 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 West. The potential for problems is probably greater than for the

East. 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). Estimated emission increases from 1980 to 2030 for sulfur dioxide and nitrogen oxides in the province are 42 and 142 percent, respectively (NAPAP Interim Assessment 1987).

Ozone is the pollutant of greatest concern in the West, mainly due to personal motor vehicles. Ozone levels reach levels of concern in the Colorado Rockies 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 that 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, sulfur dioxide and carbon monoxide); power plants (increase in nitrogen oxides, sulfur dioxide and particulate matter), mineral developments (increasing dust) and ski-area emissions (increase in particulates and volatile organic compounds).

Ten counties in the province in Colorado are experiencing violations of national air quality standards. These include Archuleta, San Miguel, Fremont, Pitkin, Routt, Boulder, Douglas, Jefferson, El Paso and Larimer counties.

Water

Aquatic resources are best assessed in terms of watersheds. Provinces and sections are composed of portions of many different watersheds that are not connected hydrologically. Rather than consider water by province, section and forest, the evaluation will be done for the Upper Yampa, North Platte and Upper Colorado River basins.

Forty-eight percent of the watersheds are in the Yampa basin, 30 percent in the North Platte, and 22 percent in the Upper Colorado basin. The entire region around the forest has experienced surface and subsurface mining for precious metals and coal. Much of current stream impairment results from earlier mining activities that introduced metals to the streams. The status of the streams given by the state of Colorado is “Water Quality Limited,” which states that designated uses are not measurably impaired due to water quality but that assessments indicate the potential for impairment of designated uses in the near future. The severity rating for all listed streams is low, and fisheries are present in each stream.

THE SECTIONS

The two sections in which the forest resides, *North-Central Highlands and Rocky Mountains* (M331H), and *Northern Parks and Ranges* (M331I), have been grouped together for this analysis.

Location and area

This two-section area includes portions of Colorado and Wyoming and covers 19,347,700 acres. Most of this area is in Colorado.

Cover types

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 A-72**. 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 percent of the oakbrush and 46 percent of the aspen in the province is found within these two sections.

Also significant is the acreage in ponderosa pine within the two-section area. The majority of this acreage occurs on the Front Range of the Rocky Mountains. The Forest has an extremely limited quantity of ponderosa pine, only 1,493 acres.

Table A-72
Cover types, acres, and percent of total for Sections M331H and M331I

Cover type	Acres	% Of the 2 sections	% Of the province in the 2 sections
Douglas fir	482,000	3	13
Ponderosa pine	1,927,100	10	37
Lodgepole pine	2,980,000	15	31
Spruce-fir	2,583,000	13	29
Oak brush (chaparral)	995,800	5	63
Piñon-juniper	1,137,900	6	14
Hardwoods (predominantly aspen)	2,311,700	12	46
Non-forested	6,888,500	36	30
Water	41,700	>1	17
Total	**19,347,700**	**100**	**29**

Source: *GIS (ARC Info), Colorado and Wyoming GAP Analysis Projects landcover layers and National Hierarchy of Ecological Units layer.*

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

Insects and disease

According to the biological diversity assessment done for Region 2 (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 and the area around Vail, Colorado, is currently experiencing a similar outbreak in lodgepole pine.

Timber resource

Of the cover types listed above, Douglas fir, ponderosa pine, lodgepole pine, aspen, and spruce-fir currently have the highest value for wood products. The total of these cover types is shown in **Table A-73**.

Table A-73
Selected cover types, acres, and percent of total for Sections M331H and M33I1I

Cover type	Acres	% Of total
Douglas fir	482,000	5
Ponderosa pine	1,927,100	19
Lodgepole pine	2,980,000	29
Spruce-fir	2,583,000	25
Aspen[1]	2,322,700	23
Total	**10,294,800**	**100**

Note: *[1]Includes minor acreages of other hardwoods, but the majority is aspen.*
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. An estimated 1,300,000 acres are available for timber management in the two-section area. This represents about 13 percent of the forested lands (cover types currently valued for wood products), and 7 percent of the total acres in the two sections.

Table A-74 shows how this acreage estimate was developed. The percentage of each national forest managed for timber estimates were taken from allocation groupings presented in the *1992 Rocky Mountain Regional Guide* and is based on current management allocations. Grassland acres, where included, are used because the allocation groupings in the regional guide included these areas. The percentage of each forest in the two sections is based on visual map estimates.

Of the 1.3 million acres available, an estimated 1 to 5 percent of these lands could be affected by some kind of timber harvest in any one decade. Assuming the 5 percent level, it would take 200 years to alter the entire 1.3 million acres or 13 percent of the forested lands. The other 87 percent would change through natural disturbance processes and succession.

Table A-74
Acres managed for timber in national forests in Sections M331H and M33I1I

National forest	Total acres	% In Sections	Acres in Sections	% Managed for timber	Total acres
Arapaho	1,027,911	100	1,027,911	1.5	15,419
Roosevelt	808,345	100	808,345	1.5	12,125
Grand Mesa	346,543	100	346,543	18.9	65,497
Gunnison	1,665,356	66	1,099,135	18.9	207,737
Medicine Bow	1,095,138	100	1,095,138	40.9	447,555[1]
Pike	1,110,114	100	1,110,114	8.9	98,800
San Isabel	11,117,458	50	558,729	8.9	49,727
Routt	1,125,568	100	1,125,568	19.6	220,611
White River	1,965,899	100	1,965,899	7.1	139,579
Total					**1,257,050**

[1]*From suitable areas in the Medicine Bow National Forest and Thunder Basin National Grassland Land and Resource Management Plan.*

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

Livestock grazing

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

Species-level analysis

The Arapaho-Roosevelt, Medicine Bow-Routt and White River national forests all fall within the two sections. Parts of the Pike-San Isabel and the Grand Mesa-Uncompahgre-Gunnison national forests are included. Federally proposed, threatened, and endangered species and Forest Service Region 2 sensitive species which potentially occur within the two-section area.are listed in Appendix EE of the 2001 Forest Plan,

Because the area being considered overlaps state boundaries, the state of Colorado's rare species have not been included.

Air quality

At the section level, the forest has portions of three airsheds identified in the Forest Service Region 2 air quality assessment. Major pollution sources whose impacts are increasing include power plants (which emit sulfur dioxide and nitrogen oxides) and oil and gas development, which leads to the emission of sulfur dioxide, nitrogen oxides, particulate matter and carbon monoxide.

Currently, Pitkin County is the only county within the two-section area experiencing occasional 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 of good overall quality, some streams on the forest are considered impaired by sedimentation, metals, or other factors. For a list of these streams see Appendix J.