CHAPTER 2. EXISTING VEGETATION

Landscape Scale

Current Vegetative Description

Vegetation communities at the Sub-Regional-scale were created by compiling existing GAP Analysis vegetation community classes from Colorado, New Mexico, Utah, and Arizona at the state level because currently no GAP Analysis exists across state borders in the Southwest; however, a Southwest Regional Gap Analysis is currently being created. We chose to use the Colorado GAP Analysis as our template for the Sub-Regional-scale GAP Analysis because the majority of the Sub-Region, 58 percent, is within Colorado, with only 26 percent in New Mexico, 14 percent in Utah, and one percent in Arizona. Our compiled Sub-Regional-scale GAP Analysis has 20 different categories, from an original 51 categories within Colorado GAP Analysis. Of these 20 categories, 17 vegetation communities have been categorized for the Sub-Regional-scale (Table 1).

Table 1. Generalized vegetation GAP vegetation classes in the subregion. Percentages are relative to the sub-region area.

Class	Name	Acres	SqMiles	Pct	SumPct
Vegetation	pinyon -juniper	7,265,426	11,352	21.3%	21.3%
	desert shrub	5,503,332	8,599	16.1%	37.4%
	spruce - fir	3,485,025	5,445	10.2%	47.6%
	sagebrush	2,965,204	4,633	8.7%	56.3%
	desert grassland	2,694,989	4,211	7.9%	64.2%
	aspen	2,272,984	3,552	6.7%	70.9%
	ponderosa pine	2,064,177	3,225	6.1%	76.9%
	deciduous oak	1,760,036	2,750	5.2%	82.1%
	alpine	1,606,281	2,510	4.7%	86.8%
	mixed conifer	1,209,315	1,890	3.5%	90.4%
	mountain grassland	589,306	921	1.7%	92.1%
	lodgepole pine	462,098	722	1.4%	93.4%
	barren	289,406	452	0.8%	94.3%
	mountain shrubland	222,042	347	0.7%	94.9%
	woody riparian/wetland	118,599	185	0.3%	95.3%
	greasewood	63,033	98	0.2%	95.5%
	herbaceous riparian/wetland	17,141	27	0.1%	95.5%
	SubTotal:	32,588,394	50,919	95.5%	
Non-Vegetation	crops	1,398,025	2,184	4.1%	99.6%
	urban	64,334	101	0.2%	99.8%
	water	63,942	100	0.2%	100.0%
	SubTotal:	1,526,301	2,385	4.5%	
	Total:	34,114,695	53,304	100.0%	

Tables 2 and 3 summarize the distribution of GAP classes in the GMUG and San Juan National Forests, respectively. The upland settings of the Forests are expressed in the dominance of upland categories including spruce-fire, aspen and alpine and the absence of classes such as desert grassland and greasewood.

Table 2. Generalized vegetation GAP vegetation classes in the GMUG. Percent values are relative to the Forest area.

Forest	Class	Name	Acres	SqMiles	Pct	SumPct
GMUG	Vegetation	spruce - fir	943,115	1,474	29.6%	29.6%
		aspen	648,763	1,014	20.4%	49.9%
		alpine	397,266	621	12.5%	62.4%
		sagebrush	274,863	429	8.6%	71.0%
		lodgepole pine	236,601	370	7.4%	78.4%
		deciduous oak	207,282	324	6.5%	84.9%
		ponderosa pine	198,087	310	6.2%	91.2%
		pinyon -juniper	116,641	182	3.7%	94.8%
		mixed conifer	92,296	144	2.9%	97.7%
		barren	13,865	22	0.4%	98.2%
		mountain shrubland	13,566	21	0.4%	98.6%
		woody riparian/wetland	8,911	14	0.3%	98.9%
		mountain grassland	6,956	11	0.2%	99.1%
		desert shrub	331	1	0.0%	99.1%
		SubTotal:	3,158,543	4,981	99.1%	
	Non-Veg	crops	23,608	37	0.7%	99.8%
		water	5,493	9	0.2%	100.0%
		SubTotal:	29,102	45	0.9%	
		Total:	3,187,645	5,026	100.0%	

Table 3. Generalized vegetation GAP vegetation classes in the San Juan National Forest. Percent values are relative to the Forest area.

Forest	Class	Name	Acres	SqMiles	Pct	SumPct
San Juan	Vegetation	spruce - fir	665,361	1,040	31.8%	31.8%
		ponderosa pine	543,573	849	26.0%	57.8%
		aspen	273,778	428	13.1%	70.8%
		alpine	252,406	394	12.1%	82.9%
		mixed conifer	145,760	228	7.0%	89.9%
		deciduous oak	65,747	103	3.1%	93.0%
		pinyon -juniper	54,924	86	2.6%	95.6%
		mountain grassland	32,274	50	1.5%	97.2%
		sagebrush	21,520	34	1.0%	98.2%
		barren	6,788	11	0.3%	98.5%
		mountain shrubland	3,032	5	0.1%	98.7%
		herbaceous riparian/wetland	1,520	2	0.1%	98.7%
		woody riparian/wetland	709	1	0.0%	98.8%
		greasewood	277	0	0.0%	98.8%
		SubTotal:	2,067,669	4,981	98.8%	
	Non-Veg	crops	15,523	24	0.7%	
		urban	72	0	0.0%	
		water	9,939	16	0.5%	
		SubTotal:	25,533	40	1.2%	
		Total:	2,093,203	5,021	100.0%	

It is important to recognize that GAP Analysis uses coarse-scale classification criteria and that each of the 17 vegetation communities that we have identified can be broken down into more detailed vegetation types. For example, the mixed conifer vegetation type can be broken down into warm, dry mixed conifer or the cool, moist mixed conifer forests. In addition, it is important to recognize that while our GAP Analysis map recognizes discrete patches of numerous vegetation types within the Sub-Region, there are in fact transition zones between these patches (ecotones) that play an important role in regional and landscape diversity and heterogeneity of the area.

Historical Range of Variability

Understanding the history of past environments and communities is very useful for managing future ecosystems. Historical ecology can help identify the extent to which current communities have deviated from historical community patterns and processes and identify which communities are in need of ecological restoration or management and susceptible to irreversible shifts to new successional trajectories (Holling and Meffe 1996). One of the primary goals of ecological restoration is to reverse the degradation of ecosystems by restoring their structure and function and natural disturbance regimes to conditions prior to degradation. Ecological restoration is also referred to as the process of renewing and maintaining ecosystem health, a current goal for ecosystem management whose main focus is on long-term ecosystem sustainability and diversity. In order to accomplish these goals, reference conditions (the historical or natural range of variability in ecological structures and processes that reflect evolutionary history, disturbance regimes, and abiotic and biotic conditions) must be determined prior to restoration or management (Fulé et al. 1997; Landres et al. 1999). Reference conditions will be referred throughout the rest of this assessment as HRV (historical range of variability). In identifying HRV, it is also important to recognize a spatial and temporal context. Disturbances may create different successional stages of ecosystems at different spatial scales within the area to be managed and therefore produce a shifting mosaic of patches (White and Walker 1997). HRV is useful for creating a benchmark on which to evaluate current conditions, identifying the restoration potential of a site, and evaluating the success of restoration or management actions (White and Walker 1997). HRV can be determined from historical data from the site (e.g., old field notes, old photographs, etc.); contemporary data from current sites that are similar to the degraded sites; on-site information [e.g., paleoecological analysis (pollen, packrat middens, charcoal), fire scars, soil seed banks, dead and down woody material, soil characteristics, species composition]; traditional indigenous knowledge (e.g., understanding indigenous peoples burning, foraging, planting methods); and historical climatic data (Naveh 1998; Sauer 1998; Swetnam and Betancourt 1998; Swetnam et al. 1999; Gray et al. 2003).

In order for HRV assessment to be applicable and properly incorporated into management, site-specific HRV assessments need to be conducted. This HRV assessment is at the Sub-Regional-scale and therefore only represents generalized trends. Forest-scale HRV assessments will be discussed later in this module. It is important to recognize that at both the Sub-Regional and Forest-scales there are inherent variations in species composition, density, and age and vertical class structures between and within different vegetation communities. Many of these differences are the result of natural disturbances prior to European settlement (~1870) and land management legacies such as timber harvesting, livestock grazing, and fire suppression since European settlement. In addition, underlying any of these management legacies are the local environmental parameters (elevation, slope, aspect, substrate, and topographic position) that influence stand composition, structure, and function. These environmental parameters are the primary drivers that represent HRV. For example, a ponderosa pine stand on a 10-degree south facing slopes historically would have lower tree density and more shrub/grass interspaces than a ponderosa pine stand within a drainage facing north. Therefore management needs to reflect these inherent environmental differences.

A paucity of specific information for the entire Sub-Regional-scale exists and therefore generalizations must be made from site-specific HRV assessments surrounding and within the Sub-Region to the larger analysis area. More detailed studies are needed at the Sub-Regional-scale in order to properly assess how actions at the Forest-scale will influence Sub-Regional-scale patterns and processes within specific vegetation types.

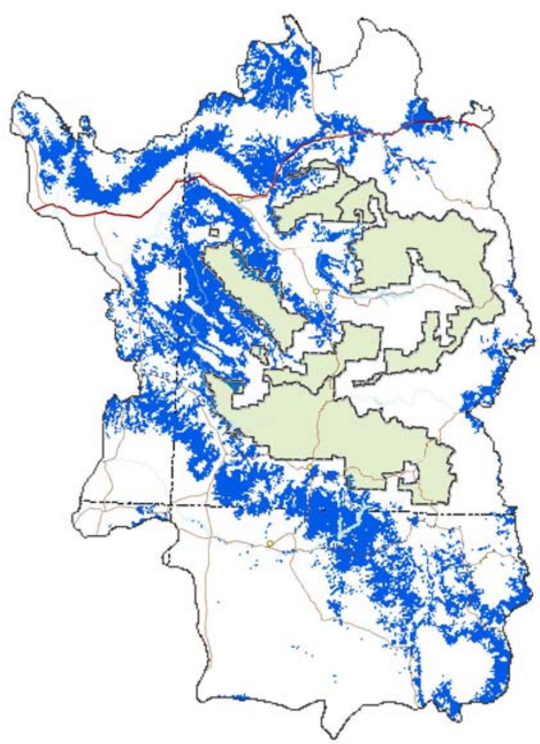
Vegetation / HRV Description

The general vegetation/HRV descriptions will be discussed in order from the most to the least dominant within the Sub-Region. For some of the vegetation types there is a large discrepancy in dominance between the Sub-Region and Forest-scales.

Pinyon-Juniper

The pinyon-juniper vegetation type compromises 7,265,426 acres (21.3 percent) of the Sub-Region and 116,641 acres (3.7 percent) within the GMUG and 54,924 acres (2.6 percent) within the SJ National Forest (Figure 1). This vegetation type is found between ~4500-8500 ft (1372-2591 m). At its lower boundary, this vegetation type grades into the sagebrush, desert shrub, and desert grassland types and at its upper boundary grades into the ponderosa pine vegetation type. Pinyon pine (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*) and Rocky Mountain (*Juniperus scopulorum*) dominate the pinyon-juniper type. *Juniperus* spp. dominates lower elevation/xeric sites and pinyon pine dominates at higher elevation/mesic sites.

Figure 1. The Pinyon-Juniper GAP class in the subregion covers 7,265,426 acres (21.3 **percent**) of the subregion.



Mountain juniper along with sagebrush (*Artemisia tridentata*), mountain mahogany (*Cercocarpus* spp.), bitterbrush (*Purshia tridentata*), and sparse grasses (*Bouteloua gracilis*, *Festuca arizonica*, *Achnatherum hymenoides*) characterize this vegetation type. No specific information is available regarding HRV for this vegetation type. Livestock grazing and fire were likely rare in this vegetation type due to the steep slopes and paucity of herbaceous vegetation that is associated with this vegetation type and therefore these areas are probably inside their HRV.

The majority of pinyon forests at the Sub-Regional-scale have previously been considered outside their HRV. This evaluation has been made from generalizing all pinyon-juniper forests as one vegetation type and not acknowledging the inherent diversity of stand structure and fire regimes for this forest type that dominates millions of hectares in the western United States. In addition, the methodological difficulty in determining HRV for this forest type (e.g., lack of fire scars, slow re-establishment after fire) in comparison to ponderosa pine has led to further discrepancies. A more thorough synthesis of current knowledge (Baker and Shinneman 2004) and site-specific studies at the Sub-Regional scale (Romme et al. 2003a; Eisenhart, 2004; Floyd et al. in press) presents a different viewpoint regarding the HRV of pinyon-juniper forests for the analysis area. These assessments indicate that recent anthropogenic disturbances such as fire suppression, grazing, and recent climatic fluctuations must be put into a longer climatic timeframe to truly understand whether or not pinyon-juniper forests are outside their HRV. For example, the large increase in pinyon recruitment in the western U.S. during the last 20 years may be considered the result of anthropogenic disturbances. However, when this recruitment pulse is put into a larger climatic timescale, it shows that this pulse is the result of high seedling survivorship following the 1950s drought in the western U.S., one of the worst in the past 1000 years, and sustained from warm, wet springs since 1976 (Swetnam et al. 1999). The current drought and subsequent *Ips confusus* outbreaks in the Southwest over the past few years in many places is thinning out dense pinyon stands that are the result of the post 1950s drought recruitment.

Baker and Shinneman (2004) and Romme and others (2003a) have identified three major types of pinyon-juniper stand structures and fire regimes for the western U.S. All three of these major pinyon-juniper types exist at the Sub-Regional-scale; however, more site-specific studies are needed throughout the analysis area and the forest to better understand their spatial distribution and abundance. It is impossible to assess percentages for each of these three pinyon-juniper types on National Forest and BLM land due to a paucity of data. Based on the limited spatial data available, it is hypothesized that the pinyon-juniper grass savanna is present but rare, the pinyon-juniper shrub woodland has low abundance, and the pinyon-juniper forest type is the most abundant on National Forest and BLM land within the analysis area. More research is necessary to support or refute this hypothesis.

The first pinyon-juniper type is referred to as the pinyon-juniper grass savanna. The pinyon-juniper grass savanna's structure is characterized as having sparse trees, few shrubs, and dense grass and herbaceous cover with a frequent, low-severity surface fire that was sustained by significant grass cover (Romme et al. 2003a). Currently there are few areas that depict this stand structure and fire regime because of anthropogenic influences over the past ~120 years have moved this type outside its HRV. One known example within our Sub-Regional-scale is in northern New Mexico where pinyon and juniper trees have become established in previously open grass/woodlands (Allen 1989). As bare ground was exposed from cattle grazing, pinyon and juniper trees were able to get established and increase in numbers because of their ability to be more efficient competitors for water and nutrients than grasses.

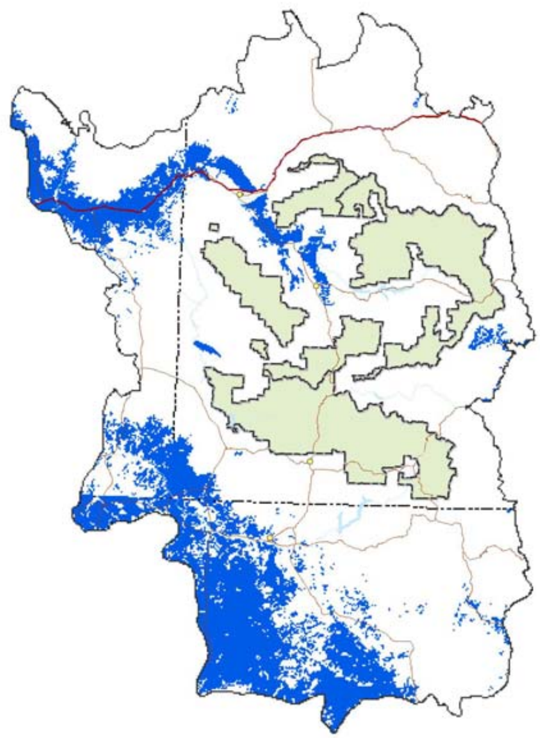
The second pinyon-juniper type is referred to as the pinyon-juniper shrub woodland. The pinyon-juniper shrub woodland's structure is characterized as having sparse to moderately dense herbs, shrubs, and trees all depending on the timing of the last fire and a moderately frequent, and a high-severity crown fire was sustained by shrubs and trees (Romme et al. 2003a). This pinyon-juniper type is most prevalent in the Great Basin region and is widespread on both sides of the Uncompahgre Plateau at lower and middle elevations on deep soils developing from sandstone substrates (Romme et al. 2003f). These areas currently would have higher herb, shrub, and tree densities due to anthropogenic influences and therefore would be outside their HRV.

The third pinyon-juniper type is referred to as the pinyon-juniper forest. The pinyon-juniper forest's structure is characterized as having dense trees, sparse to moderate shrubs, and few herbs with an infrequent, high-severity crown fire (Romme et al. 2003a). Pinyon-juniper stands on Mesa Verde (Floyd et al. in press) and the Uncompahgre Plateau (Eisenhart 2004) are examples of this forest type. These areas are not outside their HRV. Numerous HRV studies for Mesa Verde show that the unprecedented frequency of stand replacing crown fires during the past decade do not necessarily indicate any departure from the natural fire regime which had a fire turnover time of ~400 years. Rather these studies suggest that previous wet years over the past 100 years have permitted increased tree densities and fuel continuity and ensuing fires during recent drought years most likely represents natural conditions at Mesa Verde (Floyd et al. in press). Structural evidence on the Uncompahgre Plateau also supports the theory that climate is the major driver in this forest type influencing cycles of tree establishment and mortality and thus fire and insect disturbances (Eisenhart 2004). In addition, paleoecological evidence shows current pinyon distribution being just a few hundred years old in some areas of Colorado and not in equilibrium with modern climate, therefore making the assessment of whether recent tree expansion is the result of anthropogenic disturbances or long-term climatic fluctuations difficult (Allen et al. 1998).

Desert Shrub

The desert shrub vegetation type compromises 5,503,332 acres (16.13 percent) of the Sub-Region and only 331 acres within the GMUG and 0 acres within the SJ National Forest (Figure 2). There is a significant paucity of research for this vegetation type at the Forest-scale, most likely because of it local rarity. Areas within the National Forests are of higher elevation, which limits the abundance of the desert shrub community. This vegetation type is more predominant farther west in Utah, Nevada, and parts of California. The desert shrub vegetation type is one of two semiarid shrub-steppe communities covering the majority of the low elevation areas within the Sub-Region. The dominant plants in this vegetation type are shadscale (*Atrixplex confertifolia*), fourwing saltbush (*Atriplex canescens*), saltbrush (*Atriplex gardneri*), rubber rabbitbrush (*Chrysothamnus nauseosus*), and horsebrush (*Tetradymia* spp.). All these shrubs are salt tolerant (halophytic) to varying degrees. Desert shrub is generally found on marine shales with poorly drained, saline soils (Floyd-Hanna et al. 1996). In areas with extreme concentrations of salt, these shrubs are generally unable to grow and bare ground is abundant or the greasewood vegetation type replaces them. Successional dynamics are limited due to the strict adaptations needed to survive in this harsh environment. Most plants are members of the Chenopodiaceae with the vegetation compromised of monocultures due to specific plant adaptation needs and the gentle topographic gradients that permit competitive sorting (West 1983). Livestock grazing has had the most impact on this vegetation type since Euro-American settlement, altering the vegetation type towards non-palatable species. In addition, because of the lack of vegetation cover, this is one the few vegetation types in the western U.S. where fires were rare historically (West and Young 2000). Fires in recent years have emerged because of the establishment of non-native annuals, primarily cheatgrass (*Bromus tectorum*). Areas that have experienced grazing, increases in non-native annuals, and increases in fire frequency are outside their HRV. More site-specific studies are needed within the Sub-Region to get a better understanding of the spatial distribution of which desert shrub communities are outside their HRV.

Figure 2. The Desert-Shrub GAP class in the subregion covers 5,503,332 acres (16.1 percent) of the subregion.

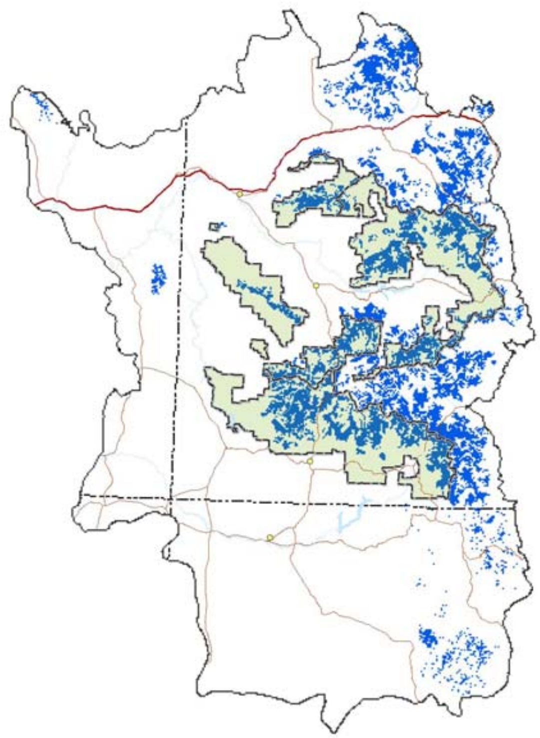


The winterfat shrub steppe is also included within this vegetation type and is found within the Upper Gunnison Basin at higher elevations, 7,500-9,000 ft (2286-2896 m), than the desert shrub community described above (Johnston 1997). The winterfat shrub steppe is compromised of dwarf shrubs, primarily winterfat (*Krasheninnikovia lanata*), and native grasses. Areas affected by historical grazing have experienced a shift in species composition towards grazing increasers (e.g., snakeweed (*Gutierrezia sarothrae),* rabbitbrush (*Chrysothamnus* spp.)) and are outside their HRV.

Spruce-Fir Forests

The spruce-fir vegetation type compromises 3,485,025 acres (10.22 percent) of the Sub-Region and 943,115 acres (29.6 percent within the GMUG and 665,361 acres (31.8 percent) within the SJ National Forest (Figure 3). Spruce/fir forests are the highest elevational forests found within the Sub-Region between ~ 8200-11,000 ft (2500-3,380 m). Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) or corkbark fir (*Abies arizonica*) dominate this vegetation type. Corkbark fir reaches its northern distribution limit in the San Juan Mountains and is replaced by subalpine fir further north. Other species intermixed within the spruce/fir vegetation type include aspen (*Populus tremuloides*), blue spruce (*Picea pungens*), bristlecone pine (*Pinus aristata*), lodgepole pine (*Pinus contorta*), and other higher elevational tree species. A diversity of spruce/fir vegetation types exists at the Forest-scale, which is discussed later in this module.

Figure 3. The Spruce-Fir GAP class in the subregion covers 3,485,025 acres (10.22 percent) of the subregion.



Stand dynamics within spruce/fir are strongly influenced by the autecologies of these two species. Both Engelmann spruce and subalpine fir are easily killed by fire. Subalpine fir is a short-lived species and rarely exceeds a lifespan of 250 years due to heart rot. Spruce has a longer longevity, often living over 500 years. Subalpine fir germinates successfully on fire prepared seedbeds and can exist under low light conditions better than Engelmann spruce. In contrast, Engelmann spruce is not an aggressive pioneer species (Bradley et al. 1992). Successional dynamics are also strongly influenced by site characteristics (elevation, topographic position, aspect, slope, soil type, and soil moisture). For example, spruce is generally more dominant in very wet or dry environments and fir in mesic environments (Peet 2000). A general successional model for this vegetation type includes four main stages. A stand initiation phase of herbaceous, seedling, and sapling establishment until 30-200 years, a stem exclusion phase comprising of dense tree cover until 150-300 years, a understory regeneration stage, which establishes two canopy layers and uneven age structure until 300-450 years, and a shifting mosaic stage that persists until a stand-replacing disturbance (Romme et al. 2003f).

Infrequent (~150-400 years), high intensity stand replacing crown fires coinciding with drought years characterize the fire regime in subalpine forests, although smaller, less intense fires may also occur in periods between larger fires (Veblen 2000; Kulakowski et al. 2003). These stand-replacing fires leave legacies of past disturbance and have large impacts on landscape patch dynamics at higher elevations. Successional development following major disturbances (fire, insect epidemics, blowdowns) can be highly variable depending on elevation, topographic position, aspect, soil substrate, slope, and disturbance interactions (Veblen et al. 1991; Peet 2000).

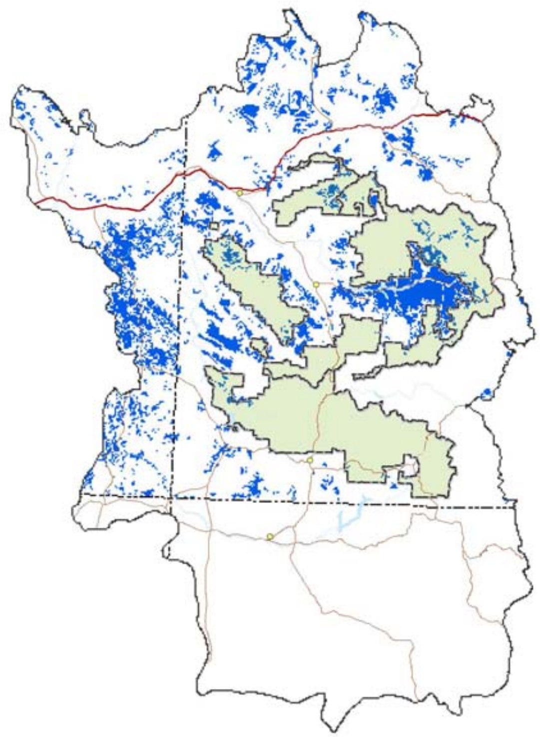
Determining HRV is more difficult in spruce/fir forests than other forest types because fire is generally lethal to trees leaving no fire scars and lags can exist between disturbance events and tree establishment. Therefore, post-fire age and size data combined are normally used to identify past disturbances (Veblen 1986). The majority of research in spruce/fir forests is near the Front Range in Colorado; however, a few studies within the Sub-Region exist (Baker and Veblen 1990; Veblen et al. 1994; Romme et al. 2003e; Kulakowski and Veblen 2004). Research in the San Juan Mountains and Grand Mesa, Colorado have shown that there has been a lack of stand replacing fires in spruce/fir forests since Euro-American settlement and that widespread stand-replacing fires occurred in the region around 1879 (Romme et al. 2003e; Kulakowski and Veblen 2004). However, visual accounts by Sudworth (1900) noted that some fires did occur in 1898 in previously burned over areas of spruce/fir forests on Grand Mesa and that the fires consumed regenerating aspen, downed logs, and patches of previously unburned spruce/fir. The general lack of stand-replacing fires in this region after Euro-American settlement could be interpreted as a result of fire suppression in the 20th century or it could be due to a lack of appropriate extreme weather conditions not occurring for stand-replacing fires to initiate. In addition, the long fire return intervals for this forest type (~150-400 years) suggests that spruce/fir forests are not outside their HRV (Kulakowski and Veblen 2004). Similar findings have been found on the White River Plateau (Veblen et al. 1994). Romme and others (2003e) have suggested however that the lack of fires in lower elevational forests during the 20th century may have prevented fires moving to higher elevational forests and therefore 20th century fire suppression would have had an effect on spruce/fir fire regimes in this region.

While spruce/fir forests may not be outside their HRV for fire frequency and intensity, patch size and patch number have significantly changed to smaller, more numerous patches as a result of roads and logging on a localized scale Romme and others (2003e). Manier and Laven (2002) found this same pattern for the entire western slope of the Rockies in Colorado. However, at the Sub-Regional-scale, changes in patch size and number would be minimal due to the limited amount of harvest in this forest type. In addition, this vegetation type historically consisted of large patches of different successional stages based upon past disturbances creating a mosaic of different spruce/fir structural classes and a heterogeneous landscape. More site-specific studies are needed within the Sub-Regional scale to better understand stand dynamics for this forest type, the spatial distribution of different successional stages across the landscape, and whether any stands are outside their HRV.

Sagebrush

The sagebrush vegetation type compromises 2,965,204 acres (8.7 percent) of the Sub-Region and 274,863 acres (8.6 percent) within the GMUG and 21,520 acres (1.0 percent) within the SJ National Forest (Figure 4). The sagebrush vegetation type is the second semiarid shrub-steppe vegetation type covering the majority of the lower elevation areas within the Sub-Region. In addition, this vegetation type also occupies higher elevation sites above 7,500 ft (2286 m). *Artemisia tridentata* is acclimatized to cold temperatures, which is common for species that live in areas with high temperature seasonality. At increased elevations, canopy cover is denser and regeneration is often found in areas with sufficient snow cover or plant cover, with regeneration in lower elevations tending to occur in interspaces between shrubs (Loik and Redar 2003).

Figure 4. The Sagebrush GAP class in the subregion covers 2,965,204 acres (8.69 percent) of the subregion.



The Great Basin shrub steppe is found in lower elevations of the Sub-Region. This vegetation type is predominant in central and western Utah, northern Arizona, and throughout Nevada. Big sagebrush (*Artemisia tridentata* ssp. *tridentata*) along with grasses such as blue grama (Bouteloua *gracilis*), galleta (*Hilaria jamesii*) and other warm season sod grasses and forbs dominate this vegetation type. This vegetation type is also intermixed at lower elevations with pinyon-juniper and ponderosa pine forests. Great Basin sagebrush is found in low areas with deep, well-drained soils that are sandstone or wind (eolian) derived (Floyd-Hanna et al. 1996). The shrub layer is generally less than 3.28 ft (1 m) tall and moderately spaced with interspaces of cryptogamic crusts. Big sagebrush generally occupies 70 percent of the plant cover regardless of its successional stage and can live to be 100 years of age (West and Young 2000). Big sagebrush does not resprout after being burned and regenerates solely through seeding with greatest survival in wetter than average years (Cawker 1980). Livestock grazing has increased soil erosion and the abundance of non-native annuals, particularly cheatgrass (*Bromus tectorum*). Sagebrush density generally increases with livestock grazing combined with a decrease in fire frequency (Daddy et al. 1988). In areas that burned recently with livestock grazing, non-native species are able to out compete native grasses and sagebrush from reestablishing. In addition, shrub species such as rabbitbrush (*Chrysothamnus* spp.), snakeweed (*Gutierrezia sarothrae*), and horsebrush (*Tetradymia* spp.) increase with grazing and increased fire frequency because of their ability to resprout after fire (Tisdale and Hironaka 1981).

Sagebrush at higher elevations between 7,500-10,000 ft (2286-3048 m) is generally found on flat to rolling hills with well-drained clay soils and is characterized by dense shrubs with a significant herbaceous understory of bunch and sod grasses. This is a predominant vegetation type within the Upper Gunnison Basin, Colorado (Johnston 1997). Mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) is the most abundant species at higher elevations along with silver sage (*Artemisia cana*). Other shrubs species include rabbitbrush (*Chrysothamnus* spp.), bitterbrush (*Purshia tridentata*) and winterfat (*Krasheninnikovia lanata*).

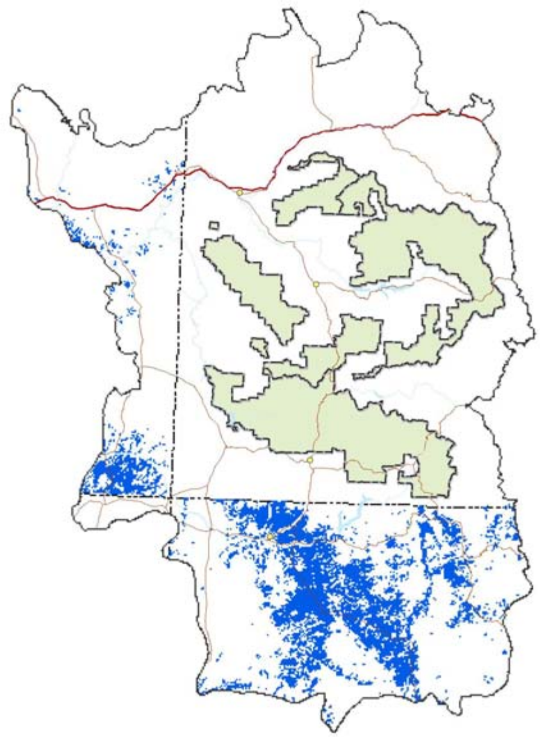
Livestock grazing and increases in fire frequencies have had similar impacts as found in the Great Basin sagebrush type at lower elevations. A study by Wright and others (1979) suggested that pre-settement stand replacing fires occurred every 40-60 years, with smaller fires less often. Welch and Criddle (2003) have questioned fire frequencies of this interval and state that fires most likely were less frequent than often inferred for sagebrush communities based on sagebrush's longevity, highly flammable bark, low growth form, inability to resprout after fires, poor seed bank, and seeds lacking adaptations to high intensity fires (e.g., thick seed coat). Increases in non-native annuals have increased fire frequency, which allows these species to out compete native perennial grasses and sagebrush.

Areas with livestock grazing, increased non-natives and increaser shrub species, and increased fire frequency are outside their HRV. Successional dynamics indicate that these areas have crossed a critical threshold and have moved to an alternative community state or new equilibrium that can not be returned by removing livestock or decreasing fire frequency because of a significant decrease in soil organic matter leading to impoverished soils that are dominated by annual species (West and Young 2000; Norton et al. 2004).

Desert Grassland

The desert grassland vegetation type compromises 2,694,989 acres (7.9 percent) of the Sub-Region and is not present within the GMUG or the SJ National Forest (Figure 5). Areas within the National Forests are of higher elevation, which limits the presence of desert grasslands. This vegetation type is predominant in lower elevational areas of Utah, Arizona, New Mexico, and Texas. The desert grassland community type includes typical semiarid grasslands and the grassland steppe. The grassland steppe community is comprised of different bunch and sod forming grasses and palatable dwarf shrubs found on deep, sandy soils in southeastern Utah (West and Young 2000). Fires were historically rare in the grassland steppe.

Figure 5. The Desert Grassland GAP class in the subregion covers 2,694,989 acres (7.90 percent) of the subregion.



Bunch and sod forming grasses, forbs, small shrubs, and cryptogamic crusts, which help stabilizes soil from rain and wind erosion, dominate semiarid grasslands. Common grasses include three-awn (*Aristida* spp.), grama (*Bouteloua* spp), galleta (*Hillaria* spp.) and other cool and warm season grasses. Changes in precipitation, grazing intensity, and fire suppression are considered the most important factors influencing vegetation changes in semiarid grasslands (Rodriguez Iglesias and Kothmann 1997). Some of the semiarid grasslands within the Sub-Region are experiencing encroachment by shrubs and trees and are outside their HRV. A study by Allen (1989) illustrated encroachment of pinyon and juniper trees into adjacent grasslands in Bandelier National Monument, New Mexico.

Areas that have been affected by historical grazing have experienced a shift in species composition towards grazing increasers and non-native species similar to the desert shrub vegetation type. Many areas that have experienced grazing have been slow to recover and are outside their HRV.

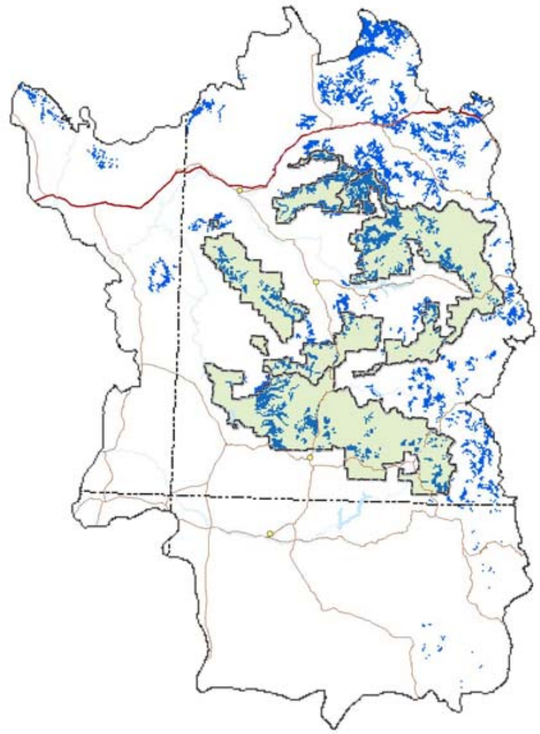
Aspen

The aspen vegetation type compromises 2,272,984 acres (6.66 percent) of the Sub-Region and 648,763 acres (20.4 percent) within the GMUG and 273,778 acres (13.1

percent) within the SJ National Forest (Figure 6). Aspen plays a crucial role in landscape diversity, spatial vegetation patterns, species habitat use and ecosystem processes (e.g., biogeochemical cycling) in an otherwise coniferous dominated landscape (Turner et al. 2003). Aspen is prevalent between ~ 6562-10,827 ft (2000-3300 m) and is generally found in areas with cool dry summers, cold winters, and deep, loamy soils with high nutrient availability within the Sub-Region. Aspen is an early colonizing, long-lived clonal species that depends on periodic disturbances for regeneration. The primary natural disturbance for regeneration is fire, although geomorphic events and wind can also initiate regeneration.

Two major aspen community types are present within the Sub-Region: stable and seral. Multilayered aspen stems (uneven aged) with no conifer invasion characterize stable aspen stands. These stands tend to be located at lower elevations in areas adjacent to ponderosa pine stands where the fire regime is frequent, although stable stands also exist at higher elevations (Romme et al. 2001). Frequent fires prevent conifer seedlings to reaching reproductive age, thereby eliminating a conifer seed source. Even in the absence of fire, these stands have remained stable because of a paucity of conifer seed sources, where at higher elevations seedlings could get established because of the prevalence for infrequent fires (Romme et al. 2003d). Studies in the San Juan Mountains also illustrated that stable stands were weakly associated with shale substrates rather than sandstone or igneous rock (Romme et al. 2003d). Fires within stables stands were most likely frequent surface fires that did not burn into the tree canopy. Fires of moderate intensity produce the highest amount of sprouting that allows stable aspen stands to persist (Parker and Parker 1983). The majority of aspen stands in the western U.S. is considered seral and is characterized by conifer invasion and lack multilayered (even aged) aspen stems (Mueggler 1985). Seral stands are prevalent at higher elevations where spruce and fir become established normally decades after a significant disturbance event. In order for aspen to successfully regenerate, fire need to be of moderate to high intensity (Bartos et al. 1994). Seral aspen stands also exist lower in elevation in ponderosa pine and mixed conifer stands where white fir and Douglas-fir replace aspen.

Figure 6. The Aspen GAP class in the subregion covers 2,272,984 acres (6.66 percent) of the subregion.



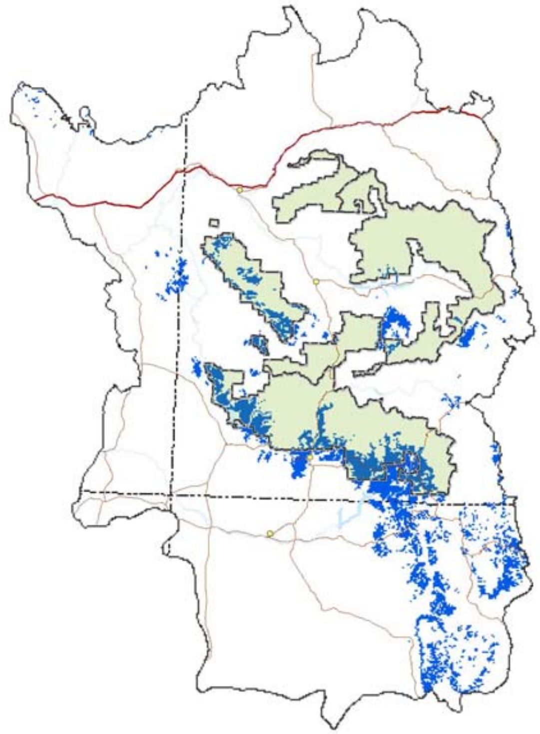
Numerous observations suggest that aspen abundance is experiencing widespread decline due to fire suppression and natural succession within the Sub-Region and therefore outside its HRV (Kay 1997; Bartos and Campbell 1998). Recent quantitative studies however illustrate a different perspective on the current status of aspen in the West (Manier and Laven 2002; Rogers 2002; Romme et al. 2003d; Elliott and Baker 2004; Kulakowski et al., in press). When assessing aspen decline, it is necessary to recognize that stable and seral aspen exist. Determining HRV is more difficult in aspen stands than other forest types because aspen trees do not create fire scars and fire is lethal to aspen. As a result, post-fire age cohorts must be used to identify fire regimes. Studies in the San Juan Mountains, Colorado indicate that some seral stands burned approximately every 70 years while other stands did not burn for over a century or longer (Romme et al. 2001). When assessing if seral aspen stands are outside of their HRV, it is important that stand age is taken into consideration. Numerous fires at the Sub-Regional-scale occurred between the late 1800s and early 1900s due to drought events during this timeframe. These fires allowed for numerous seral aspen stands to get reestablished in one localized period of time. Many of the stems in these stands currently are regarded as old (decadent) aspen, thus reaching their maximum longevity and natural succession to conifer trees is occurring. If one were to take a snapshot view of this current situation, it would appear that aspen are in fact declining due to fire suppression and other anthropogenic influences. Another interpretation of this situation, that incorporates a longer temporal scale, suggests that the lack of fire in the 20th century resembles fire activity in the late 1700s to early 1800s in the Southwest and therefore high densities of old aspen stands are most likely not outside their HRV; however, more detailed studies are needed to confirm or reject this hypothesis (Romme et al. 2003d; Kulakowski, in press).

Some studies indicate that on some level aspen loss is occurring within the Sub-Region either at the landscape scale (Rogers 2002), changes within stand age dynamics (fewer younger stand) in reference to pre-settlement stands (Romme et al. 2003d) or within seral stands of mixed conifer where conifer density and basal area has increased substantially between 1980-2001 on the Uncompahgre Plateau (Smith and Smith 2004). Other studies in the Sub-Region conclude that aspen is in fact not declining but rather increasing in spatial extent and abundance at the landscape scale. A study by Manier and Laven (2002) on the western slope of the Rockies in Colorado showed an increase in aspen over the past 100 years, along with an increase in conifer density, and a decrease in meadows, thus resulting in an overall decrease in patch diversity at the landscape scale and trends towards larger, contiguous forest patches and fewer group patches. Another study in the San Juans illustrated that aspen was increasing both in abundance and into new habitats (treeline and meadows), indicating a decrease in landscape patch diversity (Elliott and Baker 2004). Kulakowski and Veblen (2004) also determined that stable aspen stands on Grand Mesa were in fact increasing and that seral stands, where conifer encroachment was occurring, were returning within their HRV on the Mesa. In the San Juan Mountains stable stands, even without disturbances, exhibited continued recruitment with an uneven aged, multilayered canopy and were determined to be within their HRV (Romme et al. 2003d); a similar pattern was found on the Uncompahgre Plateau in stable stands (Smith and Smith 2004). While general trends indicate that stable and the majority of seral aspen stands at the Sub-Regional-scale are within their HRV, more site-specific studies are needed regarding HRV for aspen.

Ponderosa Pine

The ponderosa pine vegetation type compromises 2,064,177 acres (6.05 percent) of the Sub-Region and 198,087 acres (6.2 percent) within the GMUG and 543,573 acres (26.0 percent) within the SJ National Forest (Figure 7). Pure ponderosa pine stands are found predominantly between 6,000-9,000 ft (1829-2743 m) on sandstone substrates. Ponderosa pine is the dominant tree species with occasional Rocky Mountain juniper at lower elevations and Douglas-fir at higher elevations. The understory in southwestern Colorado is dominated by shrubs with grasses intermixed. Gambel oak (*Quercus gambelii*) is the dominant shrub species along with snowberry (*Symphoricarpos rotundifolius*), Oregon grape (*Mahonia repens*), buckbrush (Ceanothus *fendleri*), gooseberry (*Ribes* spp.), and serviceberry (*Amelanchier utahens*is).

Figure 7. The Ponderosa Pine GAP class in the subregion covers 2,064,177 acres (6.05 percent) of the subregion.



Identifying the HRV for ponderosa pine in the Southwest is much easier than for other forest types because of the ability for ponderosa pine trees to create fire scars, slow decomposition rates of dead and down woody material, and because of a massive tree irruption in 1919, which has lead to unprecedented dense stands in congruence with anthropogenic disturbances (Fulé et al. 1997). Fire statistics in this region since the 1600s show a clear pattern of an increasing number, size, and intensity of fires outside of the HRV for this forest type in the Southwest (Swetnam and Betancourt 1998). Many of the HRV studies for this region come from northern Arizona, although HRV studies also exist at the Sub-Regional-scale (Swetnam and Baisan 1996; Touchan et al. 1996; Brown and Shepperd 2003; Romme et al. 2003b). While a generalized HRV assessment is practical at the Sub-Regional-scale, it is important to recognize that other ponderosa pine HRV assessments in Colorado have shown that some ponderosa pine stands historically had stand-replacing mixed and high-severity fire regimes (Brown et al. 1999; Kaufmann et al. 2000), which likely occurred within our analysis area as well.

Quantitative reconstruction of pre-settlement (1870-1890) southwestern ponderosa pine forests indicates open, park-like stands. Covington and others (1997) determined that pre-settlement ponderosa pine stands consisted of approximately 60 stems/ha at the Gus Pearson Natural Area, Arizona. Romme and others (2003b) also found that ponderosa pine forests contained an average of 11 to 98 trees/ha during the late 1800s in the San Juan Mountains, Colorado. Similarly, several early National Forest inventories showed a range of 7 to 116 stems/ha in pre-settlement southwestern ponderosa pine forests in northern Arizona (Covington and Moore 1994). Pre-settlement southwestern ponderosa pine forests were regulated by a vital ecological attribute--fire. Low intensity surface fires carried by grass and shrubs recurred every 5-20 years in southwestern ponderosa pine ecosystems prior to Euro-American settlement and played a major role in regulating the structure, composition, and stability of these ecosystems (Swetnam and Baisan 1996, Fulé et al. 1997). Specifically, in the San Juan Mountains fire intervals are between 10-20 years (Romme et al. 2003b) and on the Uncompahgre Plateau between 10-25 years (Brown and Shepperd 2003). These frequent, low-intensity fires, along with shrub and grass competition, prevented dense ponderosa pine regeneration and maintained the open, park-like structure of pre-settlement ponderosa pine stands.

Three main anthropogenic influences are responsible for the dramatic alterations in the structure and function of ponderosa pine forest ecosystems: grazing, logging, and fire exclusion (Covington et al. 1997). In addition, climatic oscillations may have also altered ponderosa pine forest ecosystems over the past century (Covington and Moore 1994). Decadal-scale climatic variability is a primary driver for ecological processes. Shifts in climate towards warm, wet periods have been suggested as the causal mechanism for the pulse of pine recruitment in the early 1800s that corresponded to the longest intervals between fires in numerous areas in the Southwest, pine recruitment in 1919, and recruitment since 1976 due to anomalous warming of the tropical Pacific (Swetnam and Betancourt 1998). The latest recruitment since 1976 followed the worst drought in the Southwest over the past 1000 years during the 1950s. The increased stand density in ponderosa pine over the past ~120 years without a long-term climatic perspective may suggest that anthropogenic changes were the only underlying factor for this change in structure (Swetnam et al. 1999). In addition, shifts in climate can also be associated with changes in fire regimes. In the Southwest, a decrease in fire frequency between 1780-1830 coincided with a decrease in the El Nino-Southern Oscillation (ENSO) (Swetnam and Betancourt 1998). Interannual variability in moisture availability instead of drought alone plays a significant role in the occurrence of large fire years in the Southwest. Generally, large fires years in ponderosa pine are associated with one-two above-average winter and spring precipitation years followed by a drought year because the wet years permit enough fine fuels to accumulate and subsequently dry out (Swetnam and Baisan 1996).

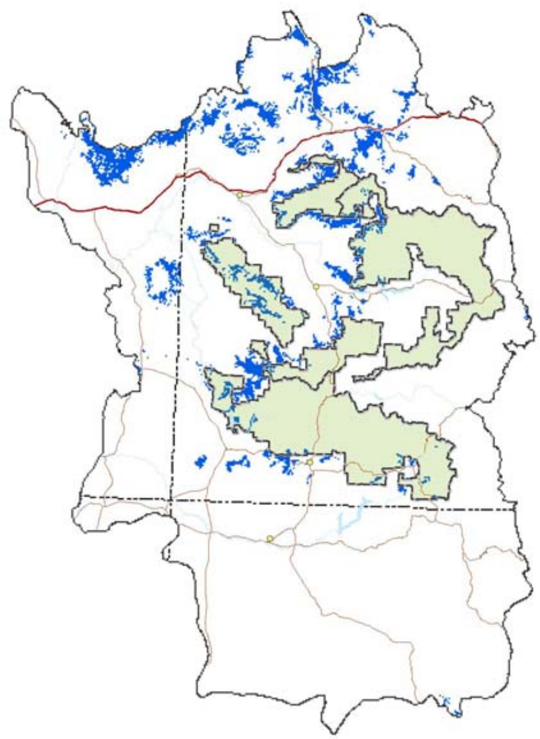
Anthropogenic effects associated with Euro-American settlement have resulted in numerous young, small trees; fewer old, large trees; increased forest fuel loads; lower herbaceous production and diversity; altered fire regimes; and changed wildlife habitats in southwestern ponderosa pine forests (Covington and Moore 1994; Covington et al. 1997; Fulé et al. 1997). As a consequence of both anthropogenic influences and climatic oscillations there has been an overall change in forest structure and function altering soil moisture availability, decomposition rates, tree health (e.g., carbon, water, nutrient, growth, and insect resistance), nutrient cycling, microbial populations, net primary production and susceptibility to invasive exotics (Covington and Sackett 1984; Wright 1996; Covington et al. 1997; Feeney et al. 1998; Crawford 2001). All of these factors indicate that a large portion of ponderosa pine stands within the Sub-Region-scale are outside of their HRV.

Ponderosa pine forests at the Sub-Regional-scale were not homogenous open park-stands prior to Euro-American settlement, but rather it appears that some dense stands of small ponderosa pine trees similar to the stands that dominate the landscape today existed. Therefore when identifying management and restoration goals for ponderosa pine, site-specific HRV assessments are necessary to maintain HRV on both a stand and landscape scale within the analysis area.

Deciduous Oak

The deciduous oak vegetation type compromises 1,760,036 acres (5.2 percent) of the Sub-Region and 207,282 acres (6.5 percent) within the GMUG and 65,747 acres (3.1 percent) within the SJ National Forest (Figure 8). This vegetation type is often considered part of the Mountain

Figure 8. The Deciduous Oak GAP class in the subregion covers 1,760,036 acres (5.16 percent) of the subregion.



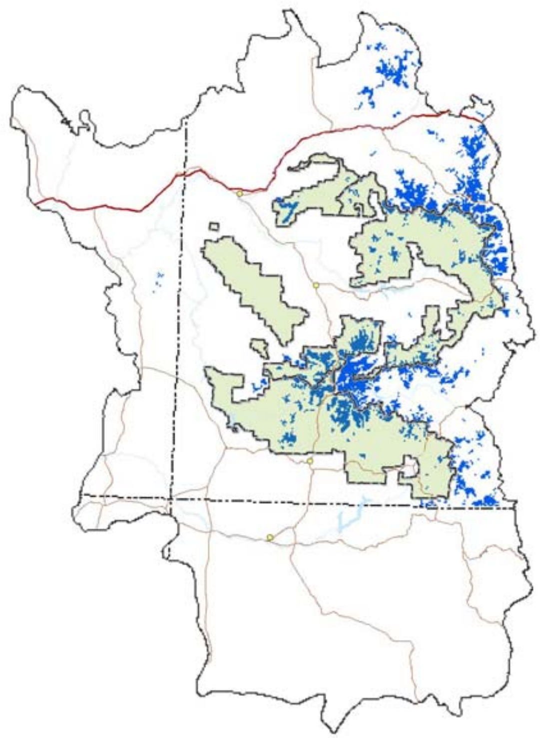
Shrubland vegetation type but can be distinguished by the predominance of Gambel oak (*Quercus gambelii*) along with other shrubs such as serviceberry (*Amelanchier utahens*is) and snowberry (*Symphoricarpos rotundifolius*), grasses, and forbs. This vegetation type is prominent along the southern and western slopes of the San Juan Mountains and on the Uncompahgre Plateau. Deciduous oak can be found between 6,000-9,000 ft (1829-2743 m) and grows either as dense shrubby patches or trees. Gambel oak grows on a diversity of soil types from fine to heavy textured loams, deep alluvial sand, and coarse gravel (Christensen 1955). Gambel oak often forms large underground systems of lignotubers and rhizomes that are capable of resprouting rapidly and vigorously after fire. Often these clones are much older than the age of the aboveground stems. The ability of these underground systems to remain viable for long periods of time without disturbances has yet to be determined (Tiedemann et al. 1987). Serviceberry, the dominant shrub associated with the deciduous oak type also resprouts vigorously after fire. Fire plays a major role in the maintenance of this vegetation type as evident by the dominant shrub adaptations to fire. One study within the Sub-Region, in Mesa Verde National Park, has estimated a fire turnover time of approximately 100 years and that these fires are generally of high intensity removing the majority of aboveground biomass (Floyd et al. 2003). This vegetation type has been hypothesized to represent a recovery stage from fire and that without fire, trees such as pinyon pine and Utah juniper at lower elevations and ponderosa pine, Douglas-fir and white fir at higher elevations would replace this vegetation type (Floyd-Hanna et al. 1996). Historically this vegetation type would be in different stages of recovery depending on the timing, frequency, and intensity of the disturbance and its relation to climatic fluctuations (Romme et al. 2003f). Increasing fire frequency within this vegetation type would lead to an increase in shrub density. The variability, proportion, and distribution of these different successional stages historically are unknown and therefore assessing whether this vegetation type is outside its HRV for the Sub-Region is difficult to assess.

Alpine

The alpine vegetation type compromises 1,606,281 acres (4.7 percent) of the Sub-Region and 397,266 acres (12.5 percent) within the GMUG and 252,406 acres (12.1 percent) within the SJ National Forest. The alpine vegetation type is distinct from other vegetation types because it occupies the upper elevational limits of forests ~11,500 ft (3505 m) on high mountain summits, slopes, and ridges (Billings 2000). Climatic variables such as intense cold, wind, solar radiation, and snow dictate the types of vegetation that can exist. Dwarf shrubs, prostate herbaceous forbs, bunchgrasses, lichens, and mosses characterize the alpine vegetation type. Topography (aspect, slope, position) plays a strong role on the diversity of alpine vegetation types because of its influence on solar radiation, solifluction, and snow/water accumulation (Jamieson et al. 1996). A difference in snow accumulation is the most influential factor influencing alpine vegetation types. Topography creates a mosaic of different depths of snow accumulation, which influences growing season lengths and moisture abundance (Walker el al. 1993). Some general alpine vegetation types from little to high snow accumulation include fellfields (windswept areas), dry meadows (low snow), moist meadows (base of snowfields), dwarf shrublands (depressions), and wet meadows (flat snowmelt drainages) (Bowman et al. 2002).

The majority of alpine areas within the Sub-Region are either designated as wilderness or roadless and therefore significantly less disturbed than other vegetation types. However, alpine environments are highly susceptible to soil disturbance (compaction, erosion) and are slow to revegetate due a limited growing season, strong winds, drought, and high evaporation rates. Livestock grazing, mining, and recreation activities result in soil disturbance that subsequently alters species composition, abundance, biomass, nutrient cycling, and water availability (Redders 2003). Atmospheric depositions of pollutants also are a major disturbance to alpine environments. Elevated nitrogen deposition is present in the southern San Juan Mountains downwind of large coal-fired power plants. Nitrogen deposition results in changes to vegetation structure and function by favoring nitrogen responsive species (grasses) over non-nitrogen responsive species (Bowman et al. 1993). Identifying HRV assessments for the alpine vegetation is difficult because of a paucity of historical information. Areas of known soil disturbance and thus vegetation changes from livestock grazing, recreation, and mining are outside their HRV. More site-specific studies are needed to assess changes to the alpine from atmospheric deposition and climate change.

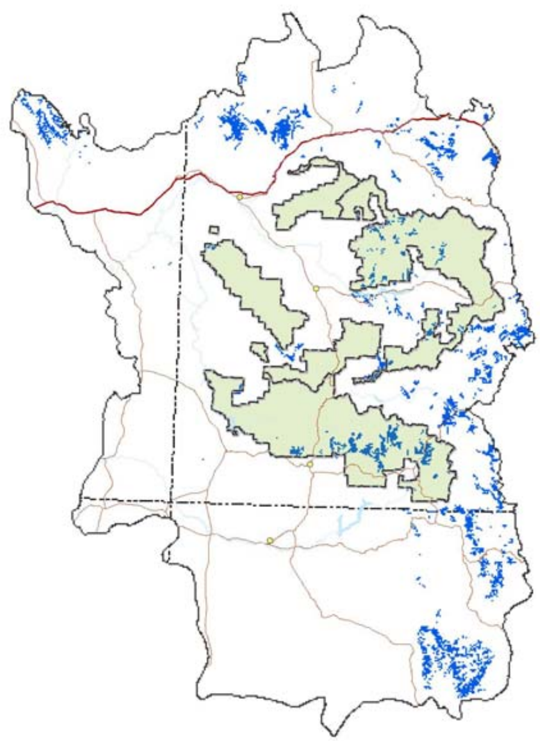
Figure 9. The Alpine GAP class in the subregion covers 1,606,281 acres (4.71 percent) of the subregion.



Mixed Conifer

The mixed conifer vegetation type compromises 1,209,315 acres (3.54 percent) of the Sub-Region and 92,296 acres (2.9 percent) within the GMUG and 145,760 acres (7.0 percent) within the SJ National Forest (Figure 10). Mixed conifer forests are one of the most variable and complex forest types in the western United States. Numerous research studies have been conducted in mixed conifer forests of the Sierra Nevada and Cascade Ranges; however, there is a paucity of analogous information for southwestern mixed conifer forests (White and Vankat 1993; Wu 1999; Romme et al. 2003; Mast and Wolf 2004), which represent approximately one million ha of forested land in the Southwest (Dieterich 1983). Southwestern mixed conifer forests are found between the lower elevational ponderosa pine and the higher elevational spruce/fir forest type. In southwest Colorado and northwest New Mexico, two broad mixed conifer forest types have been recognized: the warm, dry mixed conifer and the cool, wet mixed conifer types. Being a continuum along an elevational gradient, the warm, dry mixed conifer tends to be more similar in community structure and function with the ponderosa pine forest type and the cool, wet mixed conifer more similar with the subalpine forest type (Romme et al. 2003c).

Figure 10. The Mixed Conifer GAP class in the subregion covers 1,209,315 acres (3.54 percent) of the subregion.



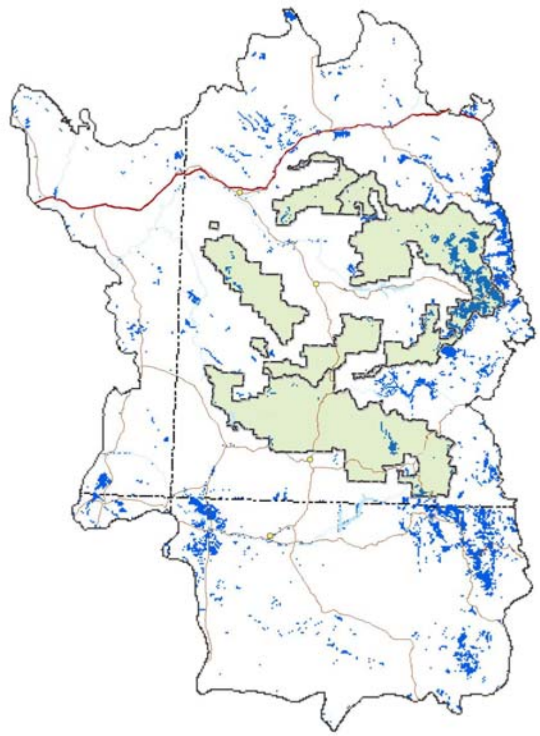
The warm-dry mixed conifer type is found between ~7500-9000 ft (2286-2743 m) and is dominated by ponderosa pine, Douglas-fir, white fir, and occasionally aspen. The abundance of individual tree species is dependent on local site characteristics (soil, aspect, slope, topographic position) and natural and anthropogenic disturbance history. Gambel oak, serviceberry, buckbrush, snowberry, mountain lover (*Paxistima myrsinites*), kinnikinnik (*Arctostaphylus uva*-ursi), grasses, and forbs dominate the understory. Different successional trajectories are present within the warm-dry mixed conifer type. For example, some warm-dry mixed conifer stands have originated from the deciduous oak vegetation type following a stand-replacing fire, while other stands formed following a moderate intensity burn, and many current stands are the result of natural succession and fire suppression and other anthropogenic disturbances combined (Redders 2004). General patterns of change since pre-settlement are well documented in stand structure within the warm, dry mixed conifer forest type in the western U.S. (White and Vankat 1993; Mast and Wolf 2004). Specifically, there has been a shift in species composition and abundance to shade tolerant species such as white fir (*Abies concolor*) and Douglas-fir (*Pseudotsuga menziesii*) at the expense of the shade intolerant but more fire resistant ponderosa pine and increased vertical and horizontal fuel continuity. This shift in stand structure has been attributed to an alteration in the natural fire regime (non-lethal fires at 20-50 yr intervals and rare lethal fires greater than 100 yr intervals) (Wu 1999; Romme et al. 2003c).

The cool, wet mixed conifer type is found between ~8,500-10,000 ft (2591-3048 m) and is dominated by Douglas-fir and white fir along with Engelmann spruce and subalpine fir with the occasional presence of aspen and blue spruce. The abundance of individual tree species is dependent on local site characteristics (soil, aspect, slope, topographic position) and natural and anthropogenic disturbance history. Serviceberry, snowberry, elderberry (*Sambucus microbotrys*) bush honeysuckle (*Distegia involucrata*), grasses, and shade loving forbs (Pyroloceae) dominate the understory. Similar patterns of change found within warm-dry mixed conifer are not found within the cool, wet mixed conifer forest type. Infrequent (greater than 100 year intervals) moderate to high severity stand-replacing burns characterize the fire regime of these forests (Romme et al. 2003c). There is a significant lack of research in this forest type regarding HRV and extant stand dynamics; therefore, only broad generalizations can be made at the Sub-Regional-scale.

Changes in forest structure and processes in warm-dry mixed conifer forests indicate they are outside their HRV. In contrast, it appears that the majority of cool, wet mixed conifer forests are within their HRV, although more site-specific research is needed to confirm this statement.

Ten of seventeen GAP classes cover just over 90 percent percent of the subregion. These classes are listed and shown in Figures 1 through 10 above. The remaining seven classes, combined cover about five percent of the subregion. Combined the seventeen vegetation classes cover about 95 percent of the subregion. These are described in the following sections and are combined in Figure 11.

Figure 11. Seven GAP vegetation classes in the subregion combined cover 1,761,625 acres (5.16 percent) of the subregion. These seven combined with the ten classes described above cover just over 95 percent of the subregion.



Mountain Grassland

The mountain grassland vegetation type compromises 589,306 acres (1.7 percent) of the Sub-Region and 6,956 acres within the GMUG and 32,274 acres within the SJ National Forest. Mountain grasslands are found interspersed between forested vegetation types between ~ 7000-10,500 ft (2286-3200 m). A variety of factors including topography, geology, soil, climate, and disturbances (fire, mass movement, and snow) are responsible for the presence of meadows in between forested vegetation (Debinski et al. 2000). Soil texture has been identified to be one of the most critical factors explaining the presence of meadows at lower elevation areas, generally being found on fine-textured alluvial or colluvial soils where adjacent forested areas are found on coarse-texture, rocky soils (Peet 2000). At higher elevations, soil moisture appears to influence the presence of meadows. Areas with excessive moisture near streams, slope bottoms, or on substrates that keep water at the surface are generally dominated by grasses, sedges, and forbs (Peet 2000). Three dominant mountain grassland types have been identified for Southwest Colorado and Northwest New Mexico: the Arizona fescue (*Festuca arizonica*) type that is associated with ponderosa pine and warm-dry mixed conifer; the Thurber fescue (*Festuca thurberi*) type that is associated with cool-moist mixed conifer and spruce fir; and, the Kentucky bluegrass (*Poa pratensis*) type that occurs at all elevations (Redders 2003b). Other native grass species associated with the Arizona fescue type include mountain muhley (*Muhlenbergia montana*), Parry oatgrass (*Danthonia parryi*), junegrass (*Koeleria macrantha*), bottlebrush squirreltail (*Elymus elymoides*), and muttongrass (*Poa* *fendleriana*). Other native grass species associated with the Thurber fescue type include junegrass, Arizona fescue, needle and thread (*Heterostipa comata*), blue wild rye (*Elymus glaucus*) and timber oatgrass (*Danthonia intermedia*).

Meadow/forest ecotones are areas that show rapid ecological change and therefore can serve as indicators of environmental changes through shifts in species composition and abundance (Harte and Shaw 1995). For example, tree encroachment of mountain meadows in surrounding areas of the Sub-Region has been well documented in juniper ecotones (Johnsen 1962), ponderosa pine ecotones (White 1985; Mast et al. 1997), aspen (Buell and Buell 1959) and the subalpine (Dunwiddle 1977). These encroachments are generally associated with changes in natural disturbance regimes, primarily fire (Turner 1975). Fire frequency intervals would be similar to adjacent forest type intervals with more frequent fires at mid elevation ponderosa pine and warm-dry mixed conifer forests and less frequent fires with cool-moist mixed conifer and spruce/fir forests. There is little evidence for fires occurring in meadows independent of fires in adjacent forested areas (Romme et al. 2003f). Livestock grazing since Euro-American settlement has also changed native species composition and abundance, altered natural disturbance processes (fire) and nutrient cycling, increased erosion, and increased non-native invasive species (Redders 2003b). Areas within the Sub-Region that have experienced changes to fire regimes, livestock grazing, introduction of non-native species, and tree invasions are outside their HRV. A paucity of historical quantitative data for mountain grasslands however makes it difficult to assess specific changes to community structure and function.

Lodgepole Pine

The lodgepole vegetation type compromises 462,098 acres (1.35 percent) of the Sub-Region and 236,601 acres (7.4 percent) within the GMUG and 0 acres within the SJ National Forest. Lodgepole pine generally occurs between 8,000-10,000 ft (2438-3048 m) and reaches it southern boundary of its range at the middle of the Gunnison Basin (Johnston 1997). Lodgepole pine south of this area within the Sub-Region were planted in the early 20th century following severe fires in the late 1800s due to a concern with the lack of natural tree regeneration (Romme 2003). Lodgepole pine has a lifespan of ~250 years, which is related to the frequency of stand-replacing fires that occur within this vegetation type (Mehl 1992). The understory of lodgepole pine is usually poorly developed with low species diversity due to a dense tree canopy cover and low soil fertility.

Lodgepole pine plays a similar successional role as aspen in higher elevational forests, but is found more predominantly in the northern latitudes and aspen is more dominant in southern latitudes (Allen et al. 1991). In environments where lodgepole pine is seral, shade tolerant species (Douglas-fir and subalpine fir) are able to replace lodgepole because of its intolerance to shade and lack of disturbances, generally fire, and inability to successfully get established without its mineral seedbed requirements (Bradley et al. 1992). A general successional model for lodgepole pine to Douglas-fir and spruce/fir stands includes the following stages. Following a stand-replacing fire, an initial herbaceous and shrub layer establishes. This stage is then followed by a dense stand of even-aged seedlings and saplings with serotinous stands regenerating faster than open-coned stands. Regeneration does not necessarily occur all at one time and is influenced by the distance to the nearest seed source, amount of competing herbaceous understory, soil texture, and availability of resources resulting in the initial cohort occurring over a period of 30-50 years (Peet 2000). Following this stand initiation stage, without a disturbance, a dense stand forms and density is decreased through competition mortality or low-moderate intensity disturbances (insects or fire), which opens up the stands allowing shade tolerant (Douglas-fir and subalpine fir) trees to invade openings. If no fire occurs, a stable Douglas-fir or spruce/fir stand eventually exists until a stand-replacing fire returns the stand to a herbaceous/shrub state (Bradley et al. 1992). Elevation is the primary factor determining whether lodgepole pine is seral to Douglas-fir or spruce/fir stands with Douglas-fir at lower elevations [<9500 ft (2896 m)] and spruce/fir at higher elevations. Topographic variables (aspect, slope, and topographic position) also influence successional pathways.

Lodgepole pine can also form stable stands similar to aspen, which evolved with stand replacing crown fires to promote seed establishment from serotinous cones, although open cones also exist. Stable lodgepole stands have been associated with thin, well-developed soils, cold microclimate, and in areas where shade tolerant species do not exist (Mehl 1992).

There is a paucity of site-specific research regarding lodgepole pine primarily because of its limited natural distribution and abundance at the Sub-Regional-scale. The majority of naturally occurring lodgepole regenerated during the late 1800s-early 1900s, similar to many aspen stands to the south, from drought initiated fire events. It appears that these stands are near the high end of their HRV for total landscape coverage in the White River N.F. and are dominated by older age classes (USDA 2002).

Mountain Shrubland

The mountain shrubland vegetation type compromises 222,042 acres (0.65 percent) of the Sub-Region and 13,566 acres within the GMUG and 3,032 acres within the SJ National Forest. This vegetation type is prominent along the southern and western slopes of the San Juan Mountains and on the Uncompahgre Plateau, which is similar to deciduous oak. This vegetation type is distinguished from deciduous oak by being dominated by a diversity of shrubs. Some of the dominant shrubs include mountain mahogany, bitterbrush, gooseberry (*Ribes cereum*), skunkbrush (*Rhus trilobata*), snowberry, Gambel oak and serviceberry. Shrubs that are unique to the mountain shrubland community include fendlerbush (*Fendlera rupicola*) and squaw-apple (*Peraphyllum ramossissimum*).

Fire is the major disturbance for this vegetation type and may be of frequent, low intensity or infrequent, high intensity but specifics on fire return intervals are unknown (Romme et al. 2003g). In addition, mountain shrub communities are commonly found on northern slopes where snow can accumulate and slide during warmer periods resulting in periodic disturbances that allow only flexible plant species to survive and therefore favoring shrubs over trees (Floyd-Hanna et al. 1996). The mountain shrub community has been hypothesized to represent a recovery stage from disturbance and that without frequent disturbances trees such as pinyon pine, Utah juniper, and ponderosa pine would replace this vegetation type (Floyd-Hanna et al. 1996). Historically this vegetation type, similar to deciduous oak, would be in different stages of recovery depending on the timing, frequency, and intensity of the disturbance and its relation to climatic fluctuations. The variability, proportion, and distribution of these different successional stages historically are unknown and therefore assessing whether this vegetation type is outside its HRV within the Sub-Region is difficult to assess.

Woody Riparian / Wetlands

The woody riparian/wetland vegetation type compromises 118,599 acres (0.35 percent) of the Sub-Region and 8,911 acres within the GMUG and 709 acres within the SJ National Forest. Riparian woodlands and wetlands are defined as the transition between the aquatic environment and the upland terrestrial environment where the water table is generally at or near the surface or the land is covered with water (Cowardin et al. 1979). This vegetation type occurs at all elevations throughout the Sub-Region as diverse vegetation types. Riparian woodlands and wetlands in the arid southwest are recognized as one of the most limited and vulnerable plant communities while at the same time the most biologically diverse. In the past century in Arizona and New Mexico alone, over 90 percent of riparian woodlands and wetlands have been lost (Johnson 1989). Riparian vegetation provides stream bank stabilization, water quality protection, fish and wildlife habitat, and flood control.

Four broad categories of wetlands have been identified within the Sub-Region: peatlands, marshes, wet meadows, and riparian. Peatlands are areas that accumulate decayed plant material, and the only peatland type within our Sub-Region is a fen. Fens are located generally above 8,000 ft (2438 m) in areas where groundwater intercepts the soil surface in low points of the landscape and inflow is maintained year round. These areas are rare within the Sub-Region and are confined to a few small areas on the Grand Mesa. Marshes are located adjacent to bodies of water that don't flow, such as lakes or ponds, or near slow-flowing bodies of water. Bullrushes, sedges, and cattails characterize this vegetation type. Wet meadows are the most abundant wetland type within Colorado and are grassland areas that are waterlogged year-round without standing water for the majority of the year. These wetlands are found at higher elevations within the Sub-Region. Riparian areas are the most easily recognized wetland type and are associated with moving water that is occasionally flooded. Riparian areas are found in desert to alpine vegetation types and are associated with cottonwood (*Populus* spp.) at low to middle elevations, grading into aspen, boxelder (*Acer negundo*), alder (*Alnus incana*), willows (*Salix* spp.) and a variety of conifer species (*Pinus* spp. *Picea* spp. and *Abies* spp.) at mid to high elevations.

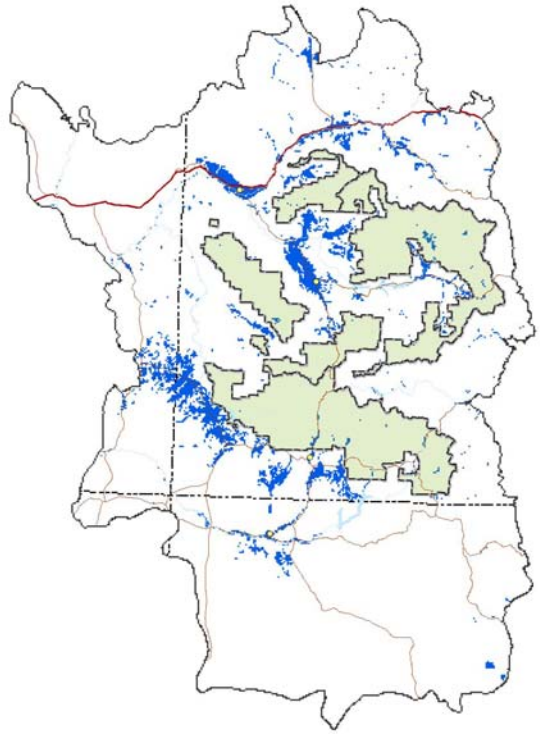
Riparian woodlands and wetlands have experienced dramatic changes since Euro-American settlement due to livestock grazing, mining, logging, road building, water diversions, and beaver extirpation. These changes include changes to native species composition and abundance and introduction of non-native invasives such as tamarisk (*Tamarisk ramosissima*) and Russian olive (*Elaeagnus angustifolia*) that have altered community function. Specific quantitative information for how these communities have changed however is poorly documented; therefore, identifying the HRV for these types is difficult (Redders, 2003a). Within the Sub-Region there are dozens of specific riparian woodland and wetland plant associations, which is beyond the scope of this discussion (see the Forest-Scale Riparian Woodland/Wetland section for descriptive riparian woodland/wetland vegetation types). In addition, Redders (2003a) provides an in-depth discussion of these community types for the San Juan and Johnston (1997) for the GMUG.

Greasewood

The greasewood vegetation type compromises 63,033 acres (0.18 percent) of the Sub-Region and is not present within the GMUG or SJ National Forest. This vegetation type is highly restricted in its distribution by hydrology, soil salinity, and soil texture. The dominant plant is black greasewood (*Sarcobatus vermiculatus)* and can be found in association with occasional salt tolerant grasses. Black greasewood is a phreatophyte that generally dominates as a monoculture over large stretches of valleys where salts and water accumulate every year (West and Young 2000). Livestock grazing in greasewood has decreased grass cover and increased shrub cover. Fires historically burned within greasewood communities but fire intervals, along with general HRV conditions, are poorly known (Romme et al. 2003f). Areas that have recently burned generally have higher grass cover than unburned areas and greasewood resprouts through belowground surviving structures. More studies are needed at the Sub-Region level to establish HRV for this vegetation type.

The seventeen vegetation classes described above cover about 95 percent percent of the subregion. The remaining five percent of the subregion are comprised of crops, urban areas and water bodies Figure 12.

Figure 12. Three GAP non-vegetation classes in the subregion combined cover 1,526,301 acres (4.47 percent) of the subregion.



General HRV Models

Community structure is the result of multiple interactions among species, environmental variability, perturbations and chance events (Samuels and Drake 1997). Spatial and temporal scales are crucial to understanding the dynamic nature of communities and whether communities converge towards a single state or multiple states. Two well-known generalized models can be used to assess how communities respond to perturbations over time and are suitable for HRV assessment of numerous vegetation types: the single stable state model and the alternative community state model (Figure 1).

The concept of alternative community states originated from the work of Lewontin (1969) who was investigating the concept of stability. Lewontin (1969) explained community structure through two opposing ways. His first explanation focused on the importance of history in explaining patterns of species, populations and communities, which is associated with multiple stable points. His second explanation emphasized the importance of fixed forces without any reference to historical events in explaining patterns of species, populations and communities (single stable point) (Lewontin 1969). A community is considered to have one unique stable point if it returns to its original state from all initial conditions following any disturbances, "like a marble seeking the bottom of a cup" (May 1977). In contrast, a community is considered to have alternative community states if a system's trajectory is influenced by the initial conditions. In this scenario, a system may return to its original state following a small perturbation or it may change to a new state following a large perturbation "like the ball in a pin-ball machine"

(May 1977). At advanced stages of deterioration, removing anthropogenic stressors is usually inadequate to stop or slow down continuing degradation and therefore early detection of changes in ecosystem structure and function are necessary (de Soyza et al. 2000). For example, the recovery of native perennial grasses in regions of the Great Basin desert that have been invaded and dominated by cheatgrass (Bromus tectorum) appears unlikely even without the presence of domestic grazing (Knapp 1996).

A system's history matters under the concept of alternative community states and is unimportant under the concept of a single community state. History is important because it is needed to interpret observed differences in the structure of communities in the same locality. The disturbance history of an area will often interact with competitive interactions among species, and the intensity and timing of the disturbance will affect community dynamics (Hughes 1989; Berlow 1997). In addition to the knowledge of historical perturbations, knowledge of a system's historical and current species pool (the number of species potentially able to exist in a particular community) is important in explaining variation in communities (Partel and Zobel 1998). Law and Morton (1993) suggested that the ability for a system to have alternative states was more likely with a large species pool and therefore suggested that species-rich systems with strong interactions were more likely to have alternative states than species poor systems. In addition, the order of species arrival plays an important role in the community structure of alternative states (Drake 1991). As stated by Dudgeon and Petraitis (2001), "in many ecosystems, the distributions and abundances of organisms carry the signatures of historical events", and the history of species' relationships that no longer exist may be the invisible keys to understanding extant community structure (Samuel and Drake 1997).

Understanding if a system has alternative community states is important for land managers trying to reverse degraded systems because of the potential implications this knowledge can have on determining if systems are within their HRV and if they are not how the systems can be restored to be within their HRV. If all communities converged to a single stable point, returning systems within their HRV would be much easier because all degradation in systems would be along a linear gradient to the inevitable solution with time being the only preventative factor (Samuels and Drake 1997). In contrast, if all systems were represented by divergence, the communities would be idiosyncratic and structured by chance making the return of systems to their HRV impossible and entirely due to chance (Samuels and Drake 1997). A crucial component to understanding the ability for multiple stable points in a community is the critical threshold at which change occurs in a system. Wissel (1984) warns that dramatic changes at thresholds in systems with alternative states may be irreversible if caused by man. He cites examples of increased eutrophication in lakes and introduction of noxious weeds as changes that may be irreversible (Wissel 1984). As a result, being able to predict critical thresholds for irreversible events is crucial to preventing permanent changes (Knowlton 1992). A critical threshold has two characteristics: 1) it is a boundary in space and time between two or more states; and 2) the shift across the boundary is not reversible within a reasonable timeframe without intervention by humans (Friedel 1991).

Understanding whether major vegetation types at our Sub-Regional-scale respond to the single stable state model or the alternative community state model is important in the context of understanding HRV assessments and how HRV can be incorporated into management decisions. For example, the importance of understanding these two opposing models can be illustrated in ponderosa pine forests. The effects of anthropogenic impacts such as fire suppression have resulted in numerous young, small trees; increased forest fuel loads; and lower herbaceous production and diversity (Covington et al. 1997). Many studies that have reintegrating fire into ponderosa pine ecosystems have not been able to return the system to a single stable community that consists of trees intermixed with shrubs and herbaceous plants. Instead, other mechanisms such as tree removal through thinning have been necessary along with reintegrating fire, which suggests that ponderosa pine systems fall under the alternative community state model.

Ecosystem Function

Understanding ecosystem function of terrestrial vegetation is important for managing global nutrient cycling. Terrestrial carbon sequestration is a major concern for land managers because of its ability to offset anthropogenic carbon emissions and climate change, which have direct and indirect effects on carbon fluxes from ecological and physiological processes (Cao and Woodward 1998; Breshears and Allen 2002). The majority of research on carbon sequestration and net primary production (NPP) is conducted at a global or large regional scale. As a result, only broad generalizations can be made at the Sub-Regional-scale regarding ecosystem function and its relation to variations in climate and disturbance regimes.

Anthropogenic disturbances to terrestrial ecosystems impact global terrestrial function, including carbon balances and net biological productivity (Law et al. 2003). When carbon sequestration is being estimated at any scale, it is crucial that not only anthropogenic (e.g., land-use change, fire suppression) induced losses and gains be taken into consideration but also large-scale climate driven losses, such as forest fires, drought induced tree mortality, and soil erosion (Bachelet et al. 2001; Breshears and Allen 2002). These large-scale climate driven carbon losses are especially important at our Sub-Regional-scale because of the current drought we are experiencing in the Southwest that is resulting in significant changes to forest stand dynamics (e.g., pinyon dieback in pinyon-juniper forests due to drought stress and *Ips confusus* infestations, increased wildfire frequency and intensity in ponderosa pine and mixed-conifer forests) in both species composition, age, and size distributions. When anthropogenic and climate-driven changes to vegetation communities are compiled, large losses may occur in both plant and soil carbon pools that could result in a net carbon loss rather than a gain, triggering a positive feedback that could intensify global warming (Houghton et al. 1999).

Forested vegetation can provide a major carbon sink, depending on its size, age, and density (Birdsey et al. 1993). Young and middle aged forests are thought to be better carbon sinks than old forests because of active growth and higher densities in these stands leading to an overall increase in NPP and decreased nutrient availability and increased stomatal limitation as stands age, which decreases overall NPP (Cao and Woodward 1998). A study in ponderosa pine forests in Oregon illustrated that young (56-89 years) and mature (95-105 years) stands had higher NPP and NBP than old stands (109-316) and that the majority of stands were in the mature stage and thus reaching maximum carbon storage and uptake (Law et al. 2003). Numerous stands within the Sub-Region, especially within ponderosa pine forests, have increased in density and are middle aged (mature) as a result of anthropogenic changes (fire suppression and old-growth logging) and a good seed year in 1919, which has resulted in an increase in carbon sequestration for this forest type. Nationally, fire suppression has led to an increased rate of C sequestration in U.S. ecosystems by increasing storage in woody biomass, soils, litter, and coarse woody debris and a decrease in the rate of CO^2 release through burning Sohngren and Haynes 1997). A study in Minnesota oak savanna showed that C stores average ~ 272 Mg/acre (110 Mg/ha) with pre-settlement fire frequencies and ~220 mg/ha in stands with fire suppression (Tilman et al. 2000). If comparable alterations to C storage have occurred in western forested communities, than current C storage values within our Sub-Region are outside their HRV due to anthropogenic disturbances. Large-scale crown fires over the past decade in this forest type within our Sub-Region however have negated carbon sequestration benefits and are now a source of carbon loss. Fire regimes outside their HRV can also result in severe soil erosion, and thus a significant carbon loss, as evident in the Cerro Grande fire in 2000 in the Jemez Mountains, New Mexico and the 2002 Missionary Ridge fire in the San Juan Mountains, Colorado. In terrestrial ecosystems, the amount of carbon stored in soil (plant, animal and microbial residues in all stages of decomposition) is usually greater than the amount in living vegetation (Post and Kwon 2000). A complete forest demographics inventory is necessary in order to estimate carbon sinks caused by forest growth at the Sub-Regional-scale, which is beyond the focus of this assessment (Birdsey et al. 1993).

Finally, climate change may exasperate anthropogenic influences on ecosystem function. Warming events since the mid 1970s in the U.S. and increased precipitation until the past decade decreased net biological productivity (NBP) due to increased plant and soil respiration from warmer temperatures (Bachelet et al. 2001). In contrast, future climate change models indicate that Leaf Area Index (LAI), which is related to NPP, will increase dramatically in the Southwest particularly in desert environments due to increased precipitation and only moderate temperature increases. In addition, fires increase in the West because of increased fuel loads and precipitation couple with several wet-dry (El Nino/La Nina) cycles (Bachelet et al. 2001). Understand historical biogeographical shifts in species composition and abundance in relation to climate change may be extremely useful to predict future changes in both community structure and function.

Possible management recommendations to mitigate anthropogenic and climatically induced carbon losses include preventive thinning and prescribed burning in forest types outside their HRV and improved soil conservation techniques (Breshears and Allen 2002). Thinning in forest types not outside their HRV and the conversion of old-growth forests to younger stands to mitigate C inputs is not recommended. Research in the Pacific Northwest illustrated that harvesting old-growth forests and converting them to younger stands actually increase C inputs to the atmosphere and these authors hypothesized similar patterns in other systems where the age of harvest is less than the age required to reach the old-growth stage (Harmon et al. 1990). More research is needed regarding individual species' function for even the most common forest species in the western U.S. While large-scale changes to communities have immense impacts on global and regional terrestrial function, understanding finer scale seasonal and annual variation of ecosystem function in relation to climate variation is also important (Law et al. 2001; Monson et al. 2002; Huxman et al. 2003).

Dominant forces affecting vegetative patterns at the Sub-Regional Scale

Natural influences

The Sub-Region is compromised of two dominant geographic features: the Colorado Plateau and the southern Rocky Mountains, which represents a diverse range of climatic environments influenced primarily by physiographic features including elevation and topography. For a more in-depth description of these two features see Module II: Biogeography Significance. Within these larger geographic features are heterogeneous landscapes that are influenced by both living (biotic) and physical (abiotic) factors that determine individual species ranges and thus biotic communities. One factor rarely limits the distribution of a species; rather it is more often an aggregate effect of many interacting factors that sets species distribution limits. Some biotic factors that influence species distribution patterns include species dispersal mechanisms and species interactions (mutualism, competition, parasitism).

Abiotic factors are often the primary drivers that influence species distribution patterns on the landscape. Species are found generally in environments where limiting factors (topography, geology, soil, climate) are conducive to their survival. The two main limiting physical factors within our Sub-Region are temperature and moisture, which are influenced by elevation and topography. Generally, precipitation is the limiting factor at lower elevations and temperature is the limiting factor at higher elevations. In the San Juan Mountains, Colorado the threshold between these two limiting factors is between 7,600-8,200 ft (2316-2500 m) (Spencer and Romme 1996). This threshold would be similar for other mountainous areas within the Sub-Region.

Elevation is the single most important gradient influencing vegetation patterns within the Sub-Region because of its direct influence on climate (temperature, relative humidity, solar radiation, precipitation, and wind) (Peet, 2000). Unique vegetation assemblages along this elevational gradient are the result of the interaction between elevation and topography (aspect and slope). Northern aspects with higher moisture availability allow vegetation communities typically found higher in elevation to establish at lower elevations and southern aspects with lower moisture availability allow vegetation communities to be located at higher elevations than normally situated. Slope position also alters general elevational patterns with ridges having higher solar radiation and lower soil moisture than valley bottoms that have higher soil moisture, lower solar radiation, and cold air drainage. Geological parent substrate and soils also interact with elevation. In the San Juan Mountains, adjacent areas with similar elevation and topography can have different vegetation communities based on soil types due to the amount of moisture availability to plants. For instance, shale derived soils have lower moisture availability than sandstone derived soils die to soil texture and depth (Spencer and Romme 1996). At higher elevations in the San Juan Mountains, differences in parent material (e.g., granite vs. limestone) have strong impacts on vegetation types due to influences on soil parameters, particularly soil pH. Numerous endemic species and unique species assemblages are found on limestone-derived soils in higher elevations of the Sub-Region.

Disturbance

Overlaying and interacting with biotic and abiotic factors that determine individual species ranges, and thus biotic communities, are natural disturbances. These disturbances play a fundamental role in the diverse patch mosaic of vegetation communities across the landscape. Within and between each vegetation type, patches of different structural characteristics are the result natural disturbance processes such as fire, insect outbreaks, wind, and avalanches. It is important to recognize that disturbances interact in complex ways and that when assessing vegetation communities all types of disturbances, both natural and anthropogenic, need to be incorporated. In addition, it is important to recognize synergism among disturbances (that the combined effects are greater than the sum of independently occurring events) and the timing or sequence of disturbances, which can have immense long-term impacts on vegetation communities. Examples include fires occurring in drought years in mixed conifer forests and ungulate browsing following fire in aspen. A few of the major natural disturbances that influence landscape heterogeneity are discussed below. See Module V: Landscape Disturbances for a more in-depth discussion.

Forested communities in the western U.S. are considered fire dependent because of their close relationship with fire. Looking at evolutionary adaptations of individual tree species can provide clues to the types of fires that they evolved with. For example, evidence of ponderosa pine evolution to frequent, low intensity surface fires is seen in selected survival adaptations: thick bark, self pruning lower branches (crown height), highly flammable needles (litter), and long needles to protect buds. There are three main types of fire regimes that occur within our Sub-Region: understory fire regime, mixed fire regime, and stand replacement fire regime (Arno and Allison-Bunnell 2002). The understory fire regime burns every 1-30 years and generally has thick barked, fire-resistant trees growing at medium or wide spacing and open understories. An example forest type in the Sub-Region would be ponderosa pine. The mixed fire regime has fires that alternate between light underburns and stand replacement. They are of intermediate intensity, killing most of the fire-susceptible trees while fire-resistant trees survive. An example forest type in the Sub-Region would be mixed conifer. Finally, infrequent fires at long intervals between 100-400 years characterize the stand replacement fire regime. Each fire kills the majority of trees, which allows for the development of a new forest. Burning is often not uniform and can occur in large, irregular patches (Arno and Allison-Bunnell 2002). An example forest type in our Sub-Region would be Spruce-fir.

Within these three fire regimes, fire behavior can vary greatly based on fuels, topography, and climate. The type, size, quantity, arrangement, and moisture content of fuels are critical to how fires burn. For example, ponderosa pine forests historically were dominated by fine fuels (needles and dry grasses) along with shrubs within our Sub-Region. Ponderosa pine trees produce on average one ton/acre of dry pine needles every fall providing appropriate conditions for understory surface fires. In contrast, higher elevational forests generally lack fine fuels and are dominated by rotten and sound coarse woody debris. These larger fuels dry out more slowly than fine fuels and therefore have a large impact on fire behavior. In prolonged drought conditions, these large fuels become quite dry enabling stand replacing fires to occur. In addition, topography and its interaction with climate have a strong influence on the fire environment. Elevation, slope position, aspect, slope steepness, and natural and artificial barriers all influence fire behavior. Elevation affects the length of the growing season, type of vegetation, and weather patterns. Slope position affects temperature and relative humidity. Aspect influences solar radiation, soil moisture content, and wind patterns. Slope steepness has a direct effect on flame length and rate of spread of a surface fire, and finally barriers can influence the extent of fire spread. When assessing the role of fire on landscape patch dynamics and identifying HRV it is crucial that variability within a given fire regime for a specific forest type is recognized and that site specific fuel, topographic, and climatic differences are used to differentiate fire regime variability.

Insect outbreaks have a large influence on landscape heterogeneity. A current example within our Sub-Region is the large outbreak of pinyon bark beetle (*Ips confusus)* killing pinyon pine. This outbreak is currently coupled with drought, and therefore is having a larger impact on the landscape patch mosaic of our Sub-Region than if the outbreak were not accompanied by drought. Other insects that have a significant impact on forest stands over large geographic areas within our Sub-Region include mountain pine beetle (*Dendroctonus ponderosae*), Douglas-fir beetle (*Dendroctonus pseudotsugae*), spruce beetle (*Dendroctonus rufipennis*), and western spruce budworm (*Choristoneura occidentalis*). It is important to recognize that all of these insects are native to our Sub-Region and are generally present as low-density, endemic populations, which have little impact on forest structure. However, periodic outbreaks occur where large contiguous areas of mature trees are killed. The mechanisms that create the shift from endemic to outbreak conditions are poorly understood but are generally associated with other disturbance events (Romme et al. 2003b, e).

Windstorm disturbances are generally more pronounced within higher elevation forest types than lower elevation types. The majority of tree species at lower elevations have extensive root systems that often include deep taproots. In addition, windstorms that do occur are generally less intense than windstorms at higher elevations. In contrast, the two most common higher elevational trees species, Engelmann spruce and subalpine fir are shallow rooted and not windfirm (Kulakowski and Veblen 2004). Winds at this elevation are stronger and can cause extensive damage such as the 1997 Routt blowndown in northwestern Colorado (Baker et al. 2002). Interactions of wind intensity with previous site disturbances, shallow or poorly drained soils, steep slopes and dense stands can all increase the vulnerability of stands to windthrow (Kulakowski and Veblen 2004). Studies within our Sub-Region indicate that windthrow most likely does not play as an important disturbance role as in other adjacent areas to our Sub-Region (Romme et al. 2003e; Kulakowski and Veblen 2004). Kulakowski and Veblen (2004) suggest however that the high elevation of Grand Mesa, Colorado makes it likely that blowdowns play a role in the development of higher elevation forests. Finally, snow avalanches also impact higher elevation forest development. These disturbances are localized events that remove significant forest cover from certain topographic locations.

Anthropogenic influences

Landscapes are heterogeneous in both space and time even without anthropogenic influences (Pickett and Cadenasso 1995). Investigating and understanding the historical biogeography of individual species and biotic communities can illustrate how natural disturbances influence biotic communities structure and function and and the shifting mosaic of these communities over time and space (see Module II: Biogeographic Significance for examples at the Sub-Region-scale).

Fire suppression

Since the large conflagrations of 1910 in the western U.S., western landscapes have been impacted by fire suppression. Natural fire regimes create landscape heterogeneity while fire suppression often leads to homogenous landscapes (Keane et al. 2002). Fire suppression is different from other anthropogenic disturbances in that it occurs gradually over time and has the potential to alter future fire disturbances in both severity and aerial extent as illustrated in ponderosa pine stands within in the Sub-Region (Swetnam and Baisan 1996). See Module III: Historical range of variability for a more detailed discussion on how fire suppression, if at all, has altered the structure and function of dominant forested vegetation communities at the Sub-Regional scale.

Development

The two major types of development that are impacting biotic communities in our Sub-Region are resort development and low-density development. Ski resorts represent a type of micro-urban development often surrounded by natural landscapes (Travis et al. 2002). Ski resorts increase public access to higher elevation forest and alpine environments for year-round recreation activities including skiing, mountain biking, and hiking. Resorts are the fastest expanding residential and commercial land-use in the Rocky Mountain region; however when compared to metropolitan areas, resorts have a relatively small footprint on the landscape (Travis et al. 2002). The second major development, low-density residential, in the Southern Rockies is growing faster in physical expansion across the landscape than actual population growth due to the large increase in "ranchette" or exurban development (SREP 2000). Exurban development results in high fragmentation primarily in low to middle elevation communities and along riparian systems. Exurban development in these areas also affects natural disturbance processes such as fire and flooding because efforts are generally taken to inhibit these processes around developed areas. Fire suppression and mitigation efforts around developed areas that interface with public land, often referred to as the wildland-urban interface, are becoming a top management priority for public land managers. The wildland-urban interface zone is forecasted to increase within the Southern Rockies because 75 percent of the region's forested communities are within 1.5 miles of private land (SREP 2000). These lands will eventually be developed, and therefore management options for fire on public lands will be restricted, often preventing ecologically beneficial fires from burning.

Roads

The presence of roads has a large impact on landscape patterns and processes by creating sharp edges in otherwise intact (interior) habitats. Some deleterious effects of roads include creating barriers to species mobility, acting as corridors for non-native and edge adapted species, and increasing human access to interior habitats (Baker and Knight 2000). Road density is more important than the actual presence of a road. Approximately 94 percent of all land located within the Southern Rockies is within two miles of a road (SREP 2000). Higher road densities can significantly affect the presence of large mammals such as elk, mountain lions, and black bear and also alters natural disturbance processes and biotic interactions with communities. Vegetation communities within the Sub-Region that are most impacted by roads are areas at low and middle elevation, which corresponds to communities most impacted by human development (SREP 2000). See Module V: Roads for a more detailed discussion within the Sub-Region.

Timber Harvest

Large areas of interior forest have been lost in Southern Rockies due to timber harvesting and subsequent road construction (Reed et al. 1996). While forestry practices do not result in land use change such as development and roads, timber harvesting does alter stand structure and function with the degree of impact based upon the size, intensity, and type of harvest, pre-existing harvest conditions (past management activities), biotic/abiotic factors (soil type, slope, aspect, and vegetation type), and how harvesting practices are distributed across the landscape. The majority of low and middle elevation forested landscapes within the Sub-Region are between 70-130 years old and are considered even-aged, mature stands due to logging and fires set intentionally by humans in the late 1800s to early 1900s (Smith 2000). This legacy of prior anthropogenic disturbances on the landscape, intertwined with natural landscape heterogeneity, has a large impact on the current mosaic of forested patches across the landscape and the diversity of structural classes for forested ecosystems. The majority of the old-growth logging occurred within the Sub-Region prior to the 1950s, however some old-growth logging still occurs today at low levels. For example, in the Intermountain Region (Four corner states plus Wyoming, Idaho, and Montana), the total volume of softwood timber from large trees decreased by 31.4 percent between 1952 and 1992 from 43,648 mbf to 30,067 mbf (Stohlgren et al. 2002). In addition, total overall harvest has also decreased as federal agency management policies have switched from resource-based management to ecosystem-based management. The types of harvests today also vary with many timber harvests focused on reducing dense stands compromised of small diameter trees. This is change in timber harvest is occurring within the Sub-Region in ponderosa pine and warm-dry mixed conifer forests to restore forest structure to within its HRV. See Module V: Timber Management for a more detailed discussion within the Sub-Region.

Grazing

Grazing impacts on biotic communities have changed over the past 150 years in the Southwest from light grazing pressure in the 1800s to intense pressure in the early-mid

1900s and recently to current levels that in some instances attempt to balance the number of grazers with biotic community capacities (Dahms and Geils 1997). Nearly 70 percent of Forest Service land in the Southern Rockes has active grazing allotments and 93 percent of BLM land in Colorado (SREP 2000). Domestic livestock have significantly different impacts on natural communities than native free roaming herbivores. Domestic livestock graze in communities historically un-grazed by native herbivores (desert environments) and tend to congregate in certain areas, especially riparian systems (Belsky et al. 1999). Potential ecological impacts of livestock grazing include decreasing overall biomass of grasses and forbs, changing vegetation composition (shift towards non-palatable species), increasing the spread of non-native weeds, increasing soil erosion, and altering nutrient cycling and natural fire regimes (Fleischer 1994). Intense grazing by sheep in ponderosa pine forests that began in the late 1800s resulted in reduced grass fuel loads, which decreased the competition of grasses with pine seedlings for soil moisture, reduced low-intensity grass fires, and increased the exposure of mineral seedbeds due to excessive livestock trampling. The combination of intense grazing, good ponderosa pine seed years, and favorable climatic conditions permitted the germination and successful establishment of large numbers of ponderosa pine trees in the Southwest during the early 1900s. See Module V: Livestock for a more detailed discussion within the Sub-Region.

Mining / Oil & Gas

Mining has played a large role historically and continues today within the Sub-Region. In Colorado alone there are over 7,000 abandoned mines and approximately 1,615 miles (2,600 km) of streams affected by mine drainage (Rueth et al. 2002). The major ecological impacts of ore mining include leaching of heavy and toxic metals into natural waterways and groundwater which impacts water quality and aquatic biotic communities and air pollution from smelters. While drilling for mineral extraction still occurs within the Sub-Region, drilling for energy minerals (methane) has increased dramatically in southwestern Colorado and the San Juan Basin, New Mexico. In the San Juan Basin alone, 18,000 oil and gas wells already exist and 10,000 new wells are currently in review for approval. Coalbed methane wells extract methane gas from coal 2,500 to 5,500 ft (762-1676 m) below the surface. Pumpjacks are used to release the methane gas by removing groundwater and therefore decreasing pressure, which allows the methane gas to release into the wells. Some ecological impacts associated with coalbed methane include gas seeps into the ground and rivers, ozone air pollution, landscape fragmentation due to increased roads, soil and vegetation disturbance and erosion due to well pads, underground coal fires, and decreased aquifer levels and drying springs. See Module V: Mineral Extraction for a more detailed discussion within the Sub-Region.

Recreation

Outdoor recreation is a growing industry due to the high percentage of public land within the Sub-Region. Recreational activities include fishing, hunting, camping, hiking, mountain biking, skiing, off road vehicle use, snowmobiling, rafting, and backpacking. The number of individuals recreating on public land has increased dramatically over the past few years. For example, in Colorado, the number of registered ATV users tripled from 1991-1998, up to 36,855 individuals (SREP 2000). While many recreational activities seem harmless to vegetation communities such as hiking and backpacking, these activities can have localized impacts on landscapes such as increasing erosion, increasing spread of non-native plants, disrupting wildlife, creating water and soil pollution and damaging vegetation similar to other more intensive recreation activities such as ATV and snowmobile use. Each vegetation community will respond differently to similar recreational activities depending on the community's natural ability to respond to these disturbances. For example, walking on a trail in a desert shrub community with biological cryptogramic crusts is more destructive to vegetation and soil communities than walking across a wet subalpine meadow. See Module V: Recreation for a more detailed discussion within the Sub-Region.

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CHAPTER 2. EXISTING VEGETATION FOREST SCALE

Gunnison Basin

Current Vegetation

Vegetation mapping for the Grand Mesa, Uncompahgre and Gunnison (GMUG) National Forests is generated primarily from aerial photo interpretation, with periodic updates resulting from field verification, management activities and natural disturbances (i.e., wildfires). Vegetation is classified by cover type. Cover type is determined by the dominant cover or species present at the time of classification. As a result, cover type classifications are more simplified than conditions that actually occur on the ground. (For example: Spruce/fir cover type includes areas where Englemann spruce and/or subalpine fir tree species are the majority of the vegetation. Aspen tree species may or may not be present as subdominant species.)

It is important to note several additional limitations in the cover type classification for the Gunnison Basin Geographic Area. Ponderosa pine, blue spruce and Douglas-fir are under represented. In some cases these species have been misidentified in the aerial photo interpretation. In other cases, these species are listed in the species mix, but because they are not the dominant species, the cover type is identified as some other species. Current vegetation cover type composition on NFS lands within the Gunnison Basin Geographic Area is shown in Figure 1. A map of current vegetation is shown in Figure 2.

Figure 1. Composition of Current Vegetation Cover Types on NFS lands within the Gunnison Basin Geographic Area

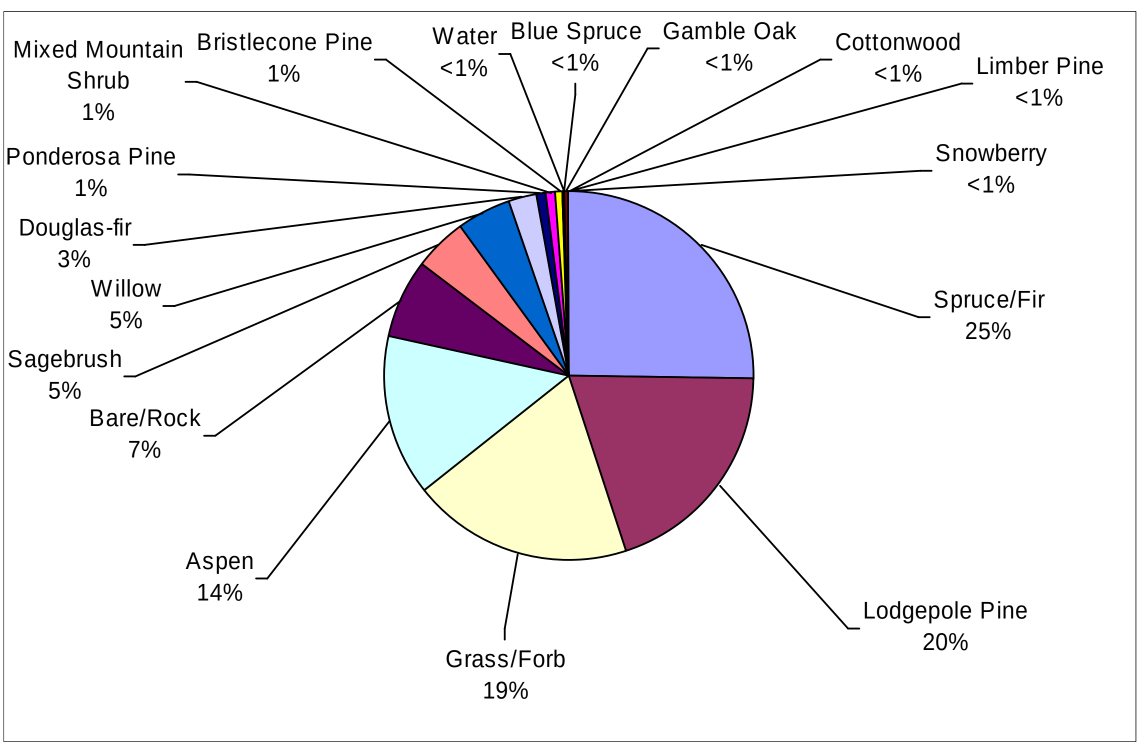
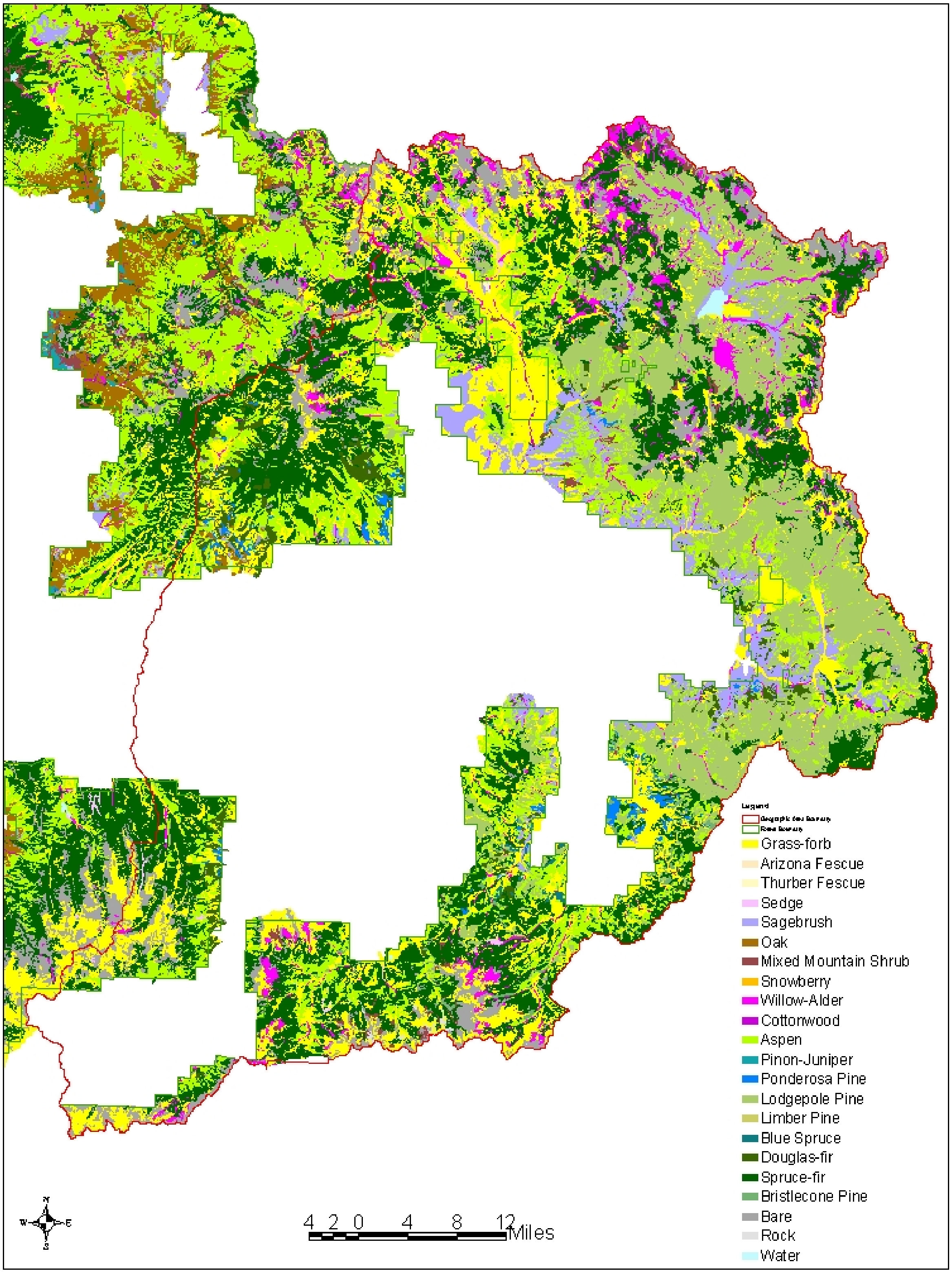


Figure 2. Map of Current Vegetation, Gunnison Basin Geographic Area



Habitat Structural Stages

Vegetation is also characterized by structure. Structure is described by habitat structural stages. Habitat structural stages are defined by size class, tree diameter, and canopy closure (or canopy density measured as crown cover percent). Table 1 displays habitat structural stage definitions (Hoover and Wills, 1987).

Table 1. Habitat Structural Stage Definitions

Habitat Structural Stage	Size Class	Diameter	Crown Cover Percent
1T[1]/1M[2]	Grass-Forb	Not applicable	0 – 10%
2T[1]/2S[3]	Shrub-Seedling	< 1 inch	0 - 10%
3A	Sapling-Pole	1 – 9 inches	11 – 40%
3B	Sapling-Pole	1 – 9 inches	41 - 70%
3C	Sapling-Pole	1 – 9 inches	71 - 100%
4A	Mature	9+ inches	11 – 40%
4B	Mature	9+ inches	41 - 70%
4C	Mature	9+ inches	71 - 100%

1 Opening in forest cover type created by some type of disturbance
2 Natural meadow
3 Shrub cover type

Habitat structural stages can be used as indicators for:

- *Wildlife habitat* - Different wildlife species have different habitat requirements. For example, species that require large diameter trees in dense stand conditions find habitat in areas with 4B and 4C habitat structural stages.
- *Potential risk for future fire, insect and/or pathogen activity* - Trees growing in dense stands can be stressed by competition for water, nutrients and sunlight, making them more susceptible to insect attack.
- *Time since disturbances (fire, harvest, etc.) affected an area*. Age of vegetation is not directly linked to habitat structural stage; however, relative stages of succession can be implied. Early stages of succession are shown as habitat structural stages 1 or 2; later successional stages are usually in habitat structural stages 4A/ 4B/4C. Sometimes structural stages 3A/3B/3C may be the same age as 4A/4B/4C.

Current habitat structural stages for NFS lands within the Gunnison Basin Geographic Areas are shown in Figure 3. Please note: natural meadows in grass-forb cover types are shown as structural stage 1M, and shrub cover types are shown as structural stage 2S. An additional limitation of habitat structural stage data for the Gunnison Basin Geographic Area concerns the lodgepole pine cover type. The narrower crowns of lodgepole pine were interpreted as having correspondingly smaller size classes (sapling-pole vs mature) than actually exist, resulting in an overrepresentation of 3A/3B/3C than actually exists. (Also see Table 2.)

Figure 3. Current Habitat Structural Stages, Gunnison Basin Geographic Area

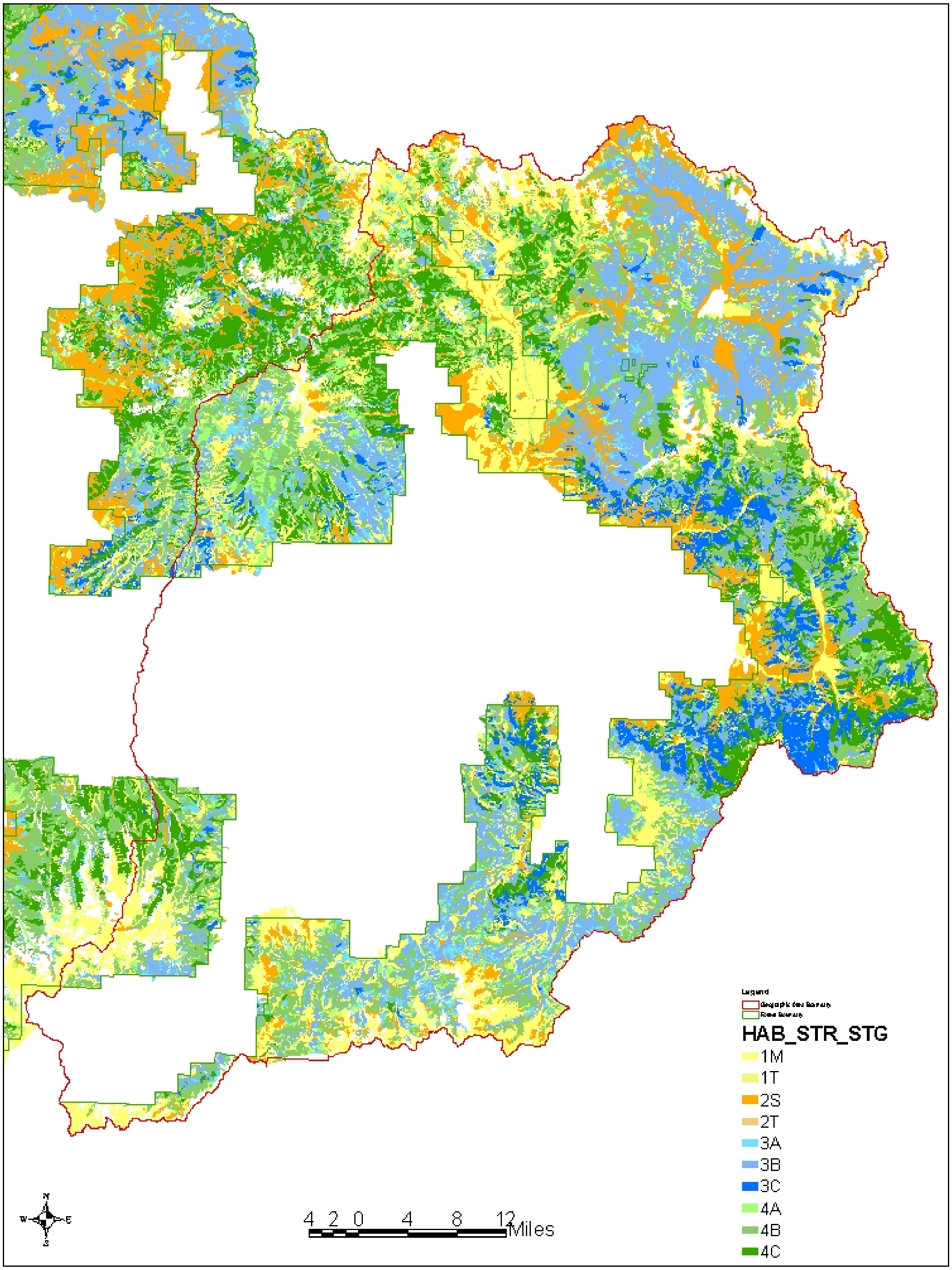
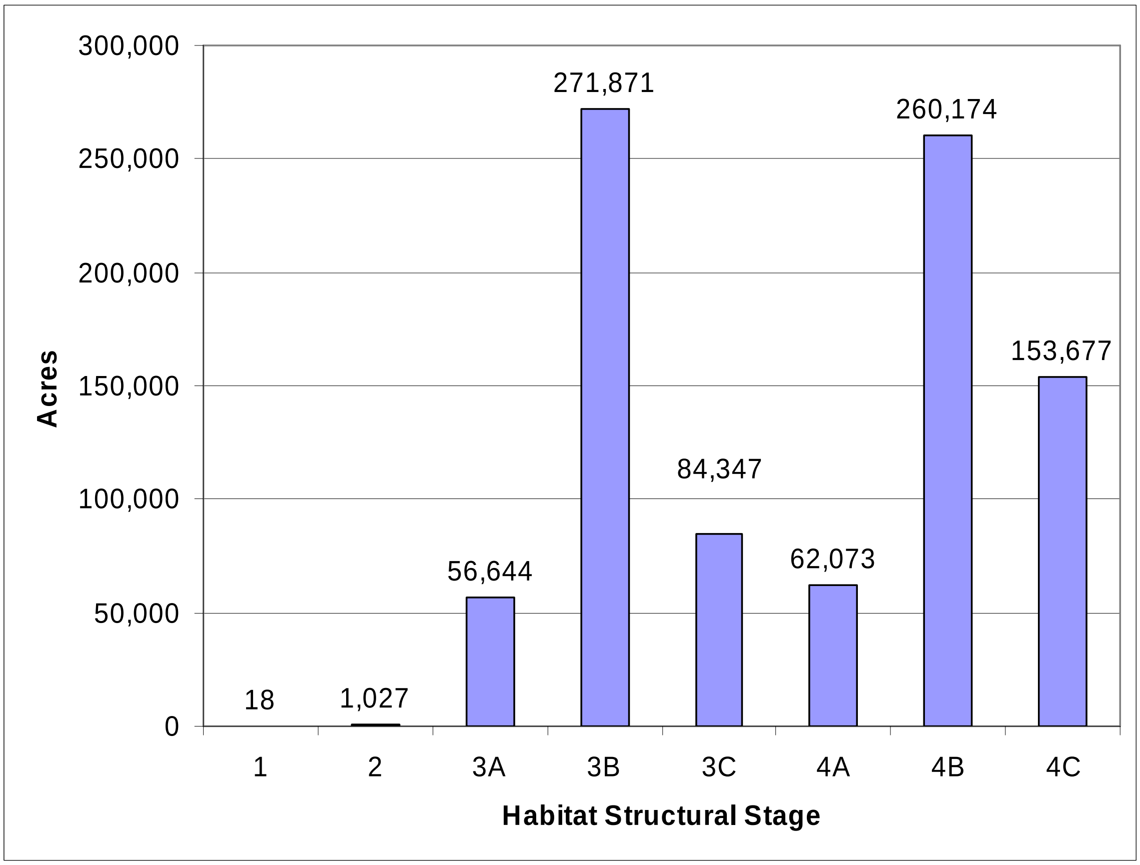


Figure 4 displays the distribution of habitat structural stages for the forest and woodland cover types (spruce-fir, aspen, lodgepole pine, Douglas-fir, ponderosa pine, cottonwood, bristlecone pine, limber pine, blue spruce) on NFS portion of the Gunnison Basin Geographic Area. Note: Natural meadows and shrublands are not included in the chart below; habitat structural stages 1 and 2 are slightly under represented due to recently harvested lodgepole pine being typed as grass-forb or shrub types; some3A/3B/3C acres are over represented and 4A/4B/4C are under represented due to photo interpretation errors related to size class in lodgepole pine.

Figure 4. Habitat Structural Stage Distribution of Forest and Woodland Cover Types, Gunnison Basin Geographic Area



This information can also be summarized by looking at the distribution of size classes (Figure 5) and densities or canopy closure (Figure 6) of forest and woodland cover types on NFS lands within the Geographic Area. Again, natural meadows and shrublands are not included in the data shown in Figures 5 and 6.

Figure 5. Class Distributions of Forest and Woodland Cover Types*
*Grass/forb and seedling/shrub types are slightly under represented, sapling/pole size class is over represented and mature is under represented due to photo interpretation errors in lodgepole pine.

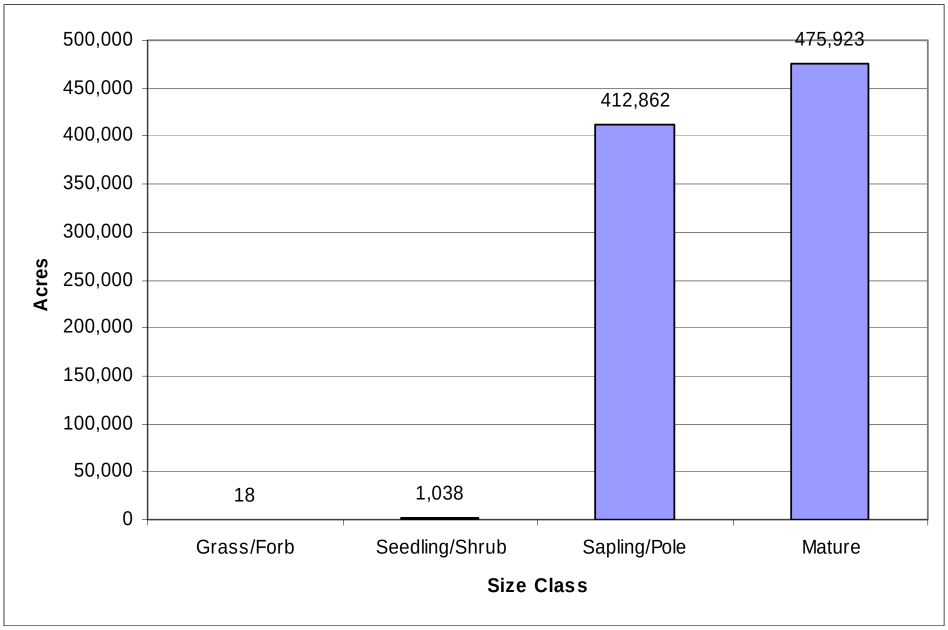
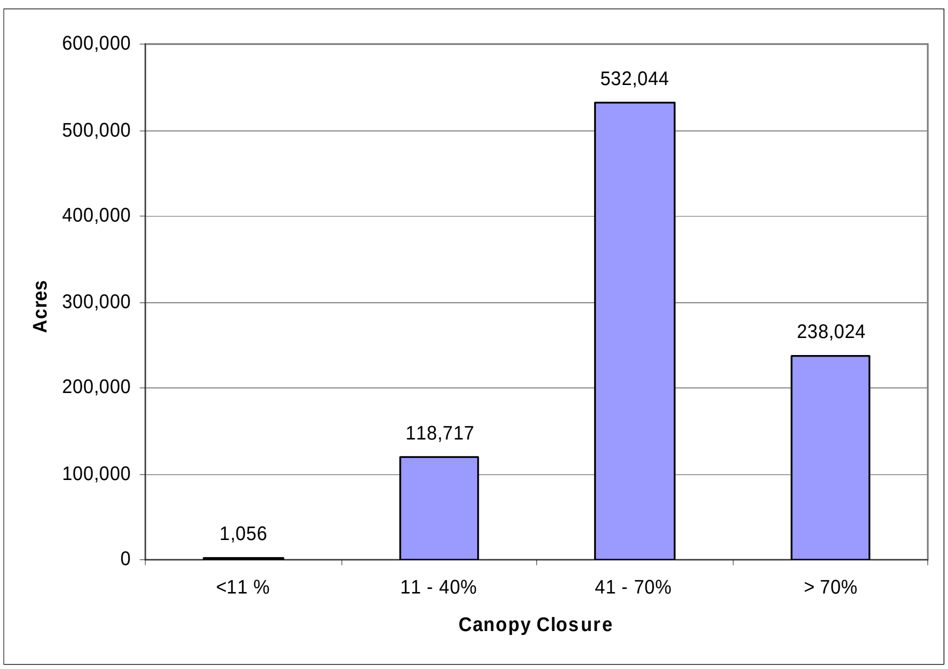


Figure 6. Canopy Closure Distributions in Forest and Woodland Cover Types



Characterization of Current Vegetation Conditions

Additional information on current conditions of different cover types is summarized in Table 2. (Also see timber, range and fire management sections).

Table 2. Current Vegetation Characterization for NFS lands on Gunnison Basin Geographic Area

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Spruce-fir (Englemann spruce – subalpine fir)	354,300 acres 25%.	Ranges from 28 to 435 years. Most spruce-fir is between 120 and 200 yr. old	7%-3A 20%-3B 2%-3C 10%-4A **42%-4B** 19%-4C	21% - single-storied 79% - multi-storied 98% - continuous canopies	11% of type has been affected by timber harvest	78% of type is within ½ mile of an open road or trail. Includes: 363 miles roads 330 miles trails
Aspen	197,500 acres 14%.	Ranges from 19 to 241 years. Most aspen is between 80-120 yr. old.	<1%-2T 9%-3A **34%-3B** 10%-3C 5%-4A 22%-4B 21%-4C	26% - single-storied 74% - multi-storied 96% - continuous canopies	1% of type has been affected by timber harvest 1% of this type has been treated with prescribed fire	82% of type is within ½ mile of an open road or trail. Includes: 252 mile roads 181 miles trails
Lodgepole Pine	279,900 acres 20%.	Ranges from 15 to 356 years. Most lodgepole pine is between 120-160 yr. old.	<1%-2T 2%-3A **44%-3B** 20%-3C 2%-4A 18%-4B 14%-4C Note: 1T/2T is under represented, 3A/3B/3C is under represented and 4A/4B/4C is over represented due to a photo interpretation error.	7% - single-storied 93% - multi-storied 100% - continuous canopies	10% of type has been affected by timber harvest 4% of this type has been treated with prescribed fire. Note: large areas were tiehacked in the late 1800s.	81% of type is within ½ mile of an open road or trail. Includes: 377 miles roads 185 miles trails

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Douglas-fir	35,400 acres 3%	Ranges from 50 to 398 years. Most Douglas-fir is between 120-180 yr. old.	7%-3A 18%-3B 6%-3C 18%-4A **36%-4B** 15%-4C	8% - single-storied 92% - multi-storied 96% - continuous canopies	10% of type has been affected by timber harvest 9% of this type has been treated with prescribed fire Note: Large areas were cutover between the late 1800s and 1950s.	77% of type is within ½ mile of an open road or trail. Includes: 22 miles roads 31 miles trails
Ponderosa Pine	11,500 acres 1%	Age data very limited.	19%-3A **27%-3B** **27%-4A** **26%-4B** 1%-4C	18% - single-storied 82% - multi-storied 100% - continuous canopies	9% of type has been affected by timber harvest. Note: Large areas were cutover between the late 1800s and 1950s.	83% of type is within ½ mile of an open road or trail. Includes: 15 miles roads 4 miles trails
Bristlecone Pine	7,400 acres 1%	Age data very limited.	**32%-3A** 21%-3B 1%-3C 28%-4A 18%-4B	16% - single-storied 84% - multi-storied 100% - continuous canopies	<1% of type has been affected by timber harvest 5% of this type has been treated with prescribed fire	91% of type is within ½ mile of an open road or trail. Includes: 8 miles roads 1 mile trail
Limber Pine	600 acres 0%	Age data very limited.	4%-4A **91%-4B** 6%-4C	14% - single-storied 86% - multi-storied 100% - continuous canopies	7% of this type has been treated with prescribed fire	83% of type is within ½ mile of an open road or trail. Includes: 2 miles roads <1 mile trail
Blue Spruce	2,300 acres <1%	Age data very limited.	4%-3A 10%-3B 24%-3C 4%-4A 20%-4B **37%-4C**	1% - single-storied 99% - multi-storied 100% - continuous canopies	46% of type has been affected by timber harvest 1% of this type has been treated with prescribed fire	91% of type is within ½ mile of an open road or trail. Includes: 3 miles roads <1 mile trail

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Cottonwood	700 acres <1%	No age data available.	3%-3A **74%-4A** 23%-4B	78% - single-storied 22% - multi-storied 97% - continuous canopies	None recorded.	57% of these types are within ½ mile of an open road or trail. Includes: <1 miles roads 0 miles trails
Gamble Oak – Mixed Mountain Shrub	13,600 acres 1%	No age data available.	100% 2S 1% large (>6.5') 63% med. (2.5-6.4') 36% small (<2.5')	37% - single-storied 63% - multi-storied 31% - >40% cover 69% - <= 40% cover	<1% of these types have been treated with prescribed fire.	74% of these types are within ½ mile of an open road or trail. Includes: 21 miles roads 17 miles trails
Sagebrush	68,300 acres 5%.	No age data available.	100% 2S 27% med. (2.5-6.4') 73% small (<2.5')	13% - single-storied 87% - multi-storied 70% - >40% cover 30% - <= 40% cover	19% of this type has been treated with prescribed fire	90% of type is within ½ mile of an open road or trail. Includes: 244 miles roads 30 miles trails
Willow	63,300 acres 5%	No age data available	100% 2S 15% large (>6.5') 66% med. (2.5-6.4') 19% small (<2.5')	21% - single-storied 78% - multi-storied 58% - >40% cover 42% - <= 40% cover	None recorded.	82% of these types are within ½ mile of an open road or trail. Includes: 152 miles roads 102 miles trails
Snowberry	400 acres 0%	No age data available	100% 2S 100% large (>6.5')	5% - single-storied 95% - multi-storied 4% - >40% cover 96% - <= 40% cover	None recorded	25% of these types are within ½ mile of an open road or trail. Includes: 1 miles roads 0 miles trails

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Grass/Forb	268,700 acres 19%	No age data available.	100% 1M	Not applicable	3% of these types have been treated with prescribed fire.	74% of these types are within ½ mile of an open road or trail. Includes: 510 miles roads 348 miles trails.

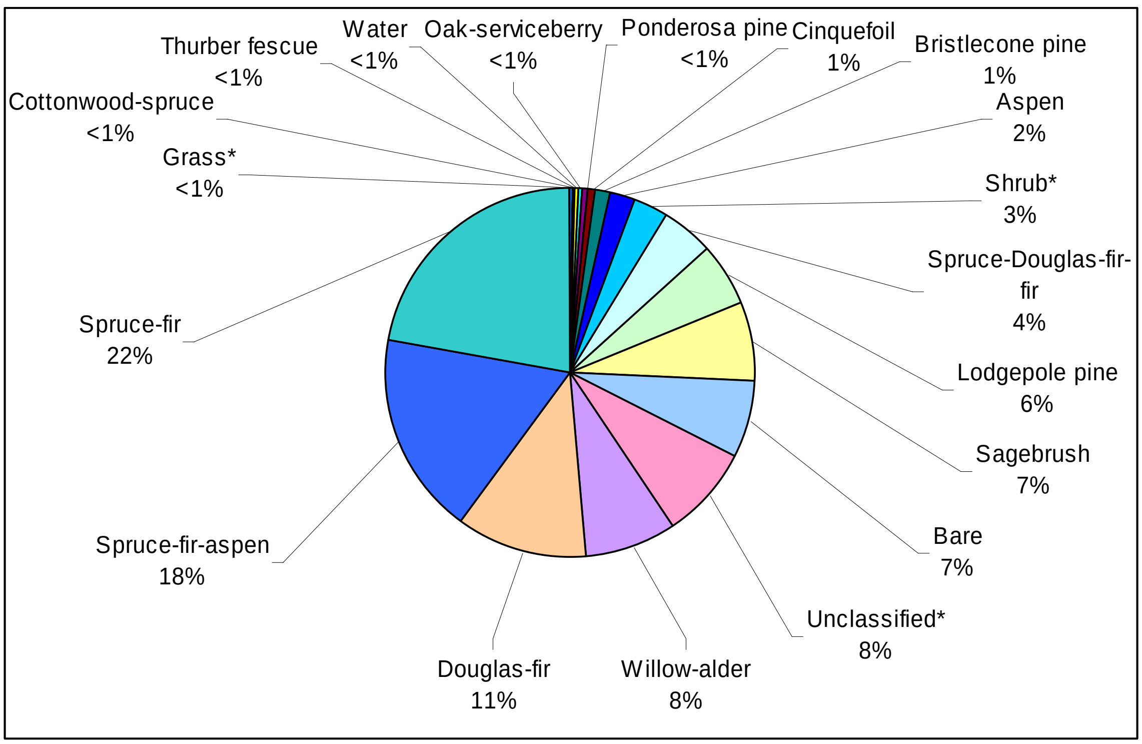
1 Common Vegetation Unit/R2VEG database
2 Stand exam data for Grand Mesa Geographic Area.
3 RMACT database
4 INFRA transportation data related to R2VEG data. Includes all inventoried roads and trail, not just routes open to public use.

<u>Comparison of Current Conditions to Historic Conditions</u>

Environmental factors such as soils, slope, aspect, climate, and elevation determine the plant communities that potentially can grow on a given area. The stable plant community that establishes in the absence of any disturbances (i.e., fire, insect/pathogen mortality, windthrow, drought, harvest) is called the climax plant community. The area where a given climax plant community can grow is classified as a Potential Natural Vegetation (PNV) type, and is named for the climax plant community. For example, spruce-fir forests are the climax plant community at elevations from 10,000 to 12,000 feet, in the subalpine climatic zone (30-40 inches of precipitation annually, 50-70 frost free days, 30-40ºF mean annual air temperature) (Johnston et al. 2001). Areas where spruce-fir is the climax plant community are classified as the spruce-fir PNV type.

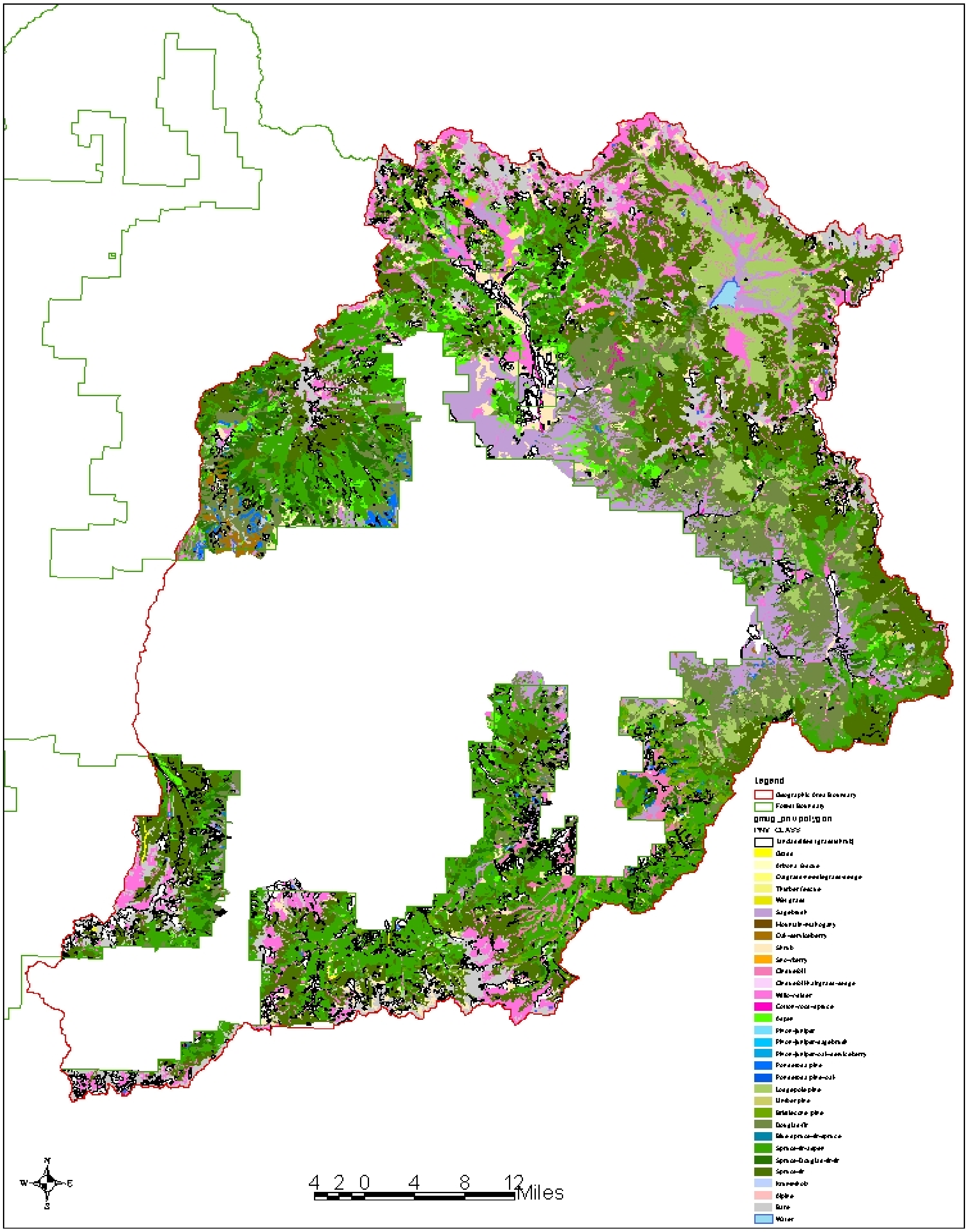
Draft PNV type classification has been completed for this Geographic Area. The PNV type composition on NFS lands within the Gunnison Basin Geographic Area is shown in Figure 7. (PNV types with <0.1 percent composition are not included in Figure 7.) A map of PNV for the Gunnison Basin GA is shown in Figure 8.

Figure 7. Composition of Potential Natural Vegetation Types on NFS lands within the Gunnison Basin Geographic Area



* Unclassified, grass/forb or shrub types where the PNV type has not yet been assigned.

Figure 8. Potential Natural Vegetation on NFS portion of Gunnison Basin Geographic Area



Historically, for any given PNV type, natural disturbances (i.e., fires, insect outbreaks) occurred at characteristic intervals and intensities, called regimes. When a disturbance was intense enough to change the existing plant community (e.g., some or all of the overstory was killed), the remaining vegetation followed a natural progression, or succession, of plant communities that changed over time. If no further disturbances occurred, an area eventually returned to the climax plant community. However, if multiple disturbances occurred on the same area earlier seral plant communities would be perpetuated on a site for extended periods. The natural disturbance regimes and succession cycles resulted in shifting mixtures (or ranges) of different seral plant communities (or stages) within any given PNV type at any point in time.

The Vegetation Dynamics Development Tool (VDDT) (Beukema et al. 2003) was used to model the expected range in seral conditions that would have existed under historic disturbance regimes for forest, woodland and shrub PNV types. The results displayed in the following tables are conditions that would have been distributed across an entire PNV type on the Geographic Area. Results are scale dependant. For example, if a large fire burned an entire watershed, all of a given PNV type in that watershed could be set back to an early seral condition. However, when the watershed is considered as part of the Geographic Area, the mixture of seral conditions for that PNV type would be within the expected ranges. Both situations would have occurred naturally.

The next sections include comparisons of current conditions to historic conditions for the most common PNV types on the Grand Mesa Geographic Area, to see where differences occur. This information can be used to identify future management opportunities.

Spruce-Fir PNV Type

The spruce-fir PNV type is mapped on 22 percent of the Gunnison Basin Geographic Area. The climax community in this PNV type includes Englemann spruce and supalpine fir as the overstory species. In some areas Englemann spruce may be the only overstory species (Romme et al. 1999, Johnston et al. 2001). In the lower elevation range of this type (10,000 to 11,000 feet) lodgepole pine is often present as an early seral species, and remnant lodgepole pine trees may persist into the later seral stages. The spruce-fir PNV type includes 61 percent of what is currently classified as spruce-fir cover type and 28 percent of what is currently in lodgepole pine cover type.

Table 3 describes the seral stages and the timeline for succession in the spruce-fir PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages) within the spruce-fir PNV type.

Table 3. Succession (Seral Stages) in Spruce-Fir PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	Initially grass/forb, low shrub with lodgepole pine or spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized lodgepole pine or spruce, grass and forb understory, lasting up to 150 years	Mature lodgepole pine overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature spruce and fir, remnant lodgepole pine, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	5%	49%	45% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

Currently much of the spruce-fir PNV type is in mid-seral conditions (includes both early-mid and late-mid), little is in early seral conditions. Approximately 69 percent of this PNV type is dominated by spruce-fir (mostly in the later seral condition above), 25 percent of this PNV type is dominated by lodgepole pine (in the early-mid seral stage), and 5 percent is in grass-forb cover.

The historic fire regime for the spruce-fir PNV type was long return interval (> 200 years), stand replacing fires, which could cover areas from 1,000 to 10,000 acres (Peet 1981 as cited in Neely et al. 2001) mixed with infrequent low-intensity surface fires that affected much smaller areas. Fire return intervals tended to be longer at higher elevations and in moist depressions and valley bottoms, up to 500 years (Romme et al. 1999). Since 1970 there have been only 60 fires in this PNV type and 63 percent were human caused. All but 2 fires burned less than 1 acre, each. The human-caused Crystal Creek fire in 1980 burned approximately 200 acres, 30 acres in this PNV type.

This PNV type occurs at higher elevations throughout the Geographic Area. Past harvest activities have affected approximately 15 percent of the spruce-fir PNV type. Shelterwood and selection harvests have been the silvicultural systems used the most (affecting 8 percent of the PNV type). Much smaller amounts of sanitation, seed tree and clearcut harvests have occurred (affecting 4 percent of the PNV type). The majority of the harvest activities have occurred since 1960, with peaks in activity in the 1980s.

The clearcuts are in the early seral stage. The sanitation/salvage cuts are included in the early-mid conditions. Shelterwood and selection harvest practices reduced the density of stands but did not alter the seral condition. Areas treated with this method are mostly in the late-mid seral condition.

Spruce-Fir-Aspen PNV Type

The spruce-fir-aspen PNV type is mapped on 18 percent of the Gunnison Basin. The climax community in this PNV type includes Englemann spruce and subalpine fir as the dominant overstory species with aspen and lodgepole occurring in all seral stages. This PNV type is currently comprised of 47 percent of the current aspen cover type, 14 percent of the current lodgepole pine type and 30 percent of the current spruce-fir cover type.

Table 4 describes the seral stages and timeline for succession in the Spruce-Fir-Aspen PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages) within the spruce-fir-aspen PNV type.

Table 4. Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	New stand of aspen seedlings/suckers , and occasional lodgepole pine with grass and forb understory lasting 30-50 years	Dense pole-sized aspen and occasional lodgepole pine, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	4%	63%	33% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

Table 4 shows the majority of this PNV type is in mid-seral conditions. This PNV type takes a very long time to progress through the different successional stages. A large percent of this type is in inaccessible areas, and information on stand ages and disturbance history that would validate seral stage assignments has not been collected.

This PNV type is generally below the spruce-fir PNV type in elevation. Approximately 43 percent of the spruce-fir-aspen PNV type is currently dominated by spruce-fir (mostly in late-mid seral stage), 16 percent of this PNV type has lodgepole pine as the dominant overstory species (early-mid seral stage), and 38 percent is currently dominated by aspen in the overstory (early-mid seral stage).

The fire regime in the spruce-fir-aspen PNV type is similar to that described above for the spruce-fir PNV type (long return interval stand replacing fires affecting large areas, mixed with infrequent low-intensity fires affecting small areas). The large amount of mid-seral conditions in this PNV type is an indication that large areas were affected by fire in the past (Johnston et al. 2001). Recent fires have been very infrequent and usually very small. Since 1970, 39 fires have been reported in this PNV type, mostly caused by lightning. A man-caused fire in 1991 burned approximately 300 acres in the West Elk Wilderness. Approximately 200 acre of the spruce-fir-aspen PNV type burned.

Timber harvest has not had a significant influence on seral stage conditions in this PNV type. Approximately 10 percent of the spruce-fir-aspen PNV type has been affected by timber harvest activities. Selection harvests, predominantly before 1950, have affected 5 percent of this PNV type. Other harvest methods include: shelterwood (1970s and 1980s, affected 3 percent of the PNV type), final removal and clearcuts (1960s, affected less than one percent). Harvests were roughly split between lodgepole pine and spruce-fir. Most of the harvest methods used result in lessening stand densities, but do not alter seral stages.

Douglas-fir PNV Type

The Douglas-fir PNV type is mapped on 11 percent of the Gunnison Basin Geographic Area. The climax community in this PNV type includes Douglas-fir as the dominant overstory species. At lower elevations (8,000-9,500 feet) in this PNV type aspen is an early seral species and may persist in the overstory in later stages. Exclusive to the Gunnison Basin Geographic Area (on the GMUG) lodgepole pine is the early seral species at higher elevations (9,000-10,500 feet). Both aspen and lodgepole pine may occur at the mid elevations. Lodgepole pine is more prevalent in the northern half of the Geographic Area (Johnston et al. 2001). Other conifer species such as ponderosa pine, limber pine, bristlecone pine, subalpine fir and spruce species may also occur in this PNV type. Currently the Douglas-fir PNV type is comprised of 25 percent of the current aspen cover type, 60 percent of the Douglas-fir cover type, 29 percent of the current lodgepole pine type and 37 percent of the identified ponderosa pine cover type.

Table 5 describes the seral stages and timeline for succession in the Douglas-fir PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages).

Table 5. Succession (Seral Stages) in Douglas-fir PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	New stand of aspen and/or lodgepole pine seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen and/or lodgepole pine, grass and forb understory, lasting up to 100 years	Mature aspen/lodgepole pine overstory with Douglas-fir trees growing in the understory. May take 100 to 200 years for Douglas-fir to dominate stand.	Mature Douglas-fir, scattered mature aspen/lodgepole pine in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	14-20%	19-20%	15-17%	58%
Current Seral Conditions	2%	63%	35% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Komarkova et al. 1988, Johnston et al. 2001

The Douglas-fir PNV type in the Gunnison Basin Geographic Area is currently comprised of 51 percent lodgepole pine dominated stands(both early-mid and late-mid seral conditions), 31 percent aspen dominated stands (early-mid seral conditions) and 13 percent Douglas-fir dominated stands (late-mid seral conditions). The large amount of lodgepole pine and aspen dominated stands (both early-mid and late-mid seral conditions) are an indication of past extensive fires in this Geographic Area. In some cases Douglas-fir seed may have been eliminated from some of these areas as a result of repeated fires (Johnston et al. 2001). This type tends to be on steeper, drier sites than the previously discussed PNV types.

Douglas-fir is often thought to have a fire-maintained open seral stage that develops from frequent, low intensity fires. Older Douglas-fir trees are resistant to fire and survive these types of fires. However, in the Gunnison Basin Geographic Area, the predominance of lodgepole pine, which has a fire regime of large scale stand replacing fires, seems to suggest that the fire regime for this PNV type may be more similar to that of lodgepole pine.

Since 1970, 59 fires have been recorded in this PNV type. Most (63 percent) have been caused by lightning and have burned less than an acre each. Several fires have burned several hundred acres, both human-caused.

Fuel loads in much of this PNV type are typically high (Johnston et al. 2001). Lack of frequent low intensity fires in this PNV type have allowed blue spruce and lodgepole pine to regenerate in the understories, creating much denser stand conditions than would have occurred historically. The potential for larger, more intense fires due to increased ladder fuels now exists in many stands. Prescribed fire has been used on approximately 8 percent of this PNV type, to reduce fuel accumulations and retain earlier seral conditions.

Timber harvest activities have affected approximately 12 percent of this PNV type. The majority of the harvest was done through selection harvests, with most of the acres being treated prior to the 1960s. Limited clearcutting, shelterwood, thinning and salvage harvest have occurred in this PNV type, predominantly in the 1970s and 1980s.

Lodgepole Pine PNV Type

The lodgepole pine PNV type is mapped on 6 percent of the Gunnison Basin Geographic Area. This PNV type only occurs on the Gunnison Basin Geographic Area portion of the GMUG. Lodgepole pine is often the only tree species that grows in the climax plant community of this PNV type. Occasionally aspen is present in the species mix. This PNV type occurs mostly in the northern half of the Geographic Area (Johnston et al. 2001). This PNV type includes approximately 27 percent of what is currently in the lodgepole pine cover type.

Table 6 depicts the seral stages and timeline for this PNV type as well as a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages).

Table 6. Succession (Seral Stages) in Lodgepole Pine PNV Type

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with lodgepole pine seedlings eventually becoming established. May last 50 years, depending on the time it takes trees to become established.	Dense pole-sized lodgepole pine, grass and forb understory, lasting to 100 years	Mature lodgepole pine overstory, lodgepole pine and regeneration in the understory where overstory gaps results from individual tree mortality, lasting up to 100 years	Stable multi-storied, multi-aged lodgepole pine stand, predominantly forb understory. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	8-14%	23-26%	17-24%	23-43%
Current Seral Conditions	6%	43%	50% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Komarkova et al. 1988, Johnston et al. 2001

Ninety-seven percent of this PNV type is currently dominated by lodgepole pine. As shown in the table above, the majority of this PNV type is in mid seral conditions (includes both early-mid and late-mid). The majority of the lodgepole pine PNV type is located in the Taylor Park area, and in scattered pockets south to Cochetopa Pass.

Fires are more frequent in lodgepole pine than spruce-fir, as lodgepole pine forests occur in warmer and drier environments. Fire intervals were historically between 200-400 years at higher elevations; however 50-150 year intervals were probably more characterisc at lower elevations (Peet 1981 as cited in Neely et al. 2001). Recent fire has not had much role in shaping this PNV type. Since 1974 only 46 fires have been reported and 70 percent have been human-caused. All but one fire burned less than 5 acres (see Fire Management section).

Approximately 27 percent of this PNV type has been affected by some type of timber harvest. Selection harvests have affected three percent of this PNV type, but most of this harvest occurred prior to 1950. Shelterwood harvests have affected one percent of the lodgepole pine PNV type since the mid-1970s. Clearcut harvests have been used on seven percent, with most acres being harvests since 1980 (these are the areas included in the early seral condition, above). Dwarf mistletoe is a problem in some areas of this PNV type. Timber stand improvement treatments to make stands less susceptible have occurred on 9 percent of this type, and disease control harvests have occurred on an addition 4 percent, since the mid-1980s. Timber harvests have mostly resulted in reducing stand densities, which tends to extend the length of time a stand remains in a given seral condition.

Aspen PNV Type

In the Aspen PNV type, pure aspen is the climax plant community, with no conifer species present. The Aspen PNV type is mapped on two percent of the Gunnison Basin Geographic Area. This PNV type is much less prevalent on this Geographic Area than any other on the GMUG. Approximately 16 percent of the current aspen cover type is within the aspen PNV type.

Table 7 depicts the seral stages and timeline for this PNV type as well as a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages).

Table 7. Succession (Seral Stages) in Aspen PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 10 to 20 years	Dense pole-sized aspen, grass and forb understory, lasting 50 to 80 years	Mature aspen overstory, aspen regeneration in the understory where overstory gaps results from individual tree mortality, lasting up to 80 years	Stable multi-storied, multi-aged aspen stand, predominantly forb understory.Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	8-14%	23-26%	17-24%	23-43%
Current Seral Conditions	6%	43%	50% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

The Aspen PNV type is also predominantly in mid seral conditions (includes both early-mid and late-mid). Few areas are in early seral. As with the previous PNV types, the distribution of seral conditions in the aspen PNV type is the result of past large scale fire activity in the late 1800s (Johnston et al. 2001).

Fire has had very little effect on this PNV type. Since 1970 only eight fires have burned in this PNV type, affecting less than one acre each, on average. Historically fire would have maintained a mosaic of aspen seral conditions through relatively frequent fire intervals (Peet 1981 as cited in Neely et al. 2001).

Less than two percent of the aspen PNV type has been affected by timber harvest. Clearcuts were done in the early 1990s affecting less than 250 acres, and selection harvest in the early 1900s affected less than 450 acres.

Aspen, particularly at lower elevations, is declining. Aspen regeneration has been reduced due to the lack of frequent fire disturbance. When aspen regeneration does occur, it is often impacted by grazing wild ungulates that eat regenerating suckers as well as inflict damage to mature trees by eating bark. Elk populations are currently much higher than historical levels.

Sagebrush

The Sagebrush PNV type is mapped on approximately seven percent of the Gunnison Basin Geographic Area. This mapping includes three different types of sagebrush communities. Wyoming big sagebrush communities are found below 9,000 feet in elevation. Big sagebrush communities usually include antelope bitterbrush in the species mix, and occur up to 10,000 feet in elevation. Both of these types reach average heights of 1.6 feet (Johnston et al. 2001). Black sagebrush communities can be found interspersed among both the big sagebrush types, on areas of heavy clay soils. Black sagebrush has a shorter growth form, averaging 0.6 feet (Johnston et al. 2001).

Current seral condition classification in the Sagebrush PNV type indicates 30 percent in early seral (currently dominated by grass and forb cover types), 51 percent in mid seral conditions and 19 percent in late seral conditions. This classification is in need of further refinement because the primary determining factor for seral condition classification was shrub height. All black sagebrush areas would have been classified as mid seral based on shrub height, and only big sagebrush types could have been classified as late seral. Seral condition in sagebrush is related to plant species composition and this information is limited in our vegetation data.

Historically, frequent fires (both natural and human ignitions) created mosaics of seral conditions in the sagebrush PNV types. During the past century the sagebrush PNV types in the Gunnison Basin Geographic Area have been influenced by livestock grazing, past spraying to reduce shrub cover and increase grass and forb production, reseeding, fire suppression and most recently prescribed burning. All three sagebrush community types recover relatively quickly (within 30 years) following burning and seeding. Livestock grazing has the largest effect on plant species composition. Activity records are not complete for treatments prior to 1980. Since 1983 approximately 14 percent of this PNV type has been treated with prescribed fire to increase early and mid seral conditions, to provide improved forage for wildlife and livestock.

This PNV type is very important to big game as winter range, and each of the different community types are used for different reasons by Gunnison sage grouse.

Key Findings

- Lodgepole pine is the most common tree species occurring on the Gunnison Basin Geographic Area. This species occurs as the dominant species on 20 percent of the Geographic Area, and is a component of the species mix on an additional 9 percent of the Geographic Area. Lodgepole pine occurs naturally only on the Gunnison Basin Geographic Area portion of the GMUG.

- Aspen is the second most common tree species occurring on the Gunnison Basin Geographic Area. This species occurs as the dominant species on 14 percent of the Geographic Area, and is a component of the species mix on an additional 13 percent of the Geographic Area.

- The large extent of lodgepole pine and aspen is the result of large scale fires in the past (Johnston et al. 2001). As a result, the majority of this geographic area is currently in mid seral conditions.

- Current vegetation classification shows approximately 46 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the lodgepole pine and aspen cover types), and 53 percent are in mature size class (mostly in the spruce-fir cover type). As mentioned above, photo interpretation errors in lodgepole pine have resulted in inflating the sapling/pole size class and under representing the mature size class that actually exists.

- The majority of the current forest and woodland vegetation conditions – 87 percent - have dense canopy closures (> 40 percent canopy closure).

- There is very little early seral condition in any cover type on the Gunnison Basin Geographic Area, as shown in Tables 3 through 7.

- When comparing the compositions of current vegetation cover types to PNV types (Figure 1 to Figure 7), the forest types total percentages are approximately equivalent. The majority of the Geographic Area is in mid seral stages currently dominated by lodgepole pine and aspen, however much of these areas will eventually succeed to spruce-fir and Douglas-fir. The biggest difference occurs in the grass/forb types. Much of the current grass/forb cover type is classified as early seral stages of sagebrush and willow PNV types.

Vegetation Trends

- The trend across all vegetation cover types on the Gunnison Basin is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Vegetation Management Implications

Management implications of vegetation conditions relate to differences between current and historic vegetation conditions. Where landscape conditions are similar to historic conditions landscapes are more resilient following disturbances, suitable habitat is provided for all species that evolved there, and ecosystems are productive and sustainable over time. Where current conditions deviate from historic ranges, there are increased risks for natural disturbances to be of higher intensities and affect larger areas than in the past; some habitats may become very limited or lost, threatening species viability; and loss of productivity can result in both ecological and economic losses. Management activities that can include both human and natural disturbances can be used to restore more desirable vegetation conditions. Management implications for specific cover types are discussed below.

Spruce-Fir

- The spruce-fir cover type occurs in the spruce-fir, spruce-fir-aspen, and spruce-Douglas-fir-fir PNV types. Disturbances (human or natural) that occur in the spruce-fir-aspen PNV type will result in aspen regeneration within a very short period of time. Intensive, large scale disturbances in the spruce-fir or spruce-Douglas-fir-fir PNV type do not have aspen as an early seral species, and may take over 200 to 300 years to regenerate to mature spruce.

- All three PNV types dominated by spruce and fir currently have large percentages in mature, dense structural conditions. These conditions are ripe for fire and epidemic insect and pathogen outbreaks (see Forest Health and Fire Management sections). Because so much of the landscape is in the same condition, there is a high probability that large areas can be affected at the same time. Large scale disturbances (both fire and insect outbreaks) are the natural regimes for these PNV types. Management activities that increase diversity in age, size and seral condition, could be used to reduce the potential effects of natural disturbances.

- The majority of this cover type in the Gunnison Basin Geographic Area is in Wilderness and currently unroaded areas. Only natural processes will alter vegetation conditions in Wilderness areas and potentially where future management decisions (i.e., theme designations) limit or restrict management activities in these unroaded areas.

Lodgepole Pine

- The lodgepole pine cover type is found in the spruce-fir, spruce-Douglas-fir-fir and Douglas-fir PNV types as an early and mid seral species. It is found in all seral stages of the lodgepole pine PNV type.

- Lodgepole pine regeneration naturally occurs in very dense stands, which can have suppressed growth rates (Johnston et al. 2001) and become very susceptible to dwarf mistletoe and mountain pine beetle. A majority of this cover type are in these stand conditions. (See Forest Health section). As with the spruce-fir type above, there is a high probability that large areas could be affected at the same time by an insect or pathogen disturbance. If diversity in stand structure, age and size was increased, potential effects from disturbances could be reduced.

Douglas-fir

- There is currently much less Douglas-fir on the Gunnison Basin Geographic Area than would be expected historically. Much of what could be in Douglas-fir is currently in lodgepole pine cover. This shift is likely due to historic fires and past insect outbreaks eliminating much of the Douglas-fir seed source (Johnston et al. 2001). Douglas-fir tends to occur on steeper, drier sites, reducing the chance that this species will regenerate if disturbed.

- Much of the Douglas-fir that does occur on the Gunnison Basin Geographic Area is in stands mixed with blue spruce. In the past frequent low intensity fires would have created and maintained more open stands. In the absence of fire resulting from approximately 100 years of fire suppression, blue spruce and other vegetation has established in the understory resulting in the currently dense stands, creating a potential for future fires to be more intense than would have occurred historically.

Aspen

- The aspen cover type occurs in most of the conifer PNV type as the early and mid seral conditions, with the exception of the spruce-fir and lodgepole pine PNV types. The aspen cover type is in all seral stages of the aspen PNV type.

- Aspen stands become very susceptible to cankers and root rots as they mature. A large percentage of the aspen cover type on the Gunnison Basin Geographic Area is between the age of 80 and 120 years. An increasing amount of mortality caused by these agents is expected in the future.

- Over half of the aspen stands on the Gunnison Basin Geographic Area include conifer species in the understory or as codominant species. In the absence of some disturbance, these stands will eventually succeed to conifer dominated cover types. A shift from an aspen cover type to various conifer cover types will change the types of habitat available on the Gunnison Basin Geographic Area to favor those species that require mature conifer forests.

- Aspen, particularly at lower elevations is in decline due to a combination of lack of disturbance that normally generates suckering and a large wild ungulate population that browses what regeneration does occur.

Sagebrush

- Past fire suppression, range treatments and livestock grazing altered the understory species composition in this cover type. Structural stage diversity has become more uniform and less patchy across the landscape. These combined changes have altered the habitat that historically would have been provided by this cover type.

- A small percent of the sagebrush cover type currently found in the Geographic Area is located on NFS lands. This cover type is very important as winter range for big game species and different elevations provide habitat for Gunnison sage grouse. The importance of these areas on Forest for species conservation may increase, depending on the condition and future management of this cover type off Forest. Any future treatments in this cover type must consider how this cover type responds to disturbances so that desired conditions will be achieved.

Grass/Forb

- Grass/forb cover types make up 19 percent of the NFS landscape in the Gunnison Basin Geographic Area. This includes areas at all elevations, including alpine areas. The species composition in grass-forb cover types has been altered from historic conditions through livestock grazing, and introduction of non-native species. These cover types may be candidates for future restoration efforts.

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CHAPTER 2. EXISTING VEGETATION – FOREST SCALE

Grand Mesa

Current Vegetation

Vegetation mapping for the Grand Mesa, Uncompahgre and Gunnison (GMUG) National Forests is generated primarily from aerial photo interpretation, with periodic updates resulting from field verification, management activities and natural disturbances (i.e., wildfires). Vegetation is classified by cover type. Cover type is determined by the dominant cover or species present at the time of classification. As a result, cover type classifications are more simplified than conditions that actually occur on the ground. (For example: Spruce/fir cover type includes areas where Englemann spruce and/or subalpine fir tree species are the majority of the vegetation. Aspen tree species may or may not be present as subdominant species.)

Current vegetation cover type composition on NFS lands within the Grand Mesa Geographic Area is shown in Figure 1. Vegetation is currently dominated by aspen, spruce and subalpine fir forests. A map of current vegetation is shown in Figure 2.

Figure 1. Composition of Current Vegetation Cover Types on NFS lands within the Grand Mesa Geographic Area

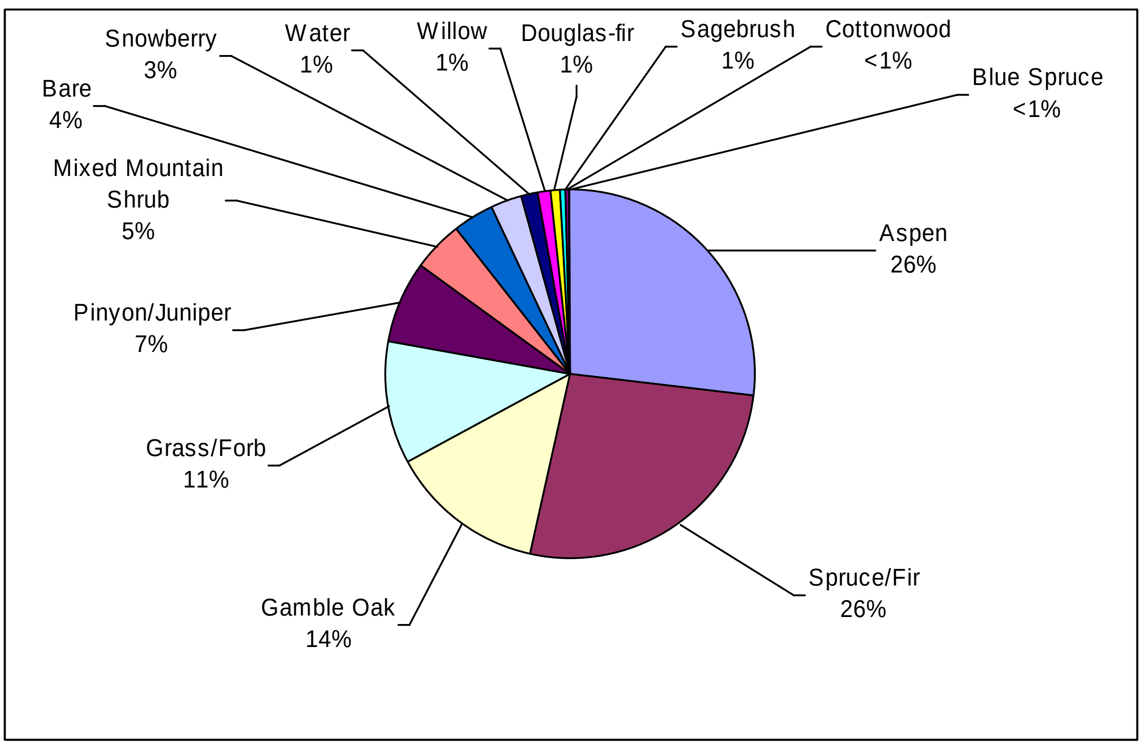
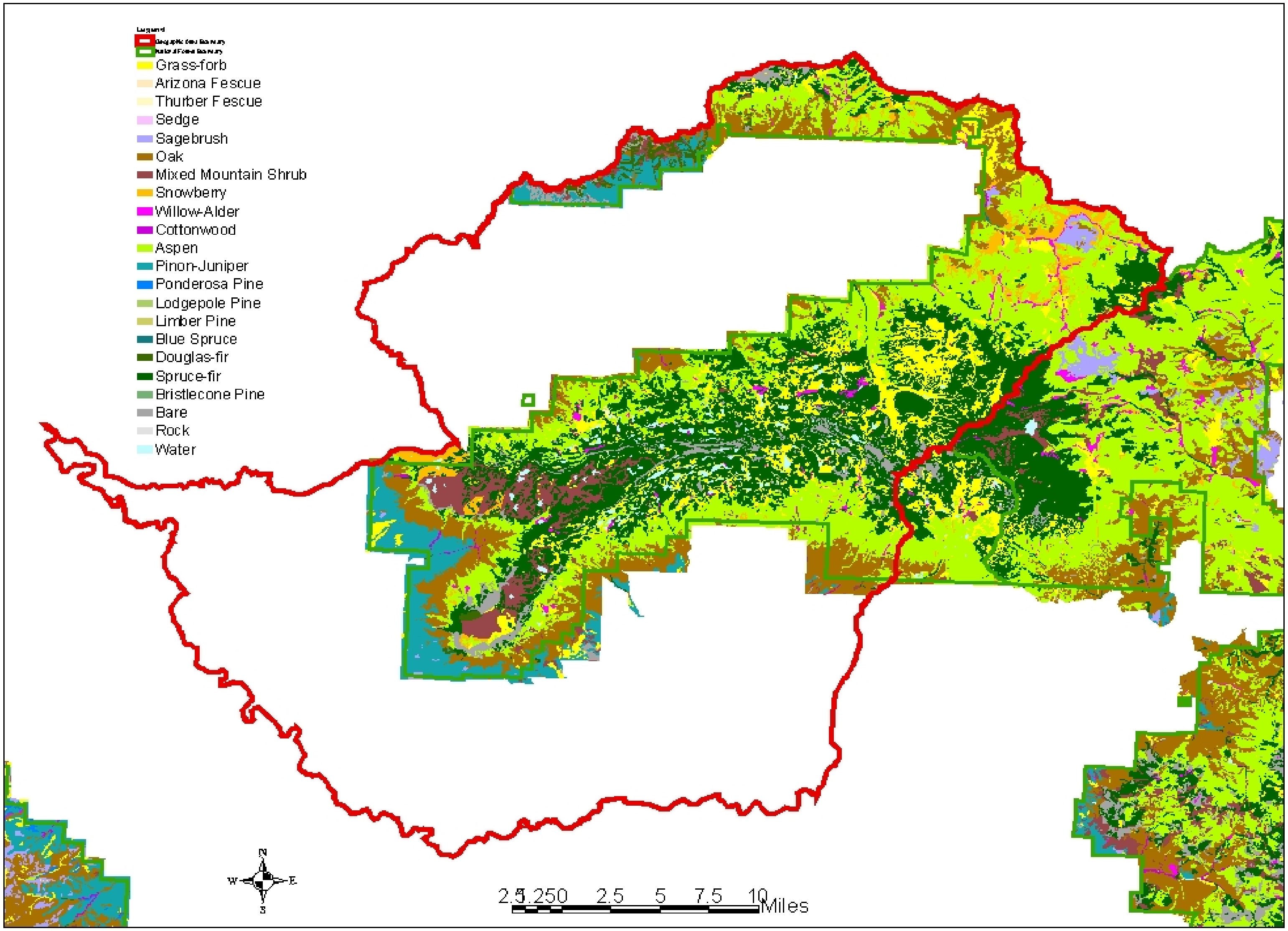


Figure 2. Map of Current Vegetation, Grand Mesa Geographic Area



Habitat Structural Stages

Vegetation is also characterized by structure. Structure is described by habitat structural stages. Habitat structural stages are defined by size class, tree diameter, and canopy closure (or canopy density measured as crown cover percent). Table 1 displays habitat structural stage definitions (Hoover and Wills, 1987).

Table 1. Habitat Structural Stage Definitions

Habitat Structural Stage	Size Class	Diameter	Crown Cover Percent
1T[1]/1M[2]	Grass-Forb	Not applicable	0 – 10%
2T[1]/2S[3]	Shrub-Seedling	< 1 inch	0 - 10%
3A	Sapling-Pole	1 – 9 inches	11 – 40%
3B	Sapling-Pole	1 – 9 inches	41 - 70%
3C	Sapling-Pole	1 – 9 inches	71 - 100%
4A	Mature	9+ inches	11 – 40%
4B	Mature	9+ inches	41 - 70%
4C	Mature	9+ inches	71 - 100%

1 Opening in tree cover type created by some type of disturbance
2 Natural meadow
3 Shrub cover type

Habitat structural stages can be used as indicators for:

- *Wildlife habitat* - Different wildlife species have different habitat requirements. For example, species that require large diameter trees in dense stand conditions find habitat in areas with 4B and 4C habitat structural stages.

- *Potential risk for future fire, insect and/or pathogen activity* - Trees growing in dense *stands* can be stressed by competition for water, nutrients and sunlight, making them more susceptible to insect attack.

- *Time since disturbances (fire, harvest, etc.) affected an area*. Age of vegetation is not directly linked to habitat structural stage; however, relative stages of succession can be *implied*. Early stages of succession are shown as habitat structural stages 1 or 2; later successional stages are usually in habitat structural stages 4A/ 4B/4C. Sometimes structural stages 3A/3B/3C may be the same age as 4A/4B/4C.

Current habitat structural stages for NFS lands within the Grand Mesa Geographic Areas are shown in Figure 3. Please note, on Figure 3 natural meadows in grass-forb cover types are shown as structural stage 1M, and shrub cover types are shown as structural stage 2S.

Figure 3. Current Habitat Structural Stages, Grand Mesa Geographic Area

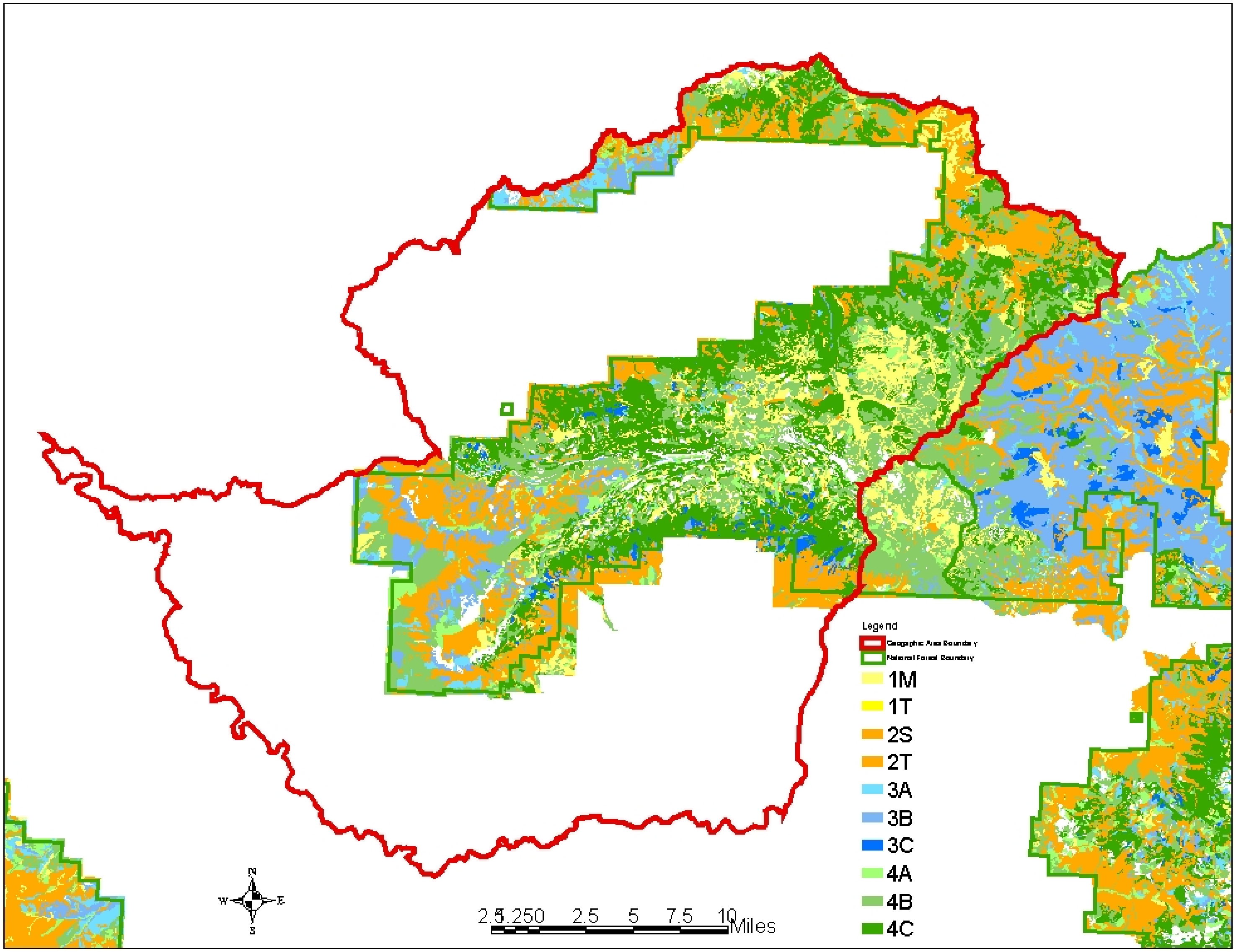
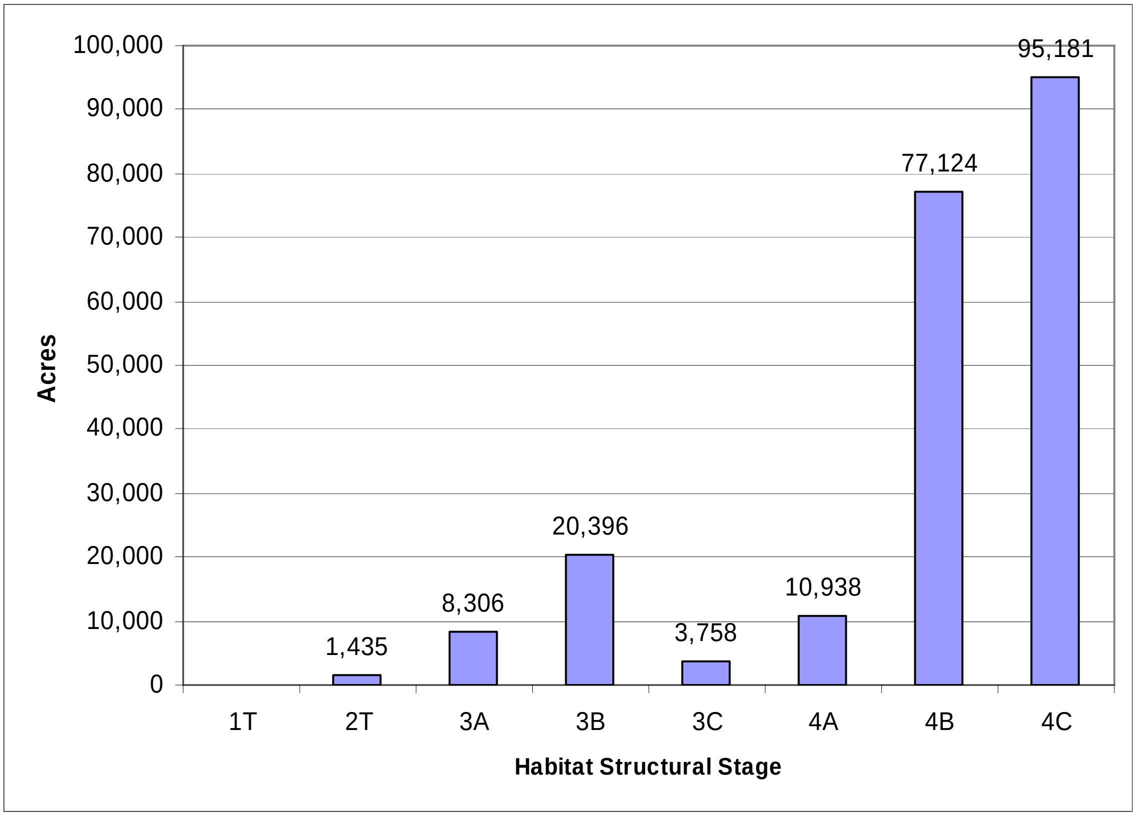


Figure 4 displays the distribution of habitat structural stages for the forest and woodland cover types (spruce-fir, aspen, Douglas-fir, ponderosa pine, cottonwood, pinyon-juniper) on NFS portion of the Grand Mesa Geographic Area. Note: Natural meadows and shrublands are not included in the chart below.

Figure 4. Habitat Structural Stage Distribution of Forest and Woodland Cover Types, Grand Mesa Geographic Area



This information can also be summarized by looking at the distribution of size classes (Figure 5) and densities or canopy closure (Figure 6) of forest and woodland cover types on NFS lands within the Geographic Area. Again, natural meadows and shrublands are not included in the data shown in Figures 5 and 6.

Figure 5. Size Class Distributions of Forest and Woodland Cover Types

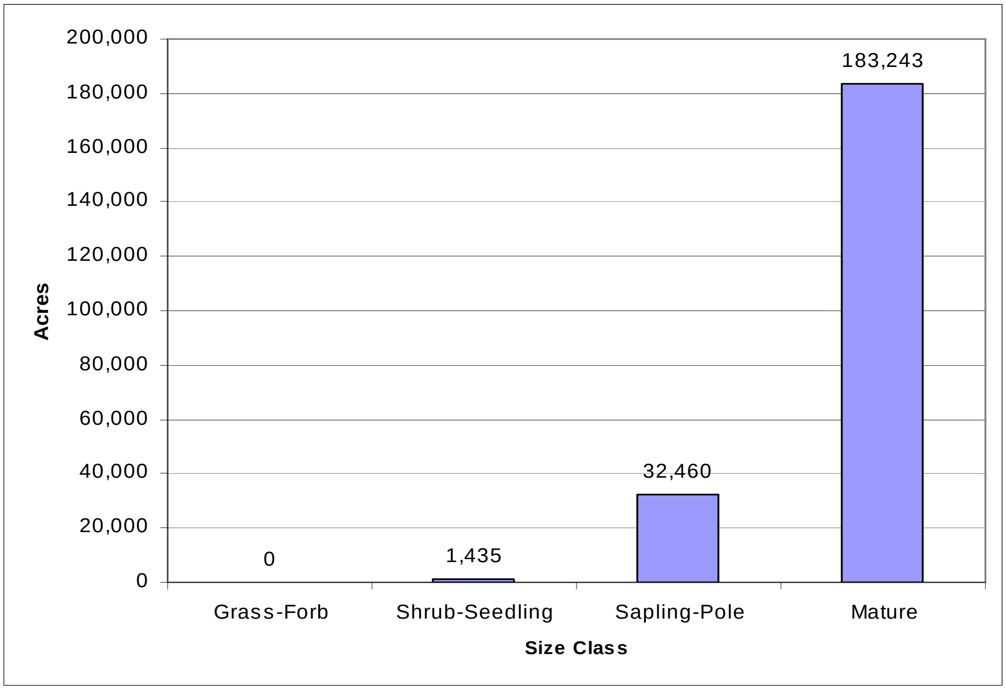
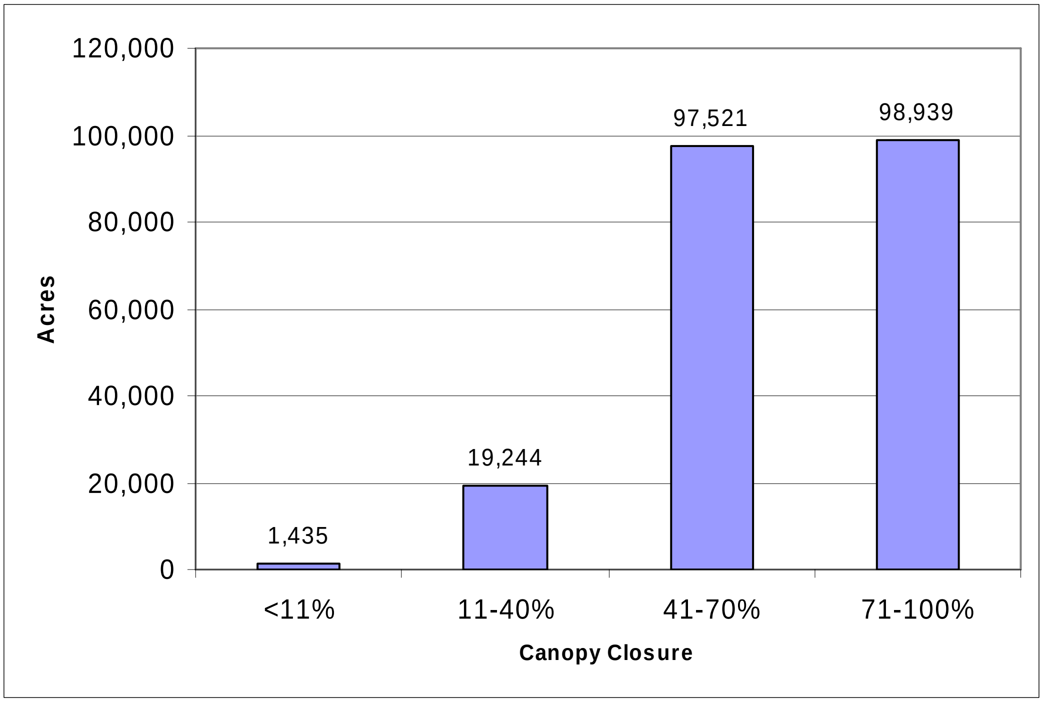


Figure 6. Canopy Closure Distributions in Forest and Woodland Cover Types



Characterization of Current Vegetation Conditions

Additional information on current conditions of different cover types is summarized in Table 2. (Also see timber, range and fire management sections.)

Table 2. Current Vegetation Characterization for NFS lands on Grand Mesa Geographic Area

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Spruce-fir (Englemann spruce – subalpine fir)	93,300 acres 26%. (58% without aspen in species mix, 42% with aspen in the species mix)	Ranges from 10 to 210 years. Most spruce-fir is between 100-160 yr. old	1%-3A 5%-3B 1%-3C 7%-4A 41%-4B **46%-4C**	34% - single-storied 71% - multi-storied 97% - continuous canopies	12% of type has been affected by timber harvest	83% of type is within ½ mile of a road or trail. Includes: 82 miles roads 101 miles trails
Aspen	94,500 acres 26%. (60% pure aspen, 39% with spruce-fir in species mix, 1% with other tree species in mix)	Ranges from 16 to 131 years. Most aspen is between 80-120 yr. old.	2%-2T 2%-3A 10%-3B 3%-3C 1%-4A 28%-4B **54%-4C**	27% - single-storied 73% - multi-storied 98% - continuous canopies	2% of type has been affected by timber harvest	83% of type is within ½ mile of a road or trail. Includes: 68 mile roads 147 miles trails
Mixed Conifer (Douglas-fir, Blue Spruce)	3,500 acres 1%.	Age data not available.	26%-3A 25%-3B **28%-4A** 19%-4B 2%-4C	21% - single-storied 79% - multi-storied 99% - continuous canopies	None recorded..	21% of type is within ½ mile of a road or trail. Includes: 1 mile road 0 miles trails
Pinyon-Juniper	25,400 acres 7%	Age data not available	20%-3A 20%-3B 8%-4A **48%-4B** 3%-4C	56% - single-storied 44% - multi-storied 100% - continuous canopies	3% of type has been mechanically treated, 2% has been prescribed burned to improve habitat for big game.	32% of type is within ½ mile of a road or trail. Includes: 10 miles roads 8 miles trails
Cottonwood	500 acres <1%	No age data available.	17%-3B **40%-4A** 33%-4B 9%-4C	16% - single-storied 84% - multi-storied 100% - continuous canopies	None recorded.	80% of these types are within ½ mile of a road or trail. Includes: <1 miles roads 1 miles trails

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Gamble Oak – Mixed Mountain Shrub	64,600 acres 19%	No age data available.	100% 2S 52% large (>6.5’) 38% med. (2.5-6.4’) 10% small (<2.5’)	21% - single-storied 79% - multi-storied 92% - >40% cover 8% - <= 40% cover	19% of these types have been treated with prescribed fire to improve habitat for big game.	69% of these types are within ½ mile of a road or trail. Includes: 75 miles roads 98 miles trails
Snowberry	10,600 acres 3%	No age data available	100% 2S 88% med. (2.5-6.4’) 12% small (<2.5’)	6% - single-storied 94% - multi-storied 94% - >40% cover 6% - <= 40% cover	2% of these types have been treated with prescribed fire to improve habitat for big game.	78% of these types are within ½ mile of a road or trail. Includes: 22 miles roads 22 miles trails
Sagebrush	2,400 acres 1%.	No age data available.	100% 2S 21% med. (2.5-6.4’) 79% small (<2.5’)	15% - single-storied 85% - multi-storied 78% - >40% cover 22% - <= 40% cover	None recorded in this period.	71% of type is within ½ mile of a road or trail. Includes: 5 miles roads 2 miles trails
Willow	3,600 acres 1%	No age data available	100% 2S 33% large (>6.5’) 59% med. (2.5-6.4’) 8% small (<2.5’)	7% - single-storied 93% - multi-storied 72% - >40% cover 28% - <= 40% cover	None recorded.	94% of these types are within ½ mile of a road or trail. Includes: 11 miles roads 8 miles trails
Grass/Forb	48,600 acres 11%	No age data available.	100% 1M	Not applicable	1% of this type has been treated with prescribed fire to improve habitat for big game.	64% of these types are within ½ mile of a road or trail. Includes: 90 miles roads 95 miles trails.

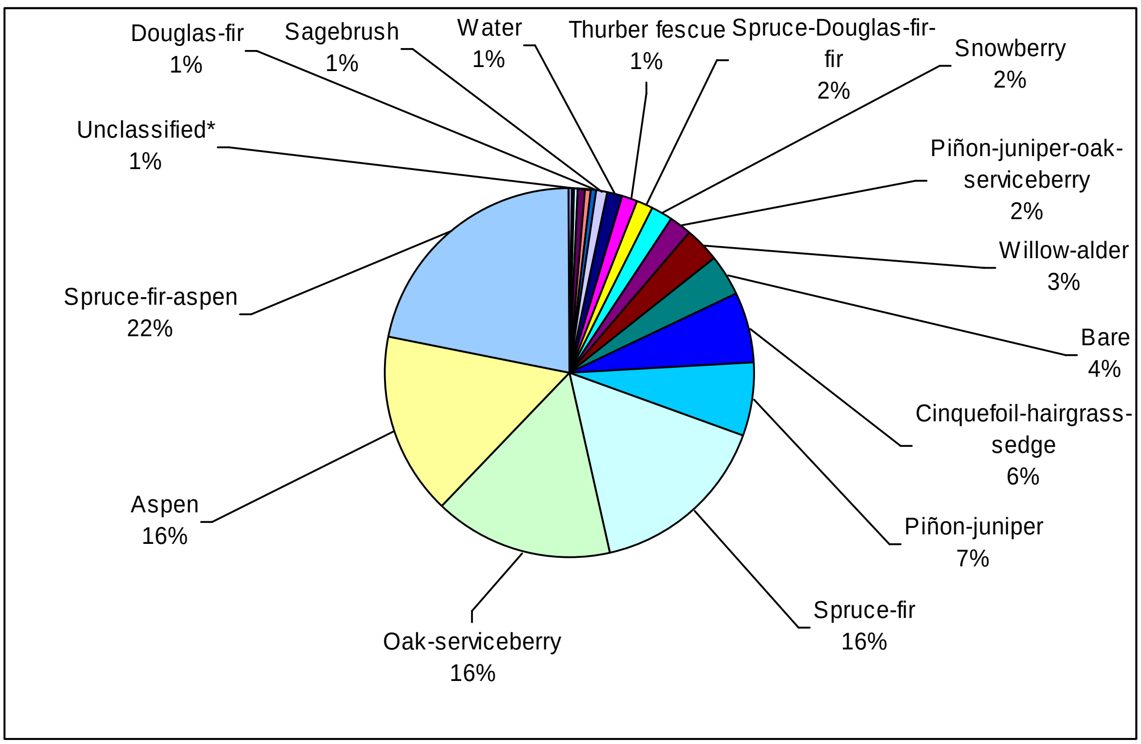
1 Common Vegetation Unit/R2VEG database
2 Stand exam data for Grand Mesa Geographic Area.
3 RMACT database
4 INFRA transportation data related to R2VEG data. Includes all inventoried roads and trail, not just routes open to public use.

Comparison of Current Conditions to Historic Conditions

Environmental factors such as soils, slope, aspect, climate, and elevation determine the plant communities that potentially can grow on a given area. The stable plant community that establishes in the absence of any disturbances (i.e., fire, insect/pathogen mortality, windthrow, drought, harvest) is called the climax plant community. The area where a given climax plant community can grow is classified as a Potential Natural Vegetation (PNV) type, and is named for the climax plant community. For example, spruce-fir forests are the climax plant community at elevations from 10,000 to 12,000 feet, in the subalpine climatic zone (30-40 inches of precipitation annually, 50-70 frost free days, 30-40ºF mean annual air temperature) (Johnston et al. 2001). Areas where spruce-fir is the climax plant community are classified as the spruce-fir PNV type.

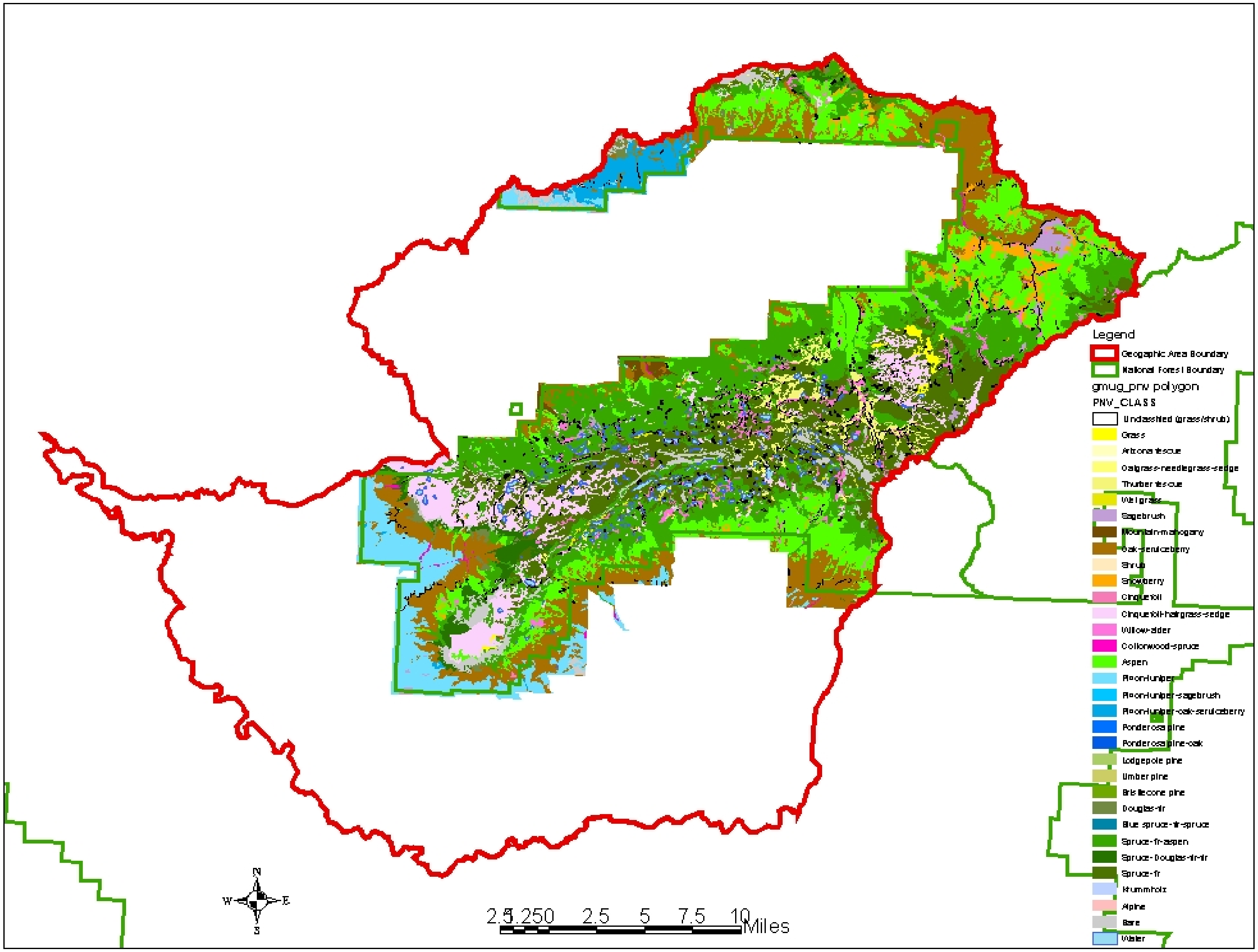
Draft PNV type classification has been completed for this Geographic Area. The PNV type composition on NFS lands within the Grand Mesa Geographic Area is shown in Figure 7. (PNV types with <0.1 percent composition are not included in Figure 7.) A map of PNV for the Grand Mesa GA is shown in Figure 8.

Figure 7. Composition of Potential Natural Vegetation Types on NFS lands within the Grand Mesa Geographic Area



* Unclassified, grass/forb or shrub types where the PNV type has not yet been assigned.

Figure 8. Potential Natural Vegetation on NFS portion of Grand Mesa Geographic Area



Historically, for any given PNV type, natural disturbances (i.e., fires, insect outbreaks) occurred at characteristic intervals and intensities, called regimes. When a disturbance was intense enough to change the existing plant community (e.g., some or all of the overstory was killed), the remaining vegetation followed a natural progression, or succession, of plant communities that changed over time. If no further disturbances occurred, an area eventually returned to the climax plant community. However, if multiple disturbances occurred on the same area earlier seral plant communities would be perpetuated on a site for extended periods. The natural disturbance regimes and succession cycles resulted in shifting mixtures (or ranges) of different seral plant communities (or stages) within any given PNV type at any point in time.

The Vegetation Dynamics Development Tool (VDDT) (Beukema et al. 2003) was used to model the expected range in seral conditions that would have existed under historic disturbance regimes for forest, woodland and shrub PNV types. The results displayed in the following tables are conditions that would have been distributed across an entire PNV type on the Geographic Area. Results are scale dependant. For example, if a large fire burned an entire watershed, all of a given PNV type in that watershed could be set back to an early seral condition. However, when the watershed is considered as part of the Geographic Area, the mixture of seral conditions for that PNV type would be within the expected ranges. Both situations would have occurred naturally.

The next sections include comparisons of current conditions to historic conditions for the most common PNV types on the Grand Mesa Geographic Area, to see where differences occur. This information can be used to identify future management opportunities.

Spruce-Fir PNV Type

The spruce-fir PNV type is mapped on 16 percent of the Grand Mesa Geographic Area. The climax community in this PNV type includes Englemann spruce and supalpine fir as the overstory species. This type occurs at the highest elevations (above 9,200 feet) on the Grand Mesa Geographic Area (Kulakowski and Veblen Draft 2004). The spruce-fir PNV type includes just over half (54 percent) of what is currently classified as spruce-fir cover type.

Table 3 describes the seral stages and the timeline for succession in the spruce-fir PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages) within the spruce-fir PNV type.

Table 3. Succession (Seral Stages) in Spruce-Fir PNV Type

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. Fir seedling establishment lags by several decades. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	8%	40%	52% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Kulakowski and Veblen, Draft 2004

Currently much of the spruce-fir PNV type is in mid-seral conditions (includes both early-mid and late-mid), and a small amount is in early seral conditions. Most of the stands in the spruce-fir PNV type originated in the mid to late 1800s (Kulakowski and Veblen, Draft 2004) making them 120 to 150 years old. The stand ages are a result of extensive fires on the Grand Mesa Geographic Area in the mid to late 1800s (Kulakowski and Veblen, Draft 2004, Sudworth 1900). The current conditions expressed in the spruce-fir PNV type demonstrate the effect of large scale disturbances setting large areas to the same seral condition. Not enough time has passed since the last major disturbance (the late 1800s) to allow a full range of seral conditions to develop in this PNV type.

The historic fire regime for the spruce-fir PNV type was long return interval (> 200 years), stand replacing fires, which could cover areas from 1,000 to 10,000 acres (Peet 1981 as cited in Neely et al. 2001) mixed with infrequent low-intensity surface fires that affected much smaller areas. Fire return intervals tended to be longer at higher elevations and in moist depressions and valley bottoms, up to 500 years (Romme et al. 1999). Recent fires have been very infrequent and very small in this PNV type. The majority of fires in this type on the Grand Mesa Geographic Area have been human caused (see Fire Management Section).

A variety of insect and pathogen agents affect spruce-fir forests (see Forest Health section). Spruce beetle outbreaks have occurred several times in the past century, affecting portions of this PNV type. In the late 1940s, portions of the Lands End and Flowing Park areas were affected. Salvage harvest operations occurred in these areas in the late 1940s and early 1950s, affecting approximately 1,900 acres. These areas are currently in early-mid conditions. In October 1997, between 8,000-12,000 acres of spruce-fir were affected by blowdown during a large wind event. Affected areas are scattered throughout the central portion of the Geographic Area. Salvage harvests have treated approximately 700 acres of blowdown to reduce spruce beetle build ups. Subalpine fir mortality has also affected approximately 17,400 acres, reducing the amount of subalpine fir in the species mix. Stand density has been reduced in the areas affected by this more recent mortality (windthrow, spruce beetle mortality, subalpine fir mortality, salvage harvest) but seral condition has not been set back. These areas are in the late-mid seral conditions.

Additional timber harvest in this PNV type includes some early thinning (pre 1960s, approximately 500 acres) in the western portion of the Geographic Area, and shelterwood harvests (1980s to present, approximately 4,100 acres) have been done in more central areas of the Geographic Area (near Neversweat, Big Creek, Atkinson and Anderson reservoirs). Shelterwood harvest practices reduced the density of stands but did not alter the seral condition, and these are still in the late-mid seral condition.

Spruce-Fir-Aspen PNV Type

The spruce-fir-aspen PNV type is mapped on 22 percent of the Grand Mesa. The climax community in this PNV type includes Englemann spruce and subalpine fir as the dominant overstory species with aspen occurring in all seral stages. The spruce-fir-aspen PNV type is comprised of the remaining 46 percent of the current spruce-fir cover type, and approximately 37 percent of the current aspen cover type.

Table 4 describes the seral stages and timeline for succession in the spruce-fir-aspen PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages) within the spruce-fir-aspen PNV type.

Table 4. Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	5%	63%	32% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

This PNV type is generally below the spruce-fir PNV type in elevation. Approximately 45 percent of the spruce-fir-aspen PNV type currently is dominated by aspen in the overstory, and 50 percent currently has more conifers in the overstory. As evidenced by the percentages in the table above, most of this PNV type is in mid seral conditions (includes both early-mid and late-mid). Current conditions are the result of large scale fires that burned through this area in the 1850s and again in 1878 to 1879 (Kulakowski and Veblen Draft 2004, Sudworth 1900). The large amount of area in the early-mid seral condition is due to a pulse of aspen regeneration that occurred following these fires. The majority of these stands are in the 80 to 100 year old range. As with the previous PNV type, the current conditions expressed in the spruce-fir-aspen PNV type demonstrate the effect of large scale disturbances setting large areas to the same seral condition. The time since the last major disturbance has not been sufficient to allow a full range of seral conditions to develop in this PNV type.

The fire regime in the spruce-fir-aspen PNV type is similar to that described above for the spruce-fir PNV type (long return interval stand replacing fires affecting large areas, mixed with infrequent low-intensity fires affecting small areas). Recent fires have been infrequent and very small in this PNV type. Most fires have been human caused in this PNV type, as well.

The spruce-fir-aspen PNV type is also host to the same insect and pathogen organisms as the spruce-fir PNV type, as well as aspen insects/pathogens. Recent insect and disease activity includes subalpine fir mortality (17,000 acres affected), with lesser amounts of spruce beetle and aspen fungi mortality. Areas affected remain in mid seral conditions for extended periods of time.

Aspen clearcutting (mid 1980s to present) has occurred on approximately 1,900 acres of this PNV type scattered in the Waterdog, Horse Mountain, Oak Creek and Owens Creek areas. Shelterwood harvests in spruce-fir during the same period have occurred on approximately 3,000 acres, mostly in the Eggleston Lake and Hay Park Reservoirs areas. The aspen clearcuts are identified as the early seral conditions in the table above. Shelterwood harvests did not alter the seral stage. These areas are included in the late seral conditions dominated by spruce and fir.

Aspen PNV Type

In the aspen PNV type, pure aspen is the climax plant community, with no conifer species present. The aspen PNV type is mapped on 16 percent of the Grand Mesa Geographic Area. Approximately 60 percent of what is currently shown as the aspen cover type is included in the aspen PNV type.

Table 5 depicts the seral stages and timeline for this PNV type as well as a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages).

Table 5. Succession (Seral Stages) in Aspen PNV Type

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 10 to 20 years	Dense pole-sized aspen, grass and forb understory, lasting 50 to 80 years	Mature aspen overstory, aspen regeneration in the understory where overstory gaps results from individual tree mortality, lasting up to 80 years	Stable multi-storied, multi-aged aspen stand, predominantly forb understory.Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	8-14%	23-26%	17-24%	23-43%
Current Seral Conditions	3%	15%	82% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

The aspen PNV type is predominantly in late-mid to late seral conditions. Few areas are in early seral conditions. As with the previous PNV types, the distribution of seral conditions in the aspen PNV type is the result of past large scale fire activity in the late 1800s (Sudworth 1900).

The same fires that influenced the distribution of seral conditions in the spruce-fir-aspen PNV type also affected this aspen PNV type. Because aspen matures faster than spruce or fir, this PNV type shifts into the later seral stages more rapidly, as reflected in the higher amount of late-mid to late seral condition as compared to the spruce-fir-aspen PNV type.

The historic fire regime for aspen is more frequent than for the two previous PNV types. Aspen forest appear to be dominated by a regime of relatively infrequent, large fires at higher elevations, and smaller more frequent fires at lower elevations (Kulakowski and Veblen, Draft 2004). Recent fires have been very infrequent and small in this type.

Two percent of this PNV type has been affected by timber harvest. Clearcuts were done between 1984 to present. The majority of the acres treated are located on Ruth Mountain and in the Crooked Creek watershed. Other clearcut areas are scattered in Surface Creek, Horse Mountain, Park Creek and Baxter Creek. These harvested areas are included in the early seral conditions listed in the table above.

Oak-Serviceberry PNV Type

The oak-serviceberry PNV type has been mapped on 16 percent of NFS lands on the Grand Mesa. Historically, fires occurred in this PNV type at frequent intervals (every 15-30 years). The dominant shrub species, Gambel oak and serviceberry resprout following fire, so areas quickly return to shrub cover. This type transitions from one seral stage to another at approximately 30 year timesteps. Table 6 compares current conditions in this PNV type to the modeled historic mix of seral conditions.

Table 6. Succession (Seral Stages) in Oak-Serviceberry PNV Type

	Early	**Mid**	**Late**
Seral Stage Descriptions*	Stands are dominated by resprouting shrubs with grasses and forbs in the understory. Persists to 20 or 30 years	Dense clumps of shrubs, usually < 6 feet high. Grass and forbs between clumps. Persists from 30 to 40 years.	Shrubs > six feet high, more open canopy. Grass/forbs between and beneath shrub canopies. Persists until next stand replacing disturbance.
VDDT Modeled Range of Seral Conditions	30-70%	28-34%	0-36%
Current Seral Conditions	8%	34%	58%

*Romme et al. 2003

Most of the oak-serviceberry PNV type in the Grand Mesa Geographic Area is currently in mid and late seral conditions, and little is in early seral conditions. The disparity between the historic conditions and current conditions is because there have been few recent disturbance in this PNV type, primarily due to fire suppression efforts over the past 100 years.

Frequent fires are the historical regime in this PNV type (0 - 35 years) (Kulakowski and Veblen Draft 2004). Fires would have started below the forest on what is mostly private land now, and burned into the oak-serviceberry PNV type on the Geographic Area. Fire suppression efforts, cover type conversion on private lands and past livestock grazing have not allowed fires to burn in this PNV type as frequently as in the past. As a result, the majority of this vegetation type has aged into mid and late seral conditions.

Approximately 14 percent of this PNV type has been treated with prescribed fire between 1978 and 2001. Approximately 70 percent of this area was burned more than once, at different times. Projects were concentrated on Battlement Mesa, Hightower and Oak Creek areas. These projects account for the early seral and part of the mid seral conditions represented in the tables above. The purposes for these treatments was to improve habitat for big game species by restoring earlier seral conditions that provide more forage than later seral conditions.

Pinyon-Juniper PNV Types

Two different pinyon-juniper PNV types have been identified on the Grand Mesa Geographic Area. Together these two types are mapped on nine percent of the NFS land on the Grand Mesa Geographic Area. The most common PNV type is pinyon-juniper (seven percent) located primarily on the west end of the Grand Mesa in the Kannah Creek area and the lower elevations of the Sunnyside area. The pinyon-juniper-oak-serviceberry PNV type two percent) is located in the Sunnyside area, above the pinyon-juniper type in elevation. Table 7 displays the seral stages and timeline for the pinyon-juniper PNV type.

Table 7. Succession in Pinyon-Juniper PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	Stands are dominated by a mixture of herbaceous species, persists from stand age 0 until age 10	Within one to several decades after a severe disturbance, shrub seedlings become established and co-dominate with the early successional herbs which are still abundant … persists from stand age 10 until age 50-70	The low shrubs dominate the stand, though the grasses and perennial forbs of earlier successional stages are still well represented, and young trees are poking through the shrub canopy … persists from stand age 50-70 until age 150-200	The stand is dominated by a mature tree canopy. The low shrubs and perennial herbs are still present, but have reduced cover if tree cover is high … persists from stand age 150-200 until the next stand-replacing disturbance
VDDT Modeled Range of Seral Conditions	1-3%	5-11%	56-59%	30-34%
Current Seral Conditions	<1%	5%	2%	93%

*Romme et all, 2003

The vast majority of the pinyon-juniper PNV type is currently in late seral tree dominated conditions. This is a result of past fire suppression not allowing fires to periodically burn in this type. Heavy livestock grazing that persisted until the mid-1950s also contributed to the current tree dominated conditions by removing competing understory species, which allowed the woody overstory species to prosper. The limited amounts of mid and early seral conditions exist where chaining (650 acres), prescribed fire (600 acres) and wildfires (see below) have occurred.

The Kannah Creek area of the Grand Mesa Geographic Area has the highest fire occurrence in the Grand Mesa. All the fires have been lightning caused between 1971 to the present. Approximately 400 acres have been burned in this PNV type. Aggressive fire suppression efforts have been used in this area, which has limited the acres that have been affected.

There is agreement that fires tend to be stand replacing in this PNV type (Eisenhart 2004, Kulakowski and Veblen Draft 2004, Romme et al. 2003). However, the historical fire return interval and fire size has been shown to be quite variable (Eisenhart 2004, Romme et al. 2003).

Key Findings

- Aspen and spruce-fir cover types each currently occupy 26 percent of the Grand Mesa Geographic Area. Aspen is also present in 31 percent of the spruce-fir cover type, making aspen the most common tree species on the Geographic Area.
- The large extent of aspen is the result of large scale fires in the late 1800s (Sudworth 1900), that affected most of the Grand Mesa Geographic Area. As a result, the majority of this geographic area is currently in mid seral conditions.
- Approximately 84 percent of the forest and woodland cover types are in the mature size class.
- The majority of the current forest and woodland vegetation conditions – 91 percent - have dense canopy closures (> 40 percent canopy closure).
- There is very little early seral condition in any cover type on the Grand Mesa Geographic Area, as shown in Tables 3 through 7.
- When comparing the compositions of current vegetation cover types to PNV types (Figure 1 through Figure 7), there is very close comparison, a further indication that current cover types are predominantly in mature conditions.

Vegetation Trends

- The trend across all vegetation cover types on the Grand Mesa is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Vegetation Management Implications

Management implications of vegetation conditions relate to differences between current and historic vegetation conditions. Where landscape conditions are similar to historic conditions landscapes are more resilient following disturbances, suitable habitat is provided for all species that evolved there, and ecosystems are productive and sustainable over time. Where current conditions deviate from historic ranges, there are increased risks for natural disturbances to be of higher intensities and affect larger areas than in the past; some habitats may become very limited or lost, threatening species viability; and loss of productivity can result in both ecological and economic losses. Management activities that can include both human and natural disturbances can be used to alter vegetation conditions. Management implications for specific cover types are discussed below.

Spruce-Fir

- The spruce-fir cover type occurs in both the spruce-fir and the spruce-fir-aspen PNV types. Disturbances (human or natural) that occur in the spruce-fir-aspen PNV type will result in aspen regeneration within a very short period of time. Disturbances in the spruce-fir PNV type do not have aspen as an early seral species, and may take 50 to 200 years to regenerate to spruce.

- Both the spruce-fir and spruce-fir-aspen PNV types are currently dominated by mature, dense structural conditions. These conditions are ripe for fire and epidemic insect and pathogen outbreaks (see Forest Health and Fire Management sections). Because so much of the landscape is in the same condition, there is a high probability that large areas can be affected at the same time. Large scale disturbances (both fire and insect outbreaks) are the natural regimes for these PNV types. Management activities that increase diversity in age, size and seral condition, could be used to reduce the potential effects of natural disturbances.

- Approximately 42 percent of the spruce-fir cover type on the Grand Mesa Geographic Area is in currently unroaded areas. Where future management decisions (i.e., theme designations) limit or restrict management activities in these unroaded areas, only natural processes will alter vegetation conditions.

Aspen

- The aspen cover type occurs in both the spruce-fir-aspen PNV type (as the early through late-mid seral conditions) and the aspen PNV type (all seral stages). Based on the percentages in each seral stage displayed in the above tables for these PNV types, aspen currently dominates the Grand Mesa landscape. This is a result of extensive fires in the late 1800s.

- Aspen stands become very susceptible to cankers and root rots as they mature. A large percentage of the aspen cover type on the Grand Mesa Geographic Area is between the age of 80 and 120 years. An increasing amount of mortality caused by these fungal agents is expected in the future.

- Approximately half of the aspen stands on the Grand Mesa Geographic Area include conifer species in the understory or as codominant species. In the absence of some disturbance, these stands will eventually succeed to conifer dominated cover types. A shift from an aspen cover type to various conifer cover types will change the types of habitat available on the Grand Mesa Geographic Area to favor those species that require mature conifer forests.

Gambel Oak and Mountain Shrubs

- Current conditions in the Gambel oak and mixed mountain shrub cover types have less patchiness and structural stage diversity than would have occurred historically. The result is current conditions are more susceptible to higher intensity fires that may affect larger areas of land than would have occurred in the past. There is also less diversity in the types of habitat provided by these cover types than would have been present.

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CHAPTER 2. EXISTING VEGETATION – FOREST SCALE

North Fork Valley

Current Vegetation

Vegetation mapping for the Grand Mesa, Uncompahgre and Gunnison (GMUG) National Forests is generated primarily from aerial photo interpretation, with periodic updates resulting from field verification, management activities and natural disturbances (i.e., wildfires). Vegetation is classified by cover type. Cover type is determined by the dominant cover or species present at the time of classification. As a result, cover type classifications are more simplified than conditions that actually occur on the ground. (For example: Spruce/fir cover type includes areas where Englemann spruce and/or subalpine fir tree species are the majority of the vegetation. Aspen tree species may or may not be present as subdominant species.)

Current vegetation cover type composition on NFS lands within the North Fork Valley Geographic Area is shown in Figure 1. A map of current vegetation is shown in Figure 2.

Figure 1. Composition of Current Vegetation Cover Types on NFS lands within the North Fork Valley Geographic Area

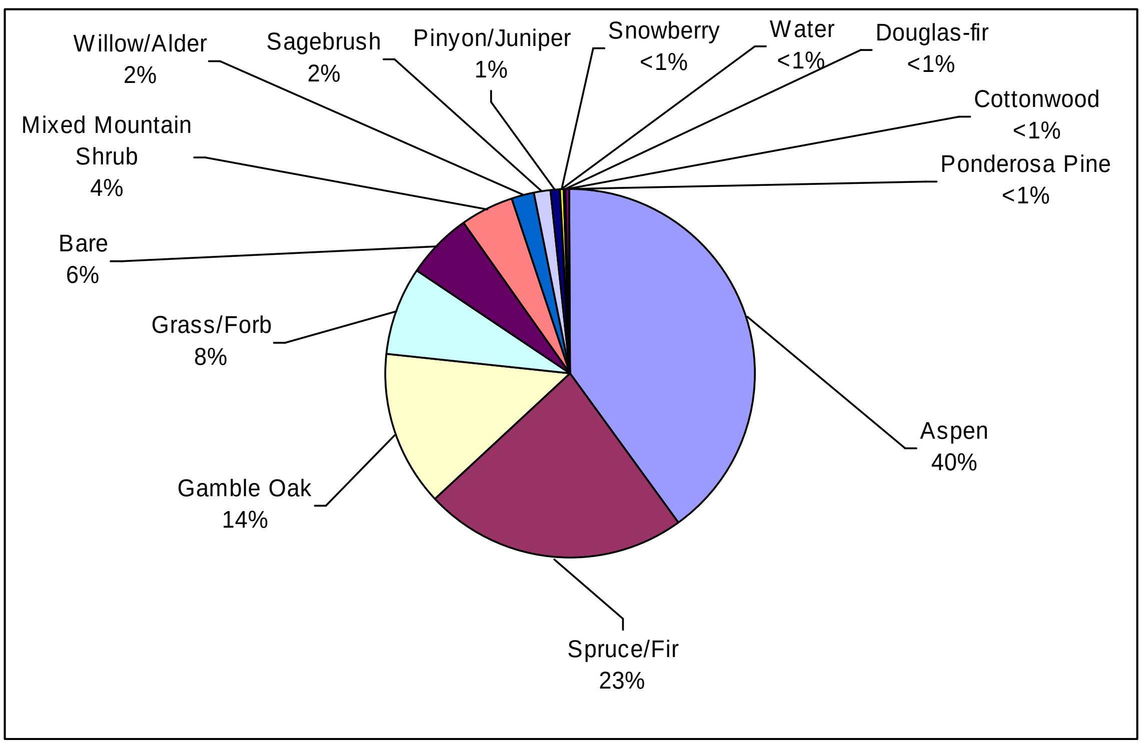
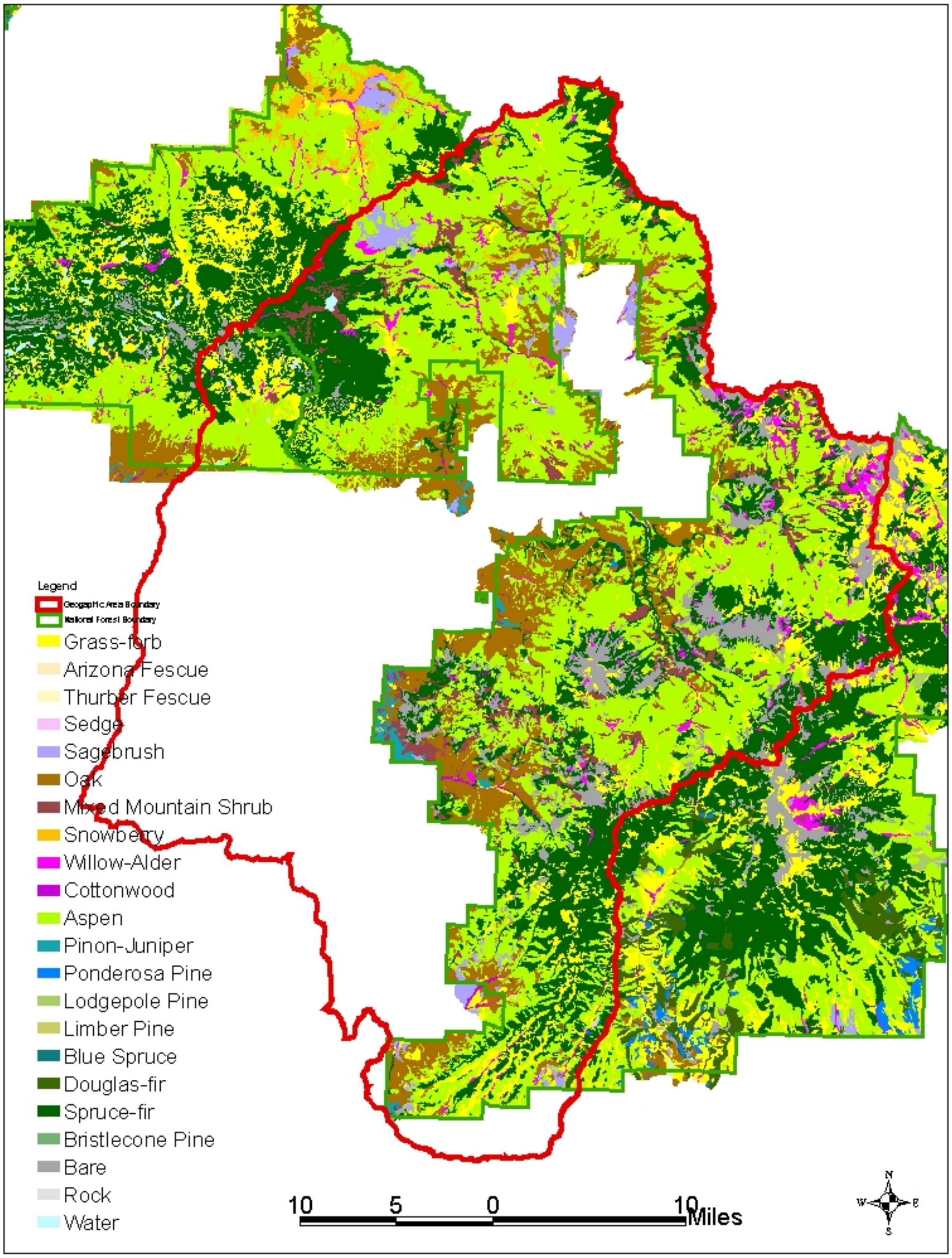


Figure 2. Map of Current Vegetation, North Fork Valley Geographic Area



Habitat Structural Stages

Vegetation is also characterized by structure. Structure is described by habitat structural stages. Habitat structural stages are defined by size class, tree diameter, and canopy closure (or canopy density measured as crown cover percent). Table 1 displays habitat structural stage definitions (Hoover and Wills, 1987).

Table 1. Habitat Structural Stage Definitions

Habitat Structural Stage	Size Class	Diameter	Crown Cover Percent
1T[1]/1M[2]	Grass-Forb	Not applicable	0 – 10%
2T[1]/2S[3]	Shrub-Seedling	< 1 inch	0 - 10%
3A	Sapling-Pole	1 – 9 inches	11 – 40%
3B	Sapling-Pole	1 – 9 inches	41 - 70%
3C	Sapling-Pole	1 – 9 inches	71 - 100%
4A	Mature	9+ inches	11 – 40%
4B	Mature	9+ inches	41 - 70%
4C	Mature	9+ inches	71 - 100%

1 Opening in forest cover type created by some type of disturbance
2 Natural meadow
3 Shrub cover type

Habitat structural stages can be used as indicators for:

- *Wildlife habitat* - Different wildlife species have different habitat requirements. For example, species that require large diameter trees in dense stand conditions find habitat in areas with 4B and 4C habitat structural stages.

- *Potential risk for future fire, insect and/or pathogen activity* - Trees growing in dense stands can be stressed by competition for water, nutrients and sunlight, making them more susceptible to insect attack.

- *Time since disturbances (fire, harvest, etc.) affected an area*. Age of vegetation is not directly linked to habitat structural stage; however, relative stages of succession can be implied. Early stages of succession are shown as habitat structural stages 1 or 2; later successional stages are usually in habitat structural stage 4A/ 4B/4C. Sometimes structural stages 3A/3B/3C may be the same age as 4A/4B/4C.

Current habitat structural stages for NFS lands within the North Fork Valley Geographic Areas are shown in Figure 3. Please note, on this map natural meadows in grass-forb cover types are shown as structural stage 1M, and shrub cover types are shown as structural stage 2S.

Figure 3. Current Habitat Structural Stages, North Fork Valley Geographic Area

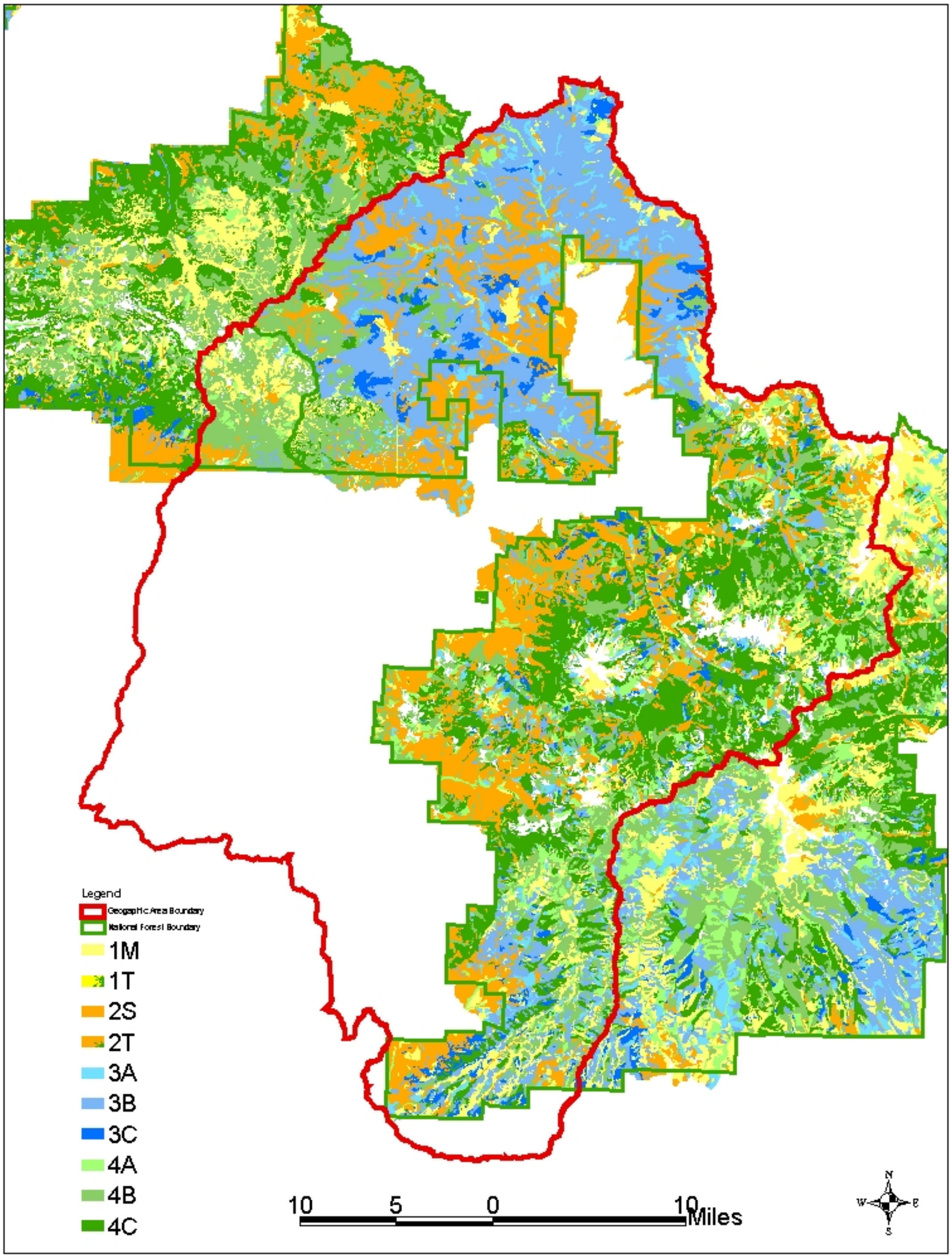
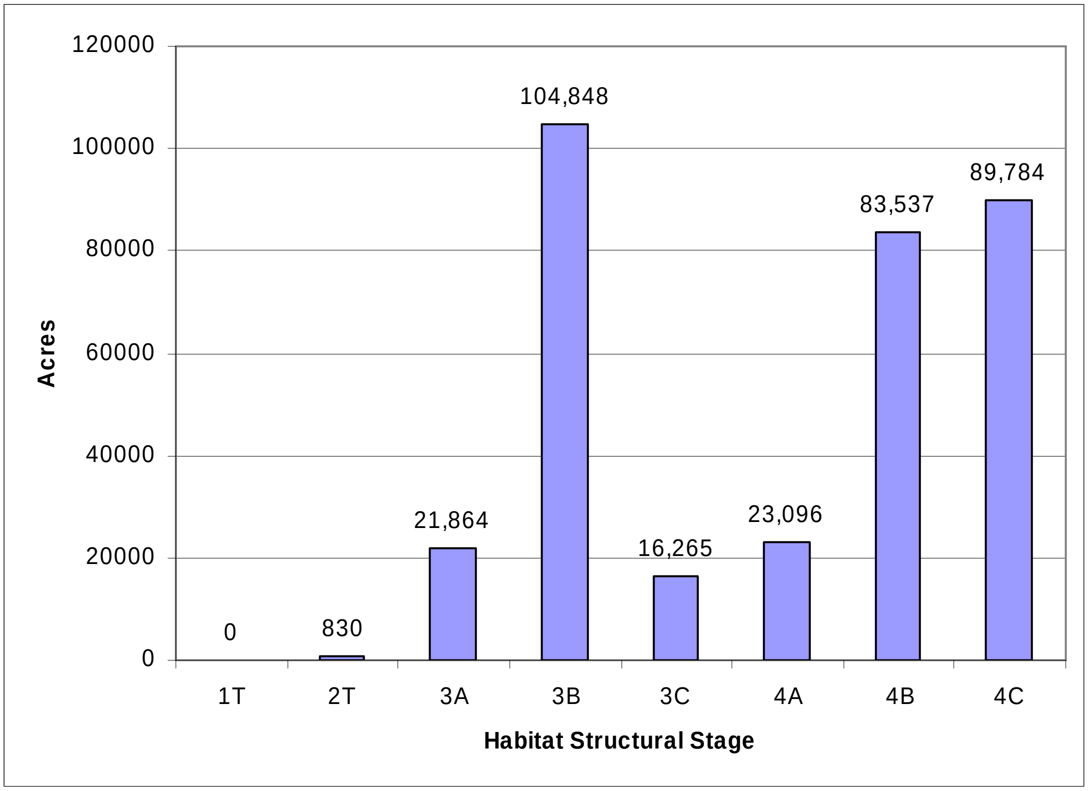


Figure 4 displays the distribution of habitat structural stages for the forest and woodland cover types (spruce-fir, aspen, Douglas-fir, ponderosa pine, cottonwood, pinyon-juniper) on NFS portion of the North Fork Valley Geographic Area. Note: Natural meadows and shrublands are not included in the chart below.

Figure 4. Habitat Structural Stage Distribution of Forest and Woodland Cover Types, North Fork Valley Geographic Area



This information can also be summarized by looking at the distribution of size classes (Figure 5) and densities or canopy closure (Figure 6) of forest and woodland cover types on NFS lands within the Geographic Area. Again, natural meadows and shrublands are not included in the data shown in Figures 5 and 6.

Figure 5. Size Class Distributions of Forest and Woodland Cover Types

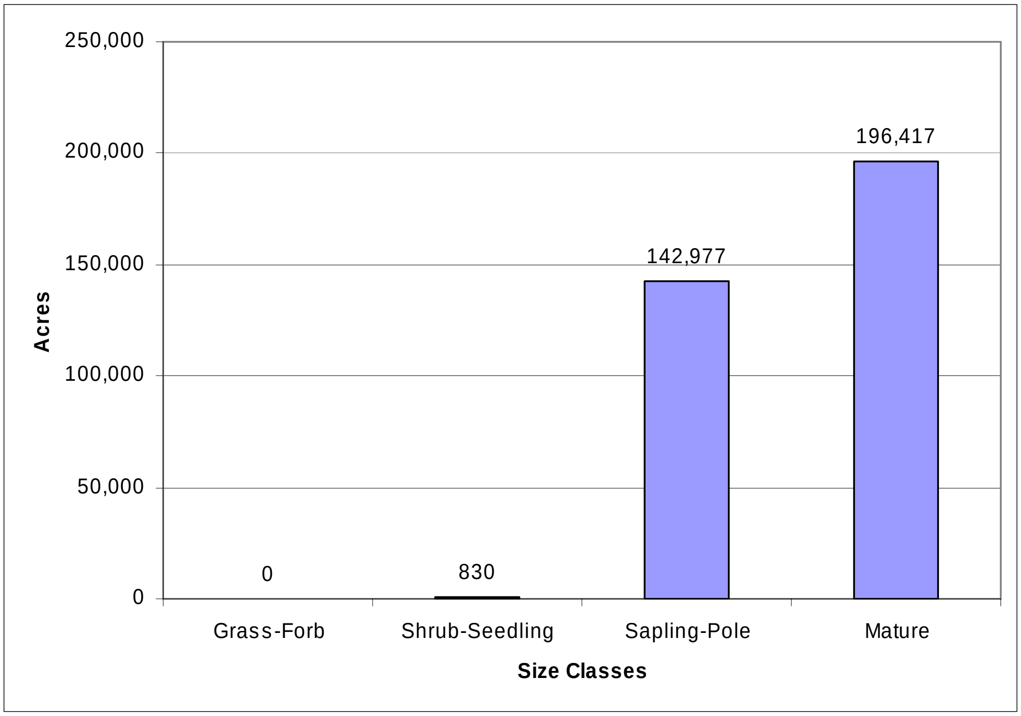
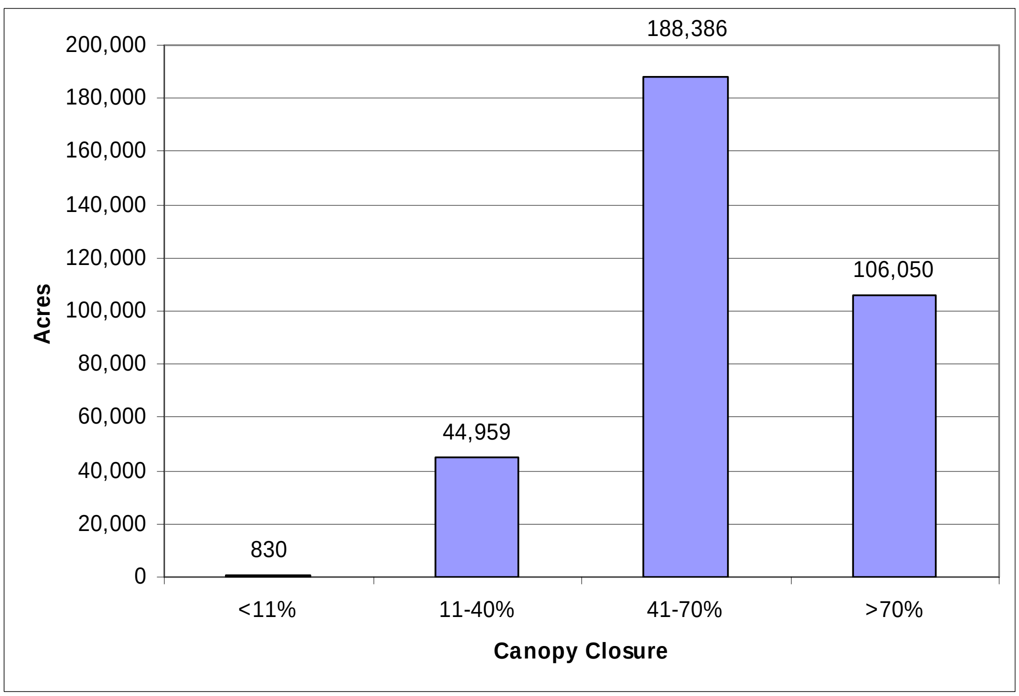


Figure 6. Canopy Closure Distributions in Forest and Woodland Cover Types



Characterization of Current Vegetation Conditions

Additional information on current conditions of different cover types is summarized in Table 2. (Also see timber, range and fire management sections.)

Table 2. Current Vegetation Characterization for NFS lands on North Fork Valley Geographic Area

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Spruce-fir (Englemann spruce – subalpine fir)	121,800 acres 23%.	Age data not available	5%-3A 14%-3B 2%-3C 13%-4A **38%-4B** 27%-4C	28% - single-storied 72% - multi-storied 99% - continuous canopies	6% of type has been affected by timber harvest	74% of type is within ½ mile of a road or trail. Includes: 53 miles roads 132 miles trails
Aspen	212,600 acres 40%.	Age data not available	<1%-2T 7%-3A **41%-3B** 6%-3C 3%-4A 16%-4B 26%-4C	40% - single-storied 60% - multi-storied 99% - continuous canopies	2% of type has been affected by timber harvest	83% of type is within ½ mile of a road or trail. Includes: 138 mile roads 328 miles trails
Mixed Conifer (Douglas-fir, ponderosa pine)	1,500 acres <1%.	Age data not available	3%-3A 27%-3B 5%-3C **29%-4A** 26%-4B 10%-4C	28% - single-storied 72% - multi-storied 100% - continuous canopies	1% of these types have been affected by timber harvest.	80% of type is within ½ mile of an open road or trail. Includes: 1 mile road 3 miles trails
Pinyon-Juniper	3,200 acres 1%	Age data not available	24%-3A 2%-3B 29%-4A **40%-4B** 4%-4C	89% - single-storied 11% - multi-storied 100% - continuous canopies	3% of type has been mechanically treated to improve habitat for big game.	75% of type is within ½ mile of a road or trail. Includes: 2 miles roads 3 miles trails
Cottonwood	1,100 acres <1%	No age data available.	6%-3A 2%-3B **61%-4A** 32%-4B	62% - single-storied 38% - multi-storied 100% - continuous canopies	None recorded.	64% of these types are within ½ mile of a road or trail. Includes: 3 miles roads 2 miles trails

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Gamble Oak – Mixed Mountain Shrub	97,500 acres 18%	No age data available.	100% 2S 44% large (>6.5') 48% med. (2.5-6.4') 8% small (<2.5')	31% - single-storied 69% - multi-storied 86% - >40% cover 14% - <= 40% cover	6% of these types have been treated with prescribed fire, <1% of these types have been mechanically treated to improve habitat for big game.	78% of these types are within ½ mile of a road or trail. Includes: 101 miles roads 153 miles trails
Sagebrush	8,600 acres 2%.	No age data available.	100% 2S 74% med. (2.5-6.4') 26% small (<2.5')	33% - single-storied 67% - multi-storied 91% - >40% cover 9% - <= 40% cover	None recorded in this period.	60% of type is within ½ mile of a road or trail. Includes: 21 miles roads 6 miles trails
Willow	10,300 acres 2%	No age data available	100% 2S 33% large (>6.5') 61% med. (2.5-6.4') 7% small (<2.5')	31% - single-storied 69% - multi-storied 61% - >40% cover 39% - <= 40% cover	None recorded.	73% of these types are within ½ mile of a road or trail. Includes: 11 miles roads 24 miles trails
Grass/Forb	40,200 acres 8%	No age data available.	100% 1M	Not applicable	None recorded for this period.	79% of these types are within ½ mile of a road or trail. Includes: 70 miles roads 79 miles trails.

1. Common Vegetation Unit/R2VEG database
2. Stand exam data for Grand Mesa Geographic Area.
3. RMACT database

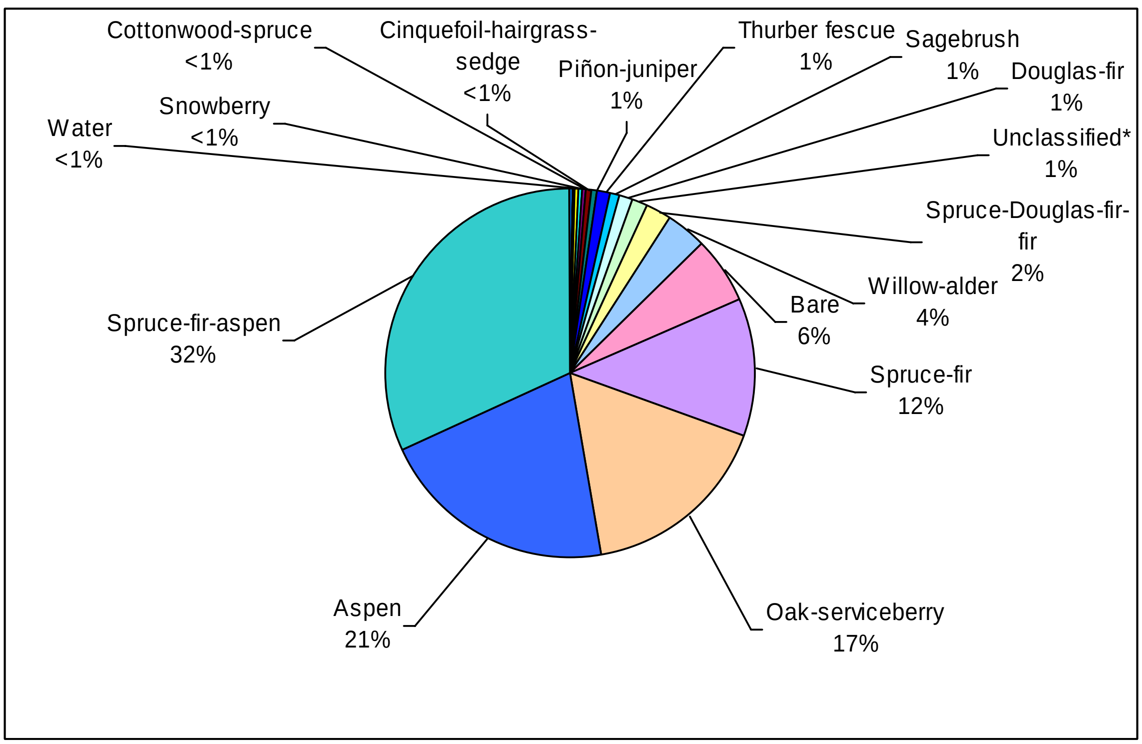
INFRA transportation data related to R2VEG data. Includes all inventoried roads and trail, not just routes open to public use.

Comparison of Current Conditions to Historic Conditions

Environmental factors such as soils, slope, aspect, climate, and elevation determine the plant communities that potentially can grow on a given area. The stable plant community that establishes in the absence of any disturbances (i.e., fire, insect/pathogen mortality, windthrow, drought, harvest) is called the climax plant community. The area where a given climax plant community can grow is classified as a Potential Natural Vegetation (PNV) type, and is named for the climax plant community. For example, spruce-fir forests are the climax plant community at elevations from 10,000 to 12,000 feet, in the subalpine climatic zone (30-40 inches of precipitation annually, 50-70 frost free days, 30-40ºF mean annual air temperature) (Johnston et al. 2001). Areas where spruce-fir is the climax plant community are classified as the spruce-fir PNV type.

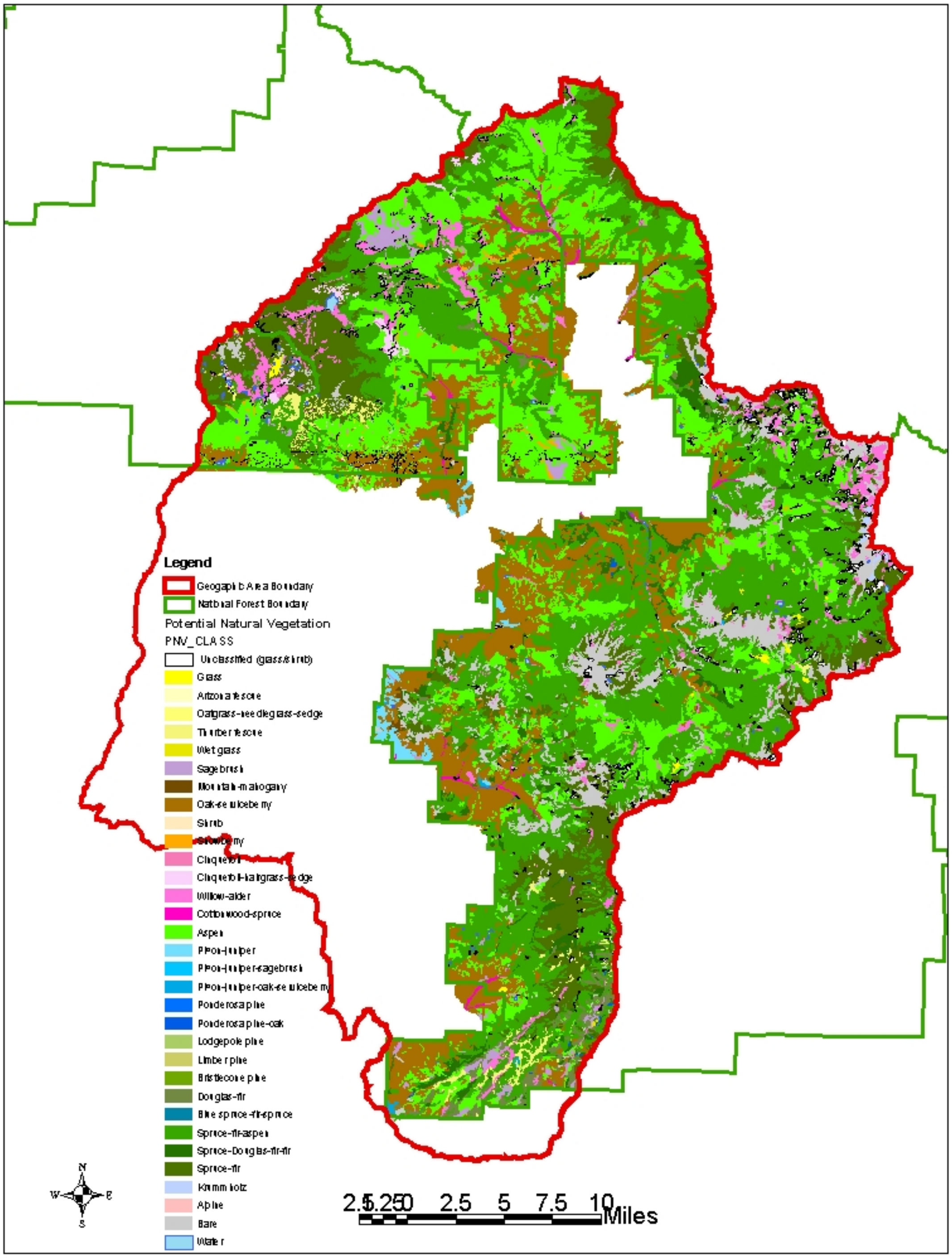
Draft PNV type classification has been completed for this Geographic Area. The PNV type composition on NFS lands within the North Fork Valley Geographic Area is shown in Figure 7. (PNV types with <0.1 percent composition are not included in Figure 7.) A map of PNV for the North Fork Valley GA is shown in Figure 8.

Figure 7. Composition of Potential Natural Vegetation Types on NFS lands within the North Fork Valley Geographic Area



* Unclassified, grass/forb or shrub types where the PNV type has not yet been assigned.

Figure 8. Potential Natural Vegetation on NFS portion of North Fork Valley Geographic Area



Historically, for any given PNV type, natural disturbances (i.e., fires, insect outbreaks) occurred at characteristic intervals and intensities, called regimes. When a disturbance was intense enough to change the existing plant community (e.g., some or all of the overstory was killed), the remaining vegetation followed a natural progression, or succession, of plant communities that changed over time. If no further disturbances occurred, an area eventually returned to the climax plant community. However, if multiple disturbances occurred on the same area earlier seral plant communities would be perpetuated on a site for extended periods. The natural disturbance regimes and succession cycles resulted in shifting mixtures (or ranges) of different seral plant communities (or stages) within any given PNV type at any point in time.

The Vegetation Dynamics Development Tool (VDDT) (Beukema et al. 2003) was used to model the expected range in seral conditions that would have existed under historic disturbance regimes for forest, woodland and shrub PNV types. The results displayed in the following tables are conditions that would have been distributed across an entire PNV type on the Geographic Area. Results are scale dependant. For example, if a large fire burned an entire watershed, all of a given PNV type in that watershed could be set back to an early seral condition. However, when the watershed is considered as part of the Geographic Area, the mixture of seral conditions for that PNV type would be within the expected ranges. Both situations would have occurred naturally.

The next sections include comparisons of current conditions to historic conditions for the most common PNV types on the North Fork Valley Geographic Area, to see where differences occur. This information can be used to identify future management opportunities.

Spruce-Fir PNV Type

The spruce-fir PNV type is mapped on 12 percent of the North Fork Valley Geographic Area. The climax community in this PNV type includes Englemann spruce and supalpine fir as the overstory species. In some areas Englemann spruce may be the only overstory species (Romme et al. 1999). The spruce-fir PNV type includes 44 percent of what is currently classified as spruce-fir cover type.

Table 3 describes the seral stages and the timeline for succession in the spruce-fir PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages) within the spruce-fir PNV type.

Table 3. Succession (Seral Stages) in Spruce-Fir PNV Type

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	14%	32%	53% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

Currently much of the spruce-fir PNV type is in mid- to late seral conditions (including both early-mid and late-mid), less in early seral conditions. This PNV type occurs at high elevations and over 70 percent of this type is on steeper slopes (> 40 percent slopes). Much of this PNV type is within or adjacent to areas affected by extensive fires on the Grand Mesa in the mid to late 1800s (Sudworth 1900). The current conditions expressed in the spruce-fir PNV type demonstrate the effect of large scale disturbances setting large areas to the same seral condition. Not enough time has passed since the last major disturbance (the late 1800s) to allow a full range of seral conditions to develop in this PNV type.

The historic fire regime for the spruce-fir PNV type was long return interval (> 200 years), stand replacing fires, which could cover areas from 1,000 to 10,000 acres (Peet 1981 as cited in Neely et al. 2001) mixed with infrequent low-intensity surface fires that affected much smaller areas. Fire return intervals tended to be longer at higher elevations and in moist depressions and valley bottoms, up to 500 years (Romme et al. 1999). Recent fires have been very infrequent and very small in this PNV type (see Fire Management Section).

A variety of insect and pathogen agents affect spruce-fir forests (see Forest Health section). Spruce beetle outbreaks have occurred in several areas of this PNV type in the late 1970s early 1980s.

Because much of the spruce-fir PNV type occurs in inaccessible areas, past harvest activities in this PNV type have been localized in certain areas (Black Mesa, Hubbard and Horse Ranch Park areas). The majority of harvest in this PNV type has occurred on Black Mesa in the southern portion of the GA. Clearcuts in the 1960s, shelterwood harvests in the 1970s, commercial thinning and selective sanitation/salvage harvests in the 1980s were the silvicultural methods used on these areas. The clearcuts are currently in the early seral stage. The sanitation/salvage areas are included in the early-mid conditions. Shelterwood harvest practices reduced the density of stands but did not alter the seral condition.

Spruce-Fir-Aspen PNV Type

The spruce-fir-aspen PNV type is mapped on 32 percent of the North Fork Valley Geographic Area. The climax community in this PNV type includes Englemann spruce and subalpine fir as the dominant overstory species with aspen occurring in all seral stages. The spruce-fir-aspen PNV type is comprised of 50 percent of the current spruce-fir cover type and approximately 46 percent of the current aspen cover type.

Table 4 describes the seral stages and timeline for succession in the spruce-fir-aspen PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages) within the spruce-fir-aspen PNV type.

Table 4. Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	6%	69%	25% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

This PNV type is generally below the spruce-fir PNV type in elevation. Approximately 60 percent of the spruce-fir-aspen PNV type currently is dominated by aspen in the overstory, and 36 percent currently has more conifer in the overstory. As evidenced by the percentages in the table above, basically all this PNV type is in mid seral conditions (includes both early-mid and late-mid). Current conditions are the result of large scale fires that burned through this area in 1878 to 1879, with less extensive burning occurring in 1883 to 1885 and again in 1890 to 1892 (Sudworth 1900). The large amount of area in the early-mid seral condition is due to a pulse of aspen regeneration that occurred following these fires. The majority of these stands are in the 80 to 100 year old range. The current conditions expressed in the spruce-fir-aspen PNV type demonstrate the effect of large scale disturbances setting large areas to the same seral condition. The time since the last major disturbance has not been sufficient to allow a full range of seral conditions to develop in this PNV type.

The fire regime in the spruce-fir-aspen PNV type is similar to that described above for the spruce-fir PNV type (long return interval stand replacing fires affecting large areas, mixed with infrequent low-intensity fires affecting small areas). Recent fires have been infrequent and very small in this PNV type. The Black Mesa portion of the Geographic Area was not affected by the fires mentioned above.

Little of this PNV type across the North Fork Valley Geographic Area has been affected by harvest activity. What has occurred is localized in the Black Mesa and Mendicant Ridge areas. Clearcuts to treat aspen and more recently commercial thinning have occurred in these areas.

Aspen PNV Type

In the aspen PNV type, pure aspen is the climax plant community, with no conifer species present. The aspen PNV type is mapped on 21 percent of the North Fork Valley Geographic Area. Approximately 49 percent of what is currently shown as aspen cover type is included in the aspen PNV type.

Table 5 depicts the seral stages and timeline for this PNV type as well as a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages).

Table 5. Succession (Seral Stages) in Aspen PNV Type

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 10 to 20 years	Dense pole-sized aspen, grass and forb understory, lasting 50 to 80 years	Mature aspen overstory, aspen regeneration in the understory where overstory gaps results from individual tree mortality, lasting up to 80 years	Stable multi-storied, multi-aged aspen stand, predominantly forb understory.Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	8-14%	23-26%	17-24%	23-43%
Current Seral Conditions	5%	58%	36% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

The Aspen PNV type is also predominantly in mid to late seral conditions. Few areas are in early seral conditions. As with the previous PNV type, the distribution of seral conditions in the aspen PNV type is the result of past large scale fire activity in the late 1800s (Sudworth 1900).

The same fires that influenced the distribution of seral conditions in the spruce-fir-aspen PNV type also affected this aspen PNV type. Because aspen matures faster than spruce or fir, this PNV type shifts into the later seral stages more rapidly, as refelected in the higher amount of late-mid seral condition as compared to the spruce-fir-aspen PNV type.

The historic fire regime for aspen is more frequent than for the two previous PNV types. Aspen forest appear to be dominated by a regime of relatively infrequent, large fires at higher elevations, and smaller more frequent fires at lower elevations (Kulakowski and Veblen, Draft 2004). Recent fires have been very infrequent and small in this type.

Two percent of this PNV type has been affected by timber harvest. Clearcuts were done mostly in the 1980s and 1990s in the Leroux Creek, Cunningham Creek, Terror Creek, Alder Creek and Black Mesa areas. These harvested areas are included in the early-mid seral conditions listed in the table above.

Oak-Serviceberry PNV Type

The Oak-Serviceberry PNV type has been mapped on 17 percent of NFS lands on the North Fork Valley Geographic Area. Historically, fires occurred in this PNV type at frequent intervals (every 15-30 years). The dominant shrub species Gambel oak and serviceberry resprout following fire so areas quickly returned to shrubs. This type transitioned from one seral stage to another at approximately 30 year timesteps. Table 6 compares current conditions in this PNV type to the expected historic mix of seral conditions.

Table 6. Succession (Seral Stages) in Oak-Serviceberry PNV Type

	Early	**Mid**	**Late**
Seral Stage Descriptions*	Stands are dominated by resprouting shrubs with grasses and forbs in the understory. Persists to 20 or 30 years	Dense clumps of shrubs, usually < 6 feet high. Grass and forbs between clumps. Persists from 30 to 40 years.	Shrubs > six feet high, more open canopy. Grass/forbs between and beneath shrub canopies. Persists until next stand replacing disturbance.
VDDT Modeled Range of Seral Conditions	30-70%	28-34%	0-36%
Current Seral Conditions	6%	50%	44%

*Romme et al. 2003

Most of the oak-serviceberry PNV type in the North Fork Valley Geographic Area is currently in mid and late seral conditions, and very little is in early seral conditions. The disparity between the historic conditions and current conditions is because there have been few recent disturbance in this PNV type, primarily due to fire suppression efforts over the past 100 years.

Frequent fires are the historical regime in this PNV type (0 - 35 years). Fires would have started below the forest on what is mostly private land now, and burned into the oak-serviceberry PNV type on the Geographic Area. Fire suppression efforts, cover type conversion and past livestock grazing have not allowed fires to burn in this PNV type as frequently as in the past. As a result, the majority of this vegetation type has aged into mid and late seral conditions.

Approximately seven percent of this PNV type has been treated with prescribed fire (6,100 acres) and mechanical treatments (700 acres). These projects occurred in the mid 1980s, and mid 1990s, and account for the early seral conditions represented in the tables above. Some of the old treatments are approaching the mid seral condition. The purposes for these treatments was to improve habitat for big game species by restoring earlier seral conditions that provide more forage than later seral conditions.

Key Findings

- Aspen is currently the dominant tree species occurring on the North Fork Valley Geographic Area, with stands dominated by aspen occurring on 40 percent of the Geographic Area and stands of aspen mixed with spruce-fir cover types currently occupying 23 percent of the Geographic Area.
- The large extend of aspen is the result of large scale fires in 1878 to 1879, with less extensive burning occurring in 1883 to 1885 and again in 1890 to 1892 (Sudworth 1900), that affected the northern two-thirds of the North Fork Valley Geographic Areas. As a result, the majority of this geographic area is currently in mid seral conditions.
- Approximately 31 percent of forest and woodland cover types are in the sapling/pole size class (mostly in the aspen cover type), and 58 percent are in mature size class (mostly in the spruce-fir cover type).
- The majority of the current forest and woodland vegetation conditions – 87 percent - have dense canopy closures (> 40 percent canopy closure).
- There is very little early seral condition in any cover type on the North Fork Valley Geographic Area, as shown in Tables 3 through 6.
- When comparing the compositions of current vegetation cover types to PNV types (Figure 1 through Figure 7), the forest types and bare areas are approximately equivalent. The biggest differences occur in the grass/forb types; however, much of the current grass/forb cover type is also the early seral stage of forest PNV types. Grass/forb PNV types are classified on only a very small amount (< one percent) of the North Fork Valley Geographic Area.

Vegetation Trends

- The trend across all vegetation cover types on the North Fork Valley Geographic Area is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Vegetation Management Implications

Management implications of vegetation conditions relate to differences between current and historic vegetation conditions. Where landscape conditions are similar to historic conditions landscapes are more resilient following disturbances, suitable habitat is provided for all species that evolved there, and ecosystems are productive and sustainable over time. Where current conditions deviate from historic ranges, there are increased risks for natural disturbances to be of higher intensities and affect larger areas than in the past; some habitats may become very limited or lost, threatening species viability; and loss of productivity can result in both ecological and economic losses. Management activities that can include both human and natural disturbances can be used to alter vegetation conditions. Management implications for specific cover types are discussed below.

Spruce-Fir

- The spruce-fir cover type occurs in both the spruce-fir and the spruce-fir-aspen PNV types. Disturbances (human or natural) that occur in the spruce-fir-aspen PNV type will result in aspen regeneration within a very short period of time. Disturbances in the spruce-fir PNV type do not have aspen as an early seral species, and may take 50 to 200 years to regenerate to spruce.

- Both the spruce-fir and spruce-fir-aspen PNV types have large percentages in mature, dense structural conditions. These conditions are ripe for fire and epidemic insect and pathogen outbreaks (see Forest Health and Fire Management sections). Because so much of the landscape is in the same condition, there is a high probability that large areas can be affected at the same time. Large scale disturbances (both fire and insect outbreaks) are the natural regimes for these PNV types. Management activities that increase diversity in age, size and seral condition, could be used to reduce the potential effects of natural disturbances.

- The majority of this cover type in the North Fork Valley Geographic Area (90,100 acres, or 74 percent) is in Wilderness and currently unroaded areas. Only natural processes will alter vegetation conditions in Wilderness areas, and potentially in unroaded areas where future management decisions (i.e., theme designations) limit or restrict management activities.

Aspen

- The aspen cover type occurs in both the spruce-fir-aspen PNV type (as the early through late-mid seral conditions) and the aspen PNV type (all seral stages). Based on the percentages in each seral stage displayed in the above tables for these PNV types, aspen currently dominates the North Fork Valley Geographic Area landscape, as a result of fires in the late 1800s.

- Aspen stands become very susceptible to cankers and root rots as they mature. A large percentage of the aspen cover type on the North Fork Valley Geographic Area is estimated to be between the age of 80 and 120 years, based on time since last major fire disturbance. An increasing amount of mortality caused by these fungal agents is expected in the future.

- Approximately half of the aspen stands on the North Fork Valley Geographic Area include conifer species in the understory or as codominant species. In the absence of some disturbance, these stands will eventually succeed to conifer dominated cover types. A shift from an aspen cover type to various conifer cover types will change the types of habitat available on the North Fork Valley Geographic Area to favor those species that require mature conifer forests.

Gambel Oak and Mountain Shrubs

- Current conditions in the Gambel oak and mixed mountain shrub cover types have less patchiness and structural stage diversity than would have occurred historically. The result is current conditions are more susceptible to higher intensity fires that may affect larger areas of land than would have occurred in the past. There is also less diversity in the types of habitat provided by these cover types than would have been present.

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CHAPTER 2. EXISTING VEGETATION – FOREST SCALE

San Juans

Current Vegetation

Vegetation mapping for the Grand Mesa, Uncompahgre and Gunnison (GMUG) National Forests is generated primarily from aerial photo interpretation, with periodic updates resulting from field verification, management activities and natural disturbances (i.e., wildfires). Vegetation is classified by cover type. Cover type is determined by the dominant cover or species present at the time of classification. As a result, cover type classifications are more simplified than conditions that actually occur on the ground. (For example: Spruce/fir cover type includes areas where Englemann spruce and/or subalpine fir tree species are the majority of the vegetation. Aspen tree species may or may not be present as subdominant species.)

Current vegetation cover type composition on NFS lands within the San Juans Geographic Area is shown in Figure 1. Vegetation is currently dominated by spruce/fir and aspen forests transitioning into open alpine meadows and bare/rock areas above timberline. A map of current vegetation is shown in Figure 2.

Figure 1. Composition of Current Vegetation Cover Types on NFS lands within the San Juans Geographic Area

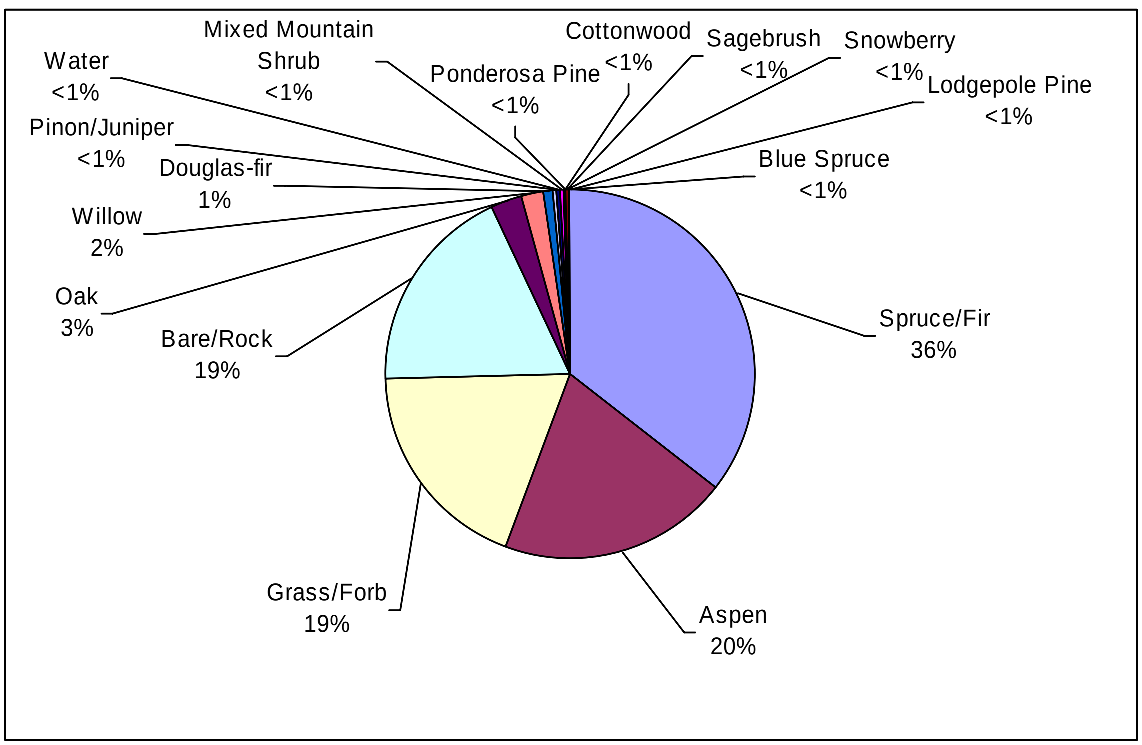
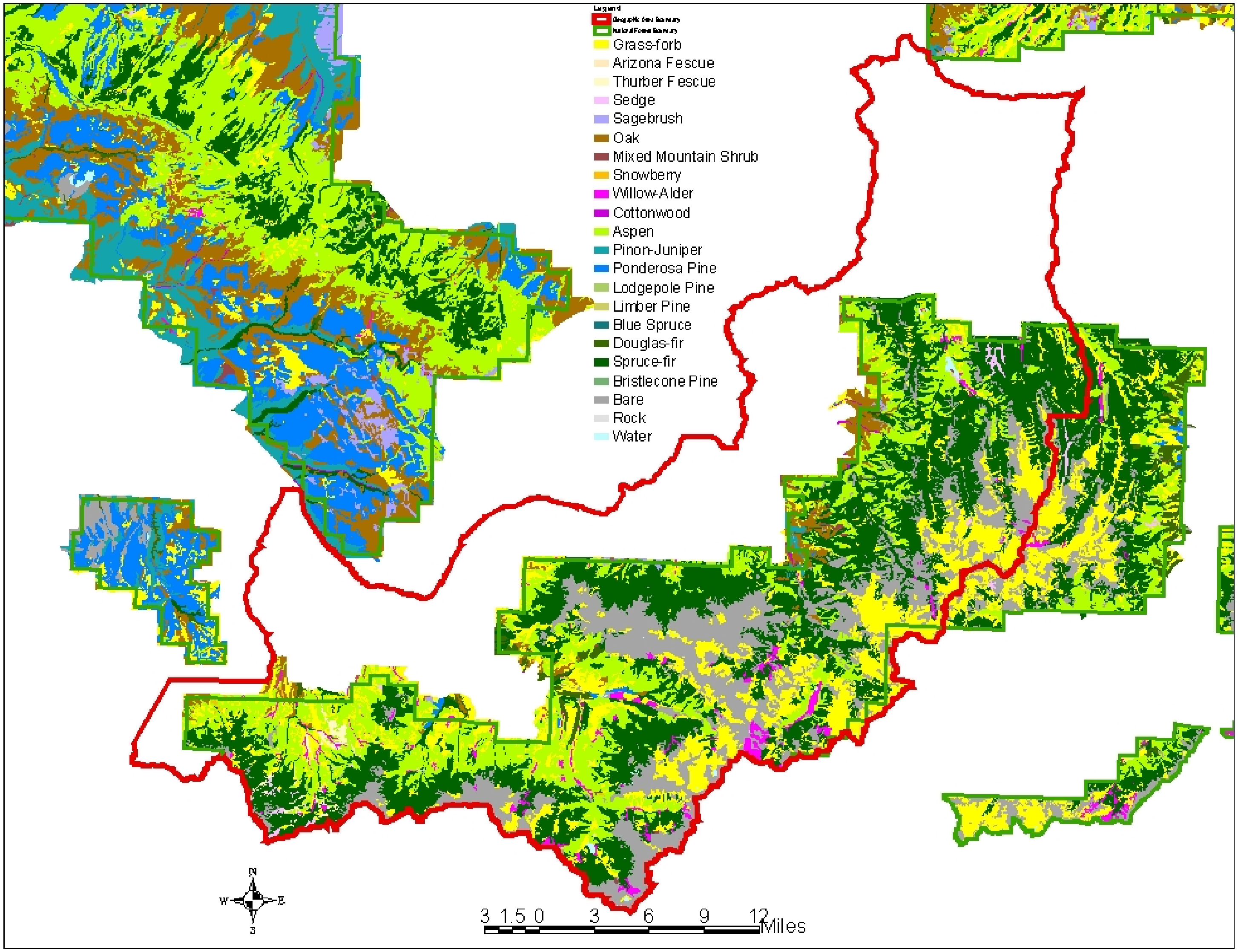


Figure 2. Map of Current Vegetation



Habitat Structural Stages

Vegetation is also characterized by structure. Structure is described by habitat structural stages. Habitat structural stages are defined by size class, tree diameter, and canopy closure (or canopy density measured as crown cover percent). Table 1 displays habitat structural stage definitions (Hoover and Wills, 1987).

Table 1. Habitat Structural Stage Definitions

Habitat Structural Stage	Size Class	Diameter	Crown Cover Percent
1T[1]/1M[2]	Grass-Forb	Not applicable	0 – 10%
2T[1]/2S[3]	Shrub-Seedling	< 1 inch	0 - 10%
3A	Sapling-Pole	1 – 9 inches	11 – 40%
3B	Sapling-Pole	1 – 9 inches	41 - 70%
3C	Sapling-Pole	1 – 9 inches	71 - 100%
4A	Mature	9+ inches	11 – 40%
4B	Mature	9+ inches	41 - 70%
4C	Mature	9+ inches	71 - 100%

1 Opening in forest cover type created by some type of disturbance
2 Natural meadow
3 Shrub cover type

Habitat structural stages can be used as indicators for:

- *Wildlife habitat* - Different wildlife species have different habitat requirements. For example, species that require large diameter trees in dense stand conditions find habitat in areas with 4B and 4C habitat structural stages.

- *Potential risk for future fire, insect and/or pathogen activity* - Trees growing in dense stands can be stressed by competition for water, nutrients and sunlight, making them more susceptible to insect attack.

- *Time since disturbances (fire, harvest, etc.) affected an area*. Age of vegetation is not directly linked to habitat structural stage; however, relative stages of succession can be implied. Early stages of succession are shown as habitat structural stages 1 or 2; later successional stages are usually in habitat structural stage 4A/4B/4C. Sometimes structural stages 3A/3B/3C may be the same age as 4A/4B/4C..

Current habitat structural stages for NFS lands within the San Juans Geographic Areas are shown in Figure 3. Please note, on Figure 3 natural meadows in grass-forb cover types are shown as structural stage 1M, and shrub cover types are shown as structural stage 2S.

Figure 3. Current Habitat Structural Stages, San Juans Geographic Area

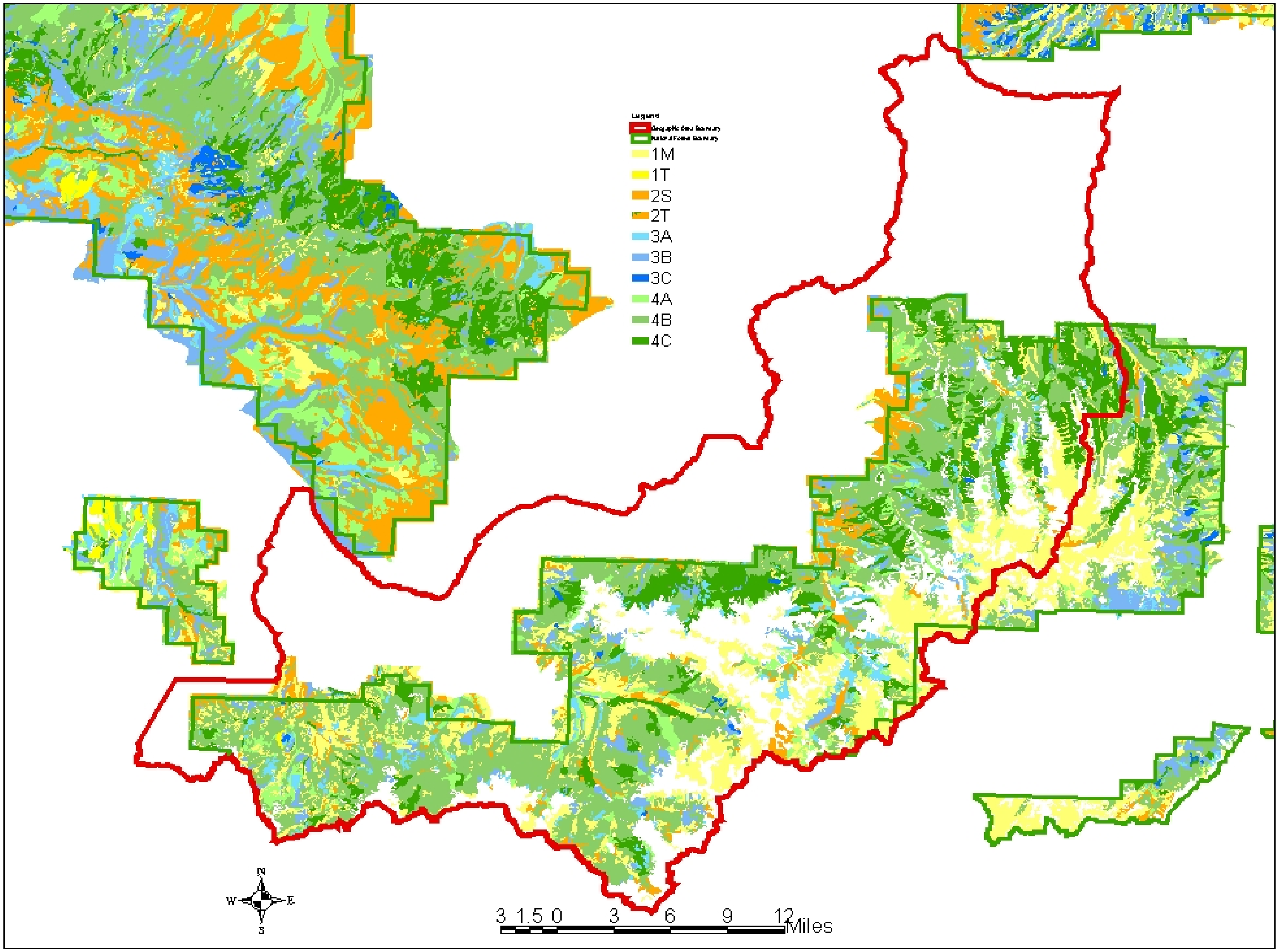
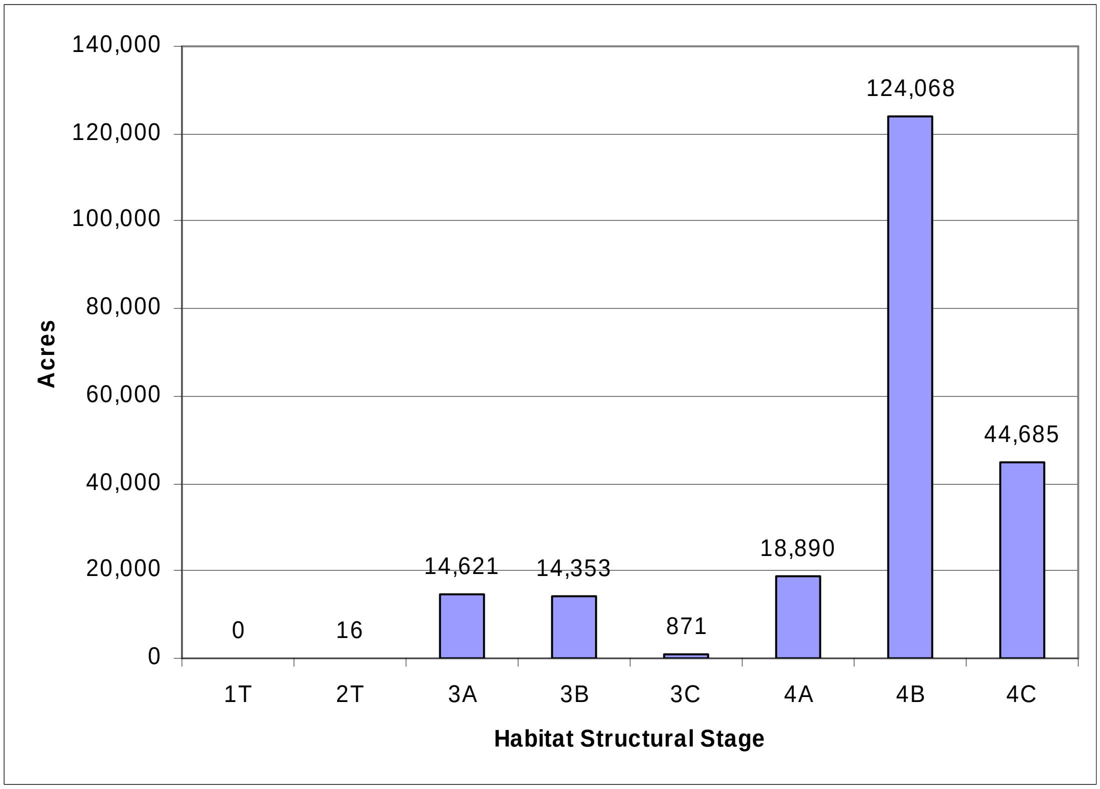


Figure 4 displays the distribution of habitat structural stages for the forest and woodland cover types (spruce-fir, aspen, Douglas-fir, ponderosa pine, blue spruce, cottonwood, lodgepole pine, pinyon-juniper) on NFS portion of the San Juans Geographic Area. Note: Natural meadows and shrublands are not included in the chart below.

Figure 4. Habitat Structural Stage Distribution of Forest and Woodland Cover Types, San Juans Geographic Area



This information can also be summarized by looking at the distribution of size classes (Figure 5) and densities or canopy closure (Figure 6) of forest and woodland cover types on NFS lands within the Geographic Area. Again, natural meadows and shrublands are not included in the data shown in Figures 5 and 6.

Figure 5. Size Class Distributions of Forest and Woodland Cover Types

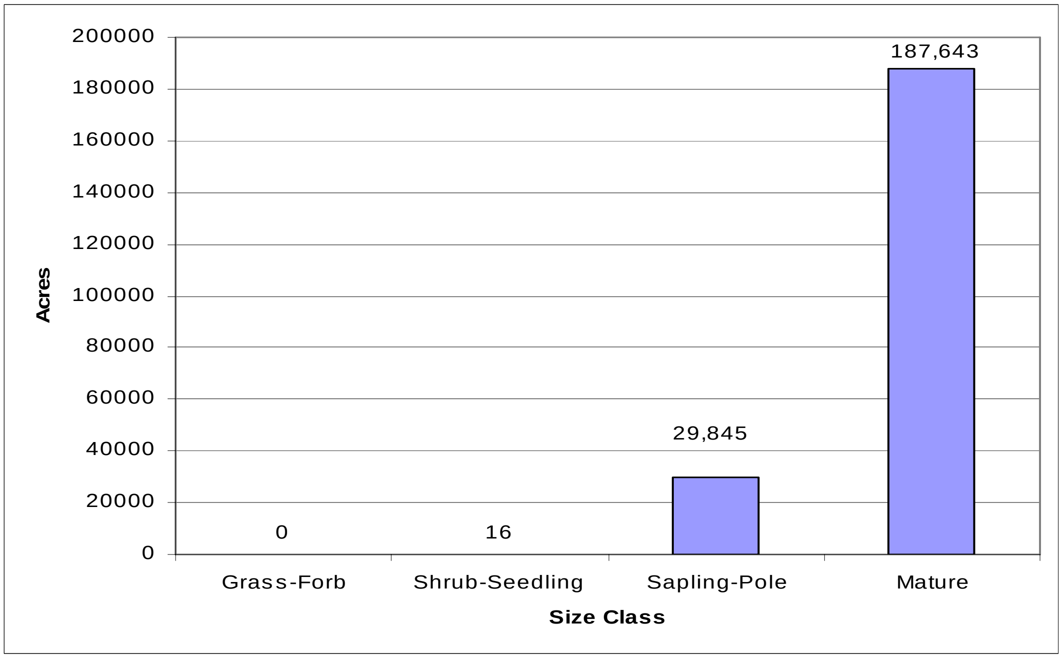
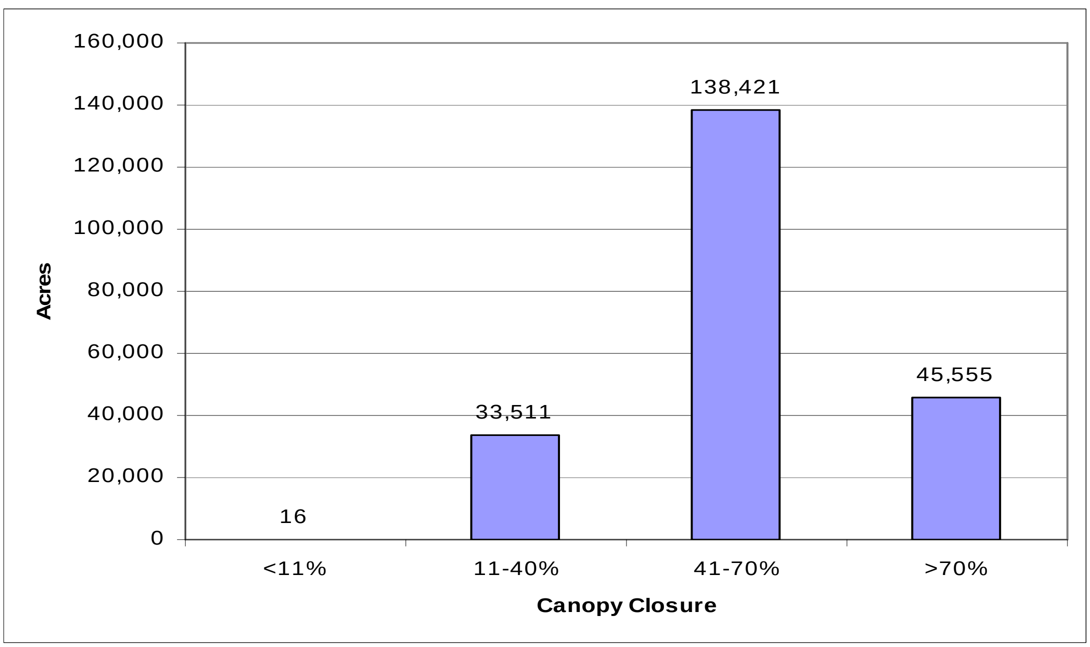


Figure 6. Canopy Closure Distributions in Forest and Woodland Cover Types



Characterization of Current Vegetation Conditions

Additional information on current conditions of different cover types is summarized in Table 2. (Also see timber, range and fire management sections.)

Table 2. Current Vegetation Characterization for NFS lands on San Juans Geographic Area

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Spruce-fir (Englemann spruce – subalpine fir)	135,900 acres 36%.	Age data not available	5%-3A 4%-3B <1%-3C 10%-4A **50%-4B** 31%-4C	85% - single-storied 15% - multi-storied 79% - continuous canopies	5% of type has been affected by timber harvest	83% of type is within ½ mile of a road or trail. Includes: 138 miles roads 223 miles trails
Aspen	76,200 acres 20%.	Age data not available	9%-3A 12%-3B 1%-3C 4%-4A **71%-4B** 3%-4C	82% - single-storied 18% - multi-storied 71% - continuous canopies	3% of type has been affected by timber harvest	85% of type is within ½ mile of a road or trail. Includes: 103 mile roads 137 miles trails
Mixed Conifer (Douglas-fir, blue spruce, lodgepole pine)	3,900 acres 1%.	Age data not available	5%-3A 7%-3B 3%-3C **47%-4A** 32%-4B 5%-4C	64% - single-storied 36% - multi-storied 77% - continuous canopies	None recorded in this period.	54% of type is within ½ mile of a road or trail. Includes: 3 miles roads 3 miles of trails
Pinyon-Juniper	900 acres <1%	Age data not available	**100%-3A**	100% - single-storied 66% - continuous canopies	None recorded in this period.	67% of type is within ½ mile of a road or trail. Includes: 1 mile road 1 mile trail
Cottonwood	600 acres <1%	No age data available.	10%-3A 31%-4A **59%-4B**	78% - single-storied 22% - multi-storied 60% - continuous canopies	None recorded.	50% of these types are within ½ mile of a road or trail. Includes: 3 miles roads 1 mils trail

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003) [3]	Effects of Roads/Trails[4]
Gamble Oak – Mixed Mountain Shrub	12,000 acres 3%	No age data available.	100% 2S Oak: 69% large (>6.5') 30% med. (2.5-6.4') 1% small (<2.5') Mixed Shrub: 22 % large 77% medium 2% small	Oak: 91% - single-storied 9% - multi-storied 67% - >40% cover 33% - <= 40% cover Mixed Shrub: 91% - single-storied 9% - multi-storied 66% - >40% cover 34% - <= 40% cover	8% of these types have been treated with prescribed fire.	52% of these types are within ½ mile of a road or trail. Includes: 10 miles roads 13 miles trails
Sagebrush	600 acres <1%.	No age data available.	100% 2S 89% large (>6.5') 11% med. (2.5-6.4')	100% - single-storied 100% - <= 40% cover	None recorded in this period.	67% of type is within ½ mile of a road or trail. Includes: 0 miles roads <1 miles trails
Willow	7,300 acres 2%	No age data available	100% 2S 60% large (>6.5') 39% med. (2.5-6.4') 1% small (<2.5')	75% - single-storied 25% - multi-storied 49% - >40% cover 51% - <= 40% cover	None recorded.	86% of these types are within ½ mile of a road or trail. Includes: 11 miles roads 18 miles trails
Grass/Forb	72,500 acres 19%	No age data available.	100% 1M	Not applicable	None recorded for this period.	72% of these types are within ½ mile of a road or trail. Includes: 90 miles roads 106 miles trails.

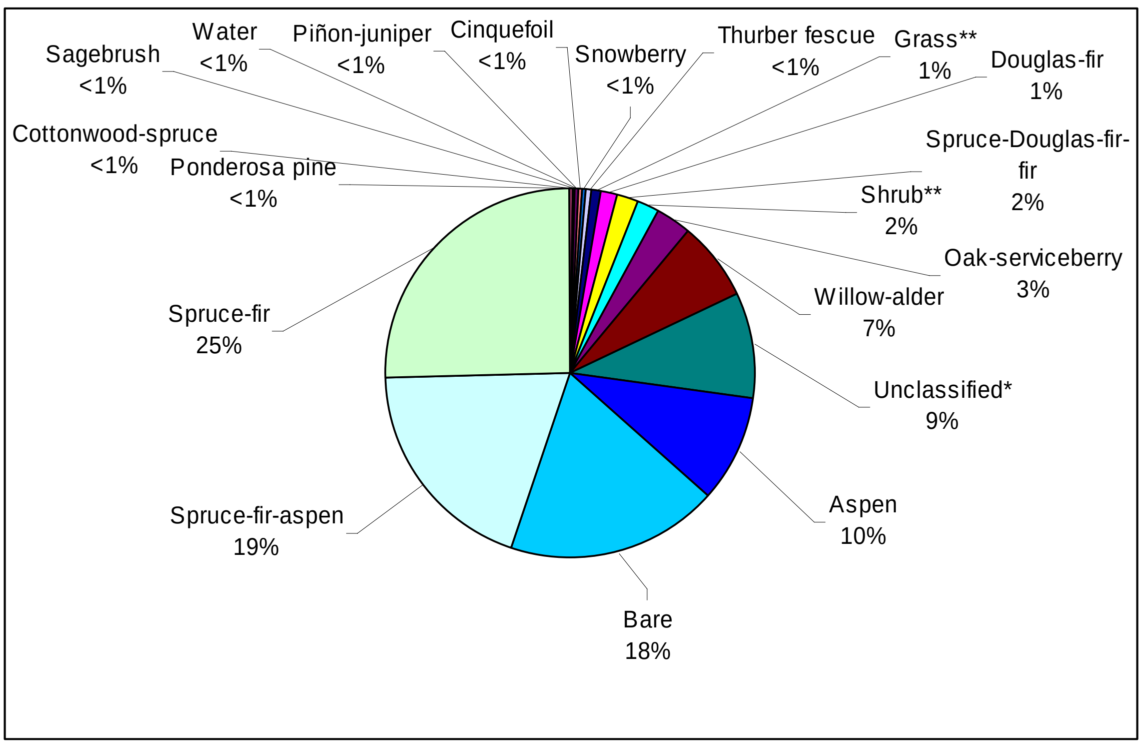
1. Common Vegetation Unit/R2VEG database
2. Stand exam data for Grand Mesa Geographic Area.
3. RMACT database
4. INFRA transportation data related to R2VEG data. Includes all inventoried roads and trail, not just routes open to public use.

Comparison of Current Conditions to Historic Conditions

Environmental factors such as soils, slope, aspect, climate, and elevation determine the plant communities that potentially can grow on a given area. The stable plant community that establishes in the absence of any disturbances (i.e., fire, insect/pathogen mortality, windthrow, drought, harvest) is called the climax plant community. The area where a given climax plant community can grow is classified as a Potential Natural Vegetation (PNV) type, and is named for the climax plant community. For example, spruce-fir forests are the climax plant community at elevations from 10,000 to 12,000 feet, in the subalpine climatic zone (30-40 inches of precipitation annually, 50-70 frost free days, 30-40ºF mean annual air temperature) (Johnston et al 2001). Areas where spruce-fir is the climax plant community are classified as the spruce-fir PNV type.

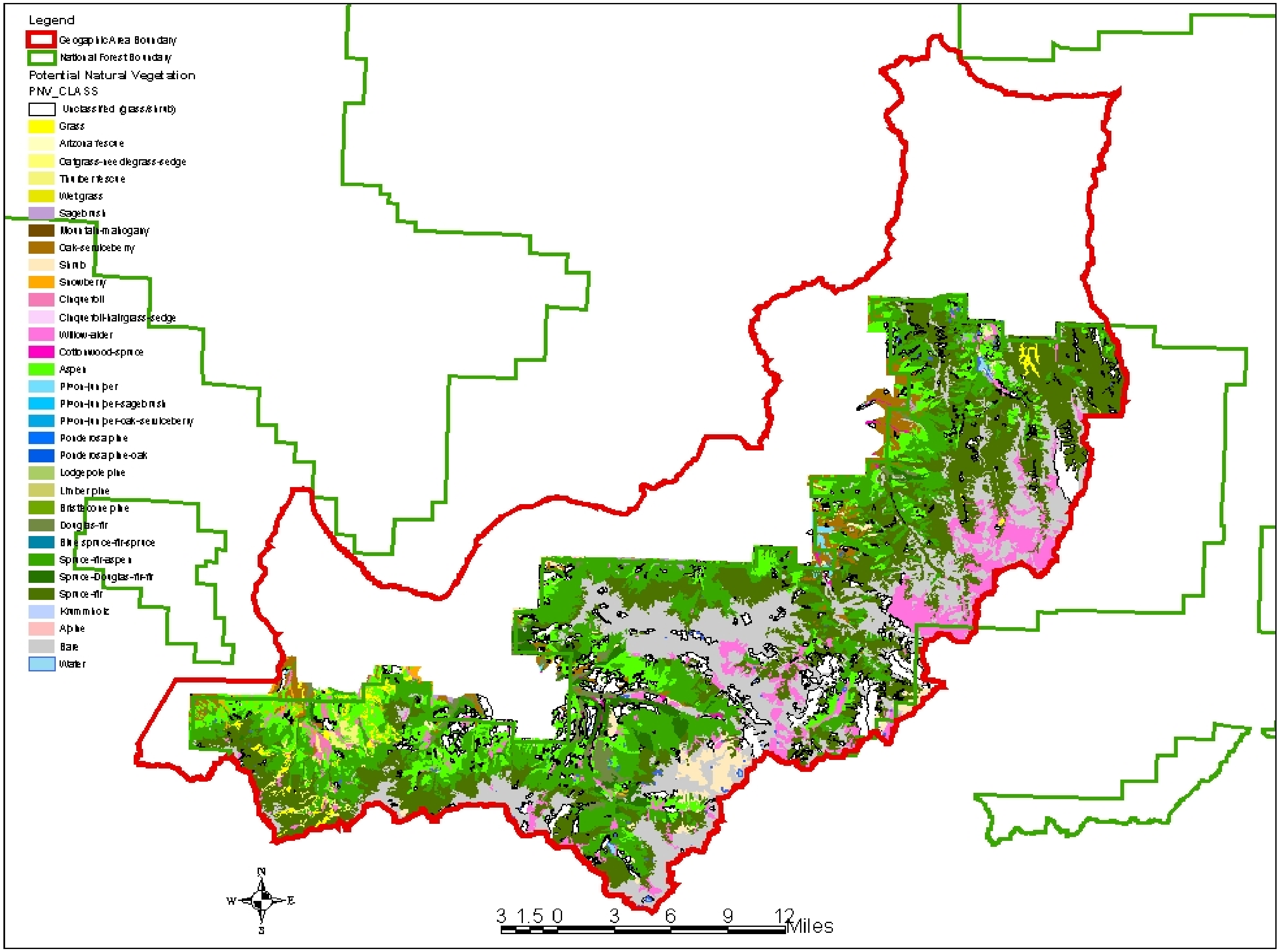
Draft PNV type classification has been completed for this Geographic Area. The PNV type composition on NFS lands within the San Juans Geographic Area is shown in Figure 7. A map of PNV for the San Juans GA is shown in Figure 8.

Figure 7. Composition of Potential Natural Vegetation Types on NFS lands within the San Juans Geographic Area



* ** Unclassified, grass and shrub areas are grass/forb or shrub types where the PNV type has not yet been assigned.

Figure 8. Potential Natural Vegetation on NFS portion of San Juans Geographic Area



Historically, for any given PNV type, natural disturbances (i.e., fires, insect outbreaks) occurred at characteristic intervals and intensities, called regimes. When a disturbance was intense enough to change the existing plant community (e.g., some or all of the overstory was killed), the remaining vegetation followed a natural progression, or succession, of plant communities that changed over time. If no further disturbances occurred, an area eventually returned to the climax plant community. However, if multiple disturbances occurred on the same area earlier seral plant communities would be perpetuated on a site for extended periods. The natural disturbance regimes and succession cycles resulted in shifting mixtures (or ranges) of different seral plant communities (or stages) within any given PNV type at any point in time.

The Vegetation Dynamics Development Tool (VDDT) (Beukema et al. 2003) was used to model the expected range in seral conditions that would have existed under historic disturbance regimes for forest, woodland and shrub PNV types. The results displayed in the following tables are conditions that would have been distributed across an entire PNV type on the Geographic Area. Results are scale dependant. For example, if a large fire burned an entire watershed, all of a given PNV type in that watershed could be set back to an early seral condition. However, when the watershed is considered as part of the Geographic Area, the mixture of seral conditions for that PNV type would be within the expected ranges. Both situations would have occurred naturally.

The next sections include comparisons of current conditions to historic conditions for the most common PNV types on the San Juans Geographic Area, to see where differences occur. This information can be used to identify future management opportunities.

Spruce-Fir PNV Type

The spruce-fir PNV type is mapped on 25 percent of the San Juans Geographic Area. The climax community in this PNV type includes Englemann spruce and supalpine fir as the overstory species. In some areas just Englemann spruce may be the overstory species (Romme et al 1999). The spruce-fir PNV type includes 69 percent of what is currently classified as spruce-fir cover type.

Table 3 describes the seral stages and the timeline for succession in the spruce-fir PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages) within the spruce-fir PNV type

Table 3. Succession (Seral Stages) in Spruce-Fir PNV Type

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	Initially grass/forb, low shrub with spruce seedlings eventually becoming established. May last 50 to-200 years, depending on the time it takes trees to become established.	Dense pole-sized spruce, grass and forb understory, lasting up to 150 years	Mature spruce overstory with fir and spruce trees growing in the understory. May persist 150 to 300 years.	Variable density of mature conifer, multiple age and size classes. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	27-32%	20-24%	12-13%	31-40%
Current Seral Conditions	1%	43%	56% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

Currently much of the spruce-fir PNV type in mid to late seral conditions (including both early-mid and late-mid) and a small amount is early seral. A large percent of this PNV type is in inaccessible areas at high elevations and over 70 percent of this type is on steeper slopes (> 40 percent slopes). Information on stand ages and disturbance history has not been collected that would validate seral stage assignments. Because this PNV type takes a very long time to progress through the different successional stages, the time since last major disturbance may not be long enough for to allow a full range of seral conditions to develop.

The historic fire regime for the spruce-fir PNV type was long return interval (> 200 years), stand replacing fires, which could cover areas from 1,000 to 10,000 acres (Peet 1981 as cited in Neely et al 2001) mixed with infrequent low-intensity surface fires that affected much smaller areas. Fire return intervals tended to be longer at higher elevations and in moist depressions and valley bottoms, up to 500 years (Romme et al. 1999). Recent fires have been very infrequent and usually very small in this PNV type, as evidenced by the large percent in late-mid seral conditions.

A variety of insect and pathogen agents affect spruce-fir forests (see Forest Health section). Spruce beetle outbreaks have occurred in several areas of this PNV type in the late 1800s and again in the 1950s. Sanitation/salvage harvest activity removed mostly older spruce trees, releasing the subalpine fir and younger spruce in the understory. These changes resulted in stands remaining in mid-seral conditions for longer periods.

Because this PNV type is relatively inaccessible (see above), past harvest activities in the spruce-fir PNV type have been localized in certain areas (Upper Middle Beaver, East Dallas, West and Middle Forks of the Cimarron, High Mesa and Failes Creek). Shelterwood (1970s to mid 1990s) and selective sanitation/salvage harvests (1950s) were the silvicultural methods used on the majority of the areas. These harvest practices reduced the density of stands but did not alter the mid-seral condition. Some clearcutting occurred in the 1960s and these areas are classified as early seral condition, above.

Spruce-Fir-Aspen PNV Type

The spruce-fir-aspen PNV type is mapped on 19 percent of the San Juans. The climax community in this PNV type includes Englemann spruce and subalpine fir as the dominant overstory species with aspen occurring in all seral stages. The spruce-fir-aspen PNV type is comprised of 28 percent of the current spruce-fir cover type and approximately 47 percent of the current aspen cover type.

Table 4 describes the seral stages and timeline for succession in the spruce-fir-aspen PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages) within the spruce-fir-aspen PNV type.

Table 4. Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	1%	24%	75% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

This PNV type is generally below the spruce-fir PNV type in elevation. Approximately half of the spruce-fir-aspen PNV type currently has more aspen in the overstory, and half currently has more conifer in the overstory. As evidenced by the percentages above, most of this PNV type is in the late-mid or late seral condition. This PNV type also takes a long time to progress through the different successional stages. If additional inventory of stand ages and understory conditions were done in stands dominated by conifer, stands could be differentiated between late-mid and late seral conditions.

Similar to the spruce-fir PNV type, the spruce-fir-aspen PNV type also has infrequent fires. However, in 2002 the West Beaver fire burned over 600 acres and in 2003 the Beaver fire burned over 300 acres adjacent to the 2002 burn. Both fires were predominantly in this PNV type, affecting approximately one percent of this type (not reflected in the percentages above).

Little of this PNV type across the San Juans Geographic Area has been affected by harvest activity. What has occurred is localized in the East and Mid Beaver watersheds, where aspen clearcutting was done in the early 1990s. These areas are reflected in the early seral conditions in the table above.

Aspen PNV Type

In the aspen PNV type, pure aspen is the climax plant community, with no conifer species present. The aspen PNV type is mapped on 10 percent of the San Juans Geographic Area. Approximately 46 percent of what is currently shown as the aspen cover type is included in the aspen PNV type.

Table 5 depicts the seral stages and timeline for this PNV type as well as a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages).

Table 5. Succession (Seral Stages) in Aspen PNV Type

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 10 to 20 years	Dense pole-sized aspen, grass and forb understory, lasting 50 to 80 years	Mature aspen overstory, aspen regeneration in the understory where overstory gaps results from individual tree mortality, lasting up to 80 years	Stable multi-storied, multi-aged aspen stand, predominantly forb understory.Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	8-14%	23-26%	17-24%	23-43%
Current Seral Conditions	4%	25%	72% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

The aspen PNV type is also predominantly in late-mid to late seral conditions. Very little (four percent) is in early seral conditions. Stand age is the significant variable that differentiates between late-mid and late seral conditions. Age data is limited. If more age information was available it is likely that some of the stands currently classified as late-mid would actually be in late seral condition.

As mentioned above, information on past natural disturbances is lacking in this Geographic Area. Elsewhere on the GMUG the historic fire regime for aspen has been shown to be more frequent than for the two previous PNV types. Aspen forest appear to be dominated by a regime of relatively infrequent, large fires at higher elevations, and smaller more frequent fires at lower elevations (Kulakowski and Veblen, Draft 2004). Fire has not had a significant effect on this PNV type, as indicated by the large amount in late-mid seral conditions.

Less than four percent of this PNV type has been affected by timber harvest. Clearcuts were done in the 1960s near Silverjack Reservoir and in East Dallas. Aspen clearcuts along the lower slopes of Lone Cone and in the Mid and East Beaver watersheds were done in the 1990s. These areas are included in the early seral conditions in the table above.

Oak-Serviceberry PNV Type

The oak-serviceberry PNV type has been mapped on three percent of NFS lands on the San Juans. Historically, fires occurred in this PNV type at frequent intervals (every 15-30 years). The dominant shrub species Gambel oak and serviceberry resprout following fire, so areas quickly returned to shrubs. This type transitioned from one seral condition to another at approximately 30 year timesteps. Table 6 compares current conditions in this PNV type to the expected historic mix of seral conditions. The majority of the oak-serviceberry PNV type is in mid to late seral conditions, indicating a lack of recent disturbances.

Table 6. Succession (Seral Stages) in Oak-Serviceberry PNV Type

	Early	**Mid**	**Late**
Seral Stage Descriptions*	Stands are dominated by resprouting shrubs with grasses and forbs in the understory. Persists to 20 or 30 years	Dense clumps of shrubs, usually < 6 feet high. Grass and forbs between clumps. Persists from 30 to 40 years.	Shrubs > six feet high, more open canopy. Grass/forbs between and beneath shrub canopies. Persists until next stand replacing disturbance.
VDDT Modeled Range of Seral Conditions	30-70%	28-34%	0-36%
Current Seral Conditions	9%	27%	64%

*Romme et al. 2003

Most of the oak-serviceberry PNV type in the San Juans Geographic Area is currently in late seral conditions, and very little is in early seral conditions. The amount of mid seral conditions is approximately what would be expected historically. The disparity between the historic conditions in early and later seral stages is due to a lack of disturbance in this PNV type.

Frequent fires are the historical regime in this PNV type. Fires would have started below the forest on what is mostly private land, now. Fire suppression efforts, cover type conversion and past livestock grazing have not allowed fires to burn in this PNV type.

A prescribed fire in the Baldy area in the early 1990s burned approximately 1,000 acres of this PNV type (approximately eight percent of the total type in the Geographic Area). The purpose of this treatment was to improve habitat for the bighorn sheep herd that occupies this area, by restoring earlier seral conditions that provide more forage than later seral conditions.

Key Findings

- Spruce-fir and aspen cover types currently occupy just over half of the NFS lands in the San Juans Geographic Area.
- Grass/forb types and bare/rock each comprise 19 percent of the San Juans Geographic Area. The majority of these types are in alpine areas (elevations > 11,000 feet), with 56 percent of the grass/forb types and 86 percent of the bare/rock occurring at these elevations.
- The San Juans Geographic Areas is dominated by late-mid seral conditions in forest and woodland cover types.
- Approximately 86 percent of the forest and woodland cover types are in mature size classes.
- The lack of recent disturbances (fire, insect and disease mortality, harvest) is also reflected in current forest and woodland vegetation conditions – 85 percent have dense canopy closures (> 40 percent canopy closure).
- There is very little early seral condition in any cover type on the San Juans Geographic Area, as shown in Tables 3 through 6. Lack of age data does not allow differentiation between late-mid and late seral conditions in the dominant forest types.
- When comparing the compositions of current vegetation cover types to PNV types (Figure 1 through Figure 7), the forest types and bare areas are approximately equivalent. The biggest differences occur in the willow and grass/forb types. There is currently less of the willow cover type and more grass/forb types on the landscape that would be expected. These conditions occur in alpine areas and are partly a result of limitations in both the current vegetation and the PNV type data. Additional evaluation is needed to determine if this shift in cover type has a relationship to past management activities, such as livestock grazing.

Vegetation Trends

- The trend across all vegetation cover types on the San Juans is to continue successional progress predominantly with the absence of human-caused disturbances. Structural and compositional conditions in each cover type will continue to progress along successional timelines. A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes.

Vegetation Management Implications

Management implications of vegetation conditions relate to differences between current and historic vegetation conditions. Where current landscape conditions are similar to historic conditions, landscapes are more resilient following disturbances, suitable habitat is provided for all species that evolved there, and ecosystems are productive and sustainable over time. Where current conditions deviate from historic ranges, there are increased risks for natural disturbances to be of higher intensities and affect larger areas than in the past; some habitats may become very limited or lost, threatening species viability; and loss of productivity can result in both ecological and economic losses. Management activities that can include both human and natural disturbances can be used to restore more desirable vegetation conditions. Management implications for specific cover types are discussed below.

Spruce-Fir

- The spruce-fir cover type occurs in both the spruce-fir and the spruce-fir-aspen PNV types. Disturbances (human or natural) that occur in the spruce-fir-aspen PNV type will result in aspen regeneration within a very short period of time. Disturbances in the spruce-fir PNV type do not have aspen as an early seral species, and may take 50 to 200 years to regenerate to spruce.

- Both the spruce-fir and spruce-fir-aspen PNV types are currently dominated by mature, dense structural conditions. These conditions are ripe for fire and epidemic insect and pathogen outbreaks (see Forest Health and Fire Management sections). Because so much of the landscape is in the same condition, there is a high probability that large areas can be affected at the same time. Large scale disturbances (both fire and insect outbreaks) are the natural regimes for these PNV types. Management activities that increase diversity in age, size and seral condition, could be used to reduce the potential effects of natural disturbances.

- The majority of this cover type in the San Juans Geographic Area (72,800 acres, or 54 percent) is in Wilderness and currently unroaded areas. Only natural process will alter vegetation conditions in Wilderness areas and potentially in unroaded areas where future management decisions (i.e., theme designations) limit or restrict management activities.

Aspen

- The aspen cover type occurs in both the spruce-fir-aspen PNV type (as the early through late-mid seral conditions) and the aspen PNV type (all seral stages). Based on the percentages in each seral stage displayed in the above tables for these PNV types, there is less aspen cover type currently on the landscape than would have been expected historically, and what is present is in predominantly in later seral conditions.

- Aspen stands become very susceptible to cankers and root rots above the age of 110 years. A large percentage of the aspen cover type on the San Juans Geographic Area is estimated to be between the age of 80 and 120 years. An increasing amount of mortality caused by these fungal agents is expected in the future.

- Over 40 percent of the aspen stands on the San Juans Geographic Area include conifer species in the understory or as codominant species. In the absence of some disturbance that affects entire stands, these stands will eventually succeed to conifer dominated cover types. A shift from an aspen cover type to various conifer cover types will change the types of habitat available on the San Juans Geographic Area to favor those species that require mature conifer forests.

Gambel Oak and Mountain Shrubs

- Current conditions in the Gambel oak and mixed mountain shrub cover types have less patchiness and structural stage diversity than would have occurred historically. The result is current conditions are more susceptible to higher intensity fires that may affect larger areas of land than would have occurred in the past. There is also less diversity in the types of habitat provided by these cover types than would have been present.

Grass-Forb

- The species composition in grass-forb cover types on the San Juans has been altered from historic conditions through livestock grazing, and some localized seeding of non-native species (i.e., Big Cimarron Forks area). There is a need to improve data on species composition in these areas to determine to what extent these areas are departed from historic conditions.

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CHAPTER 2. EXISTING VEGETATION – FOREST SCALE

Uncompahgre Plateau

Current Vegetation

Vegetation mapping for the Grand Mesa, Uncompahgre and Gunnison (GMUG) National Forests is generated primarily from aerial photo interpretation, with periodic updates resulting from field verification, management activities and natural disturbances (i.e., wildfires). Vegetation is classified by cover type. Cover type is determined by the dominant cover or species present at the time of classification. As a result, cover type classifications are more simplified than conditions that actually occur on the ground. (For example: Spruce/fir cover type includes areas where Englemann spruce and/or subalpine fir tree species are the majority of the vegetation. Aspen tree species may or may not be present as subdominant species.)

Current vegetation cover type distribution on NFS lands within the Uncompahgre Plateau Geographic Area is shown in Figure 1. A map of current vegetation is shown in Figure 2.

Figure 1. Distribution of Current Vegetation Cover Types on NFS lands within the Uncompahgre Plateau Geographic Area

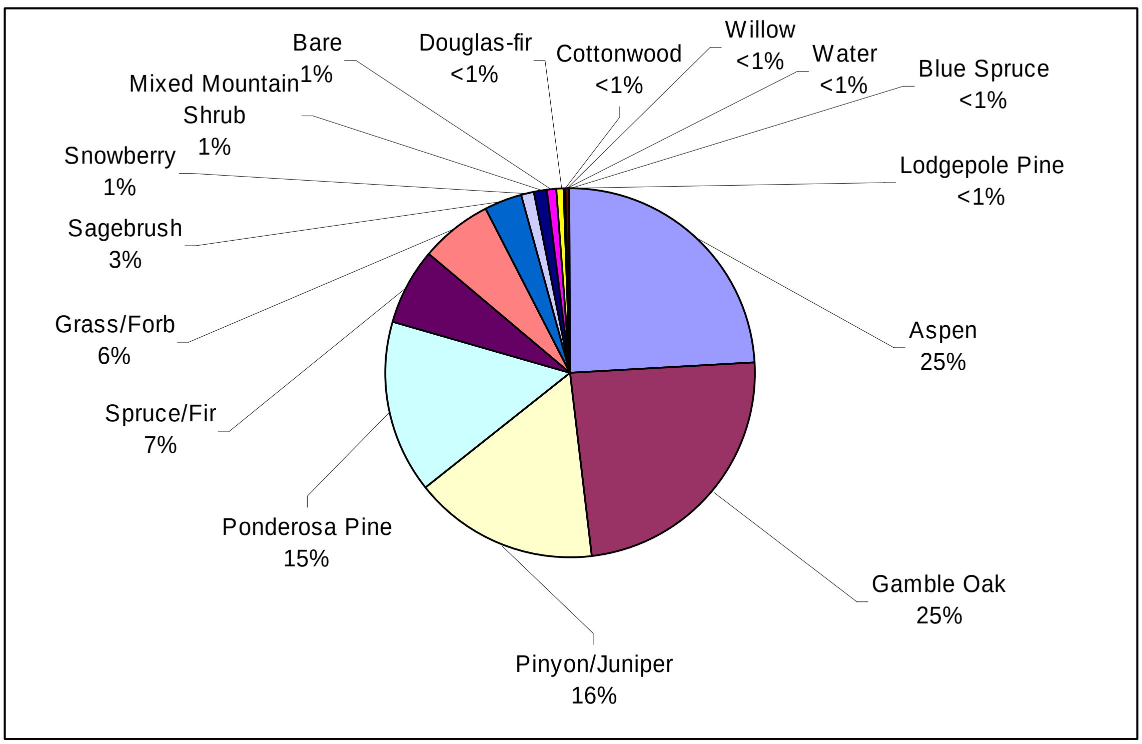
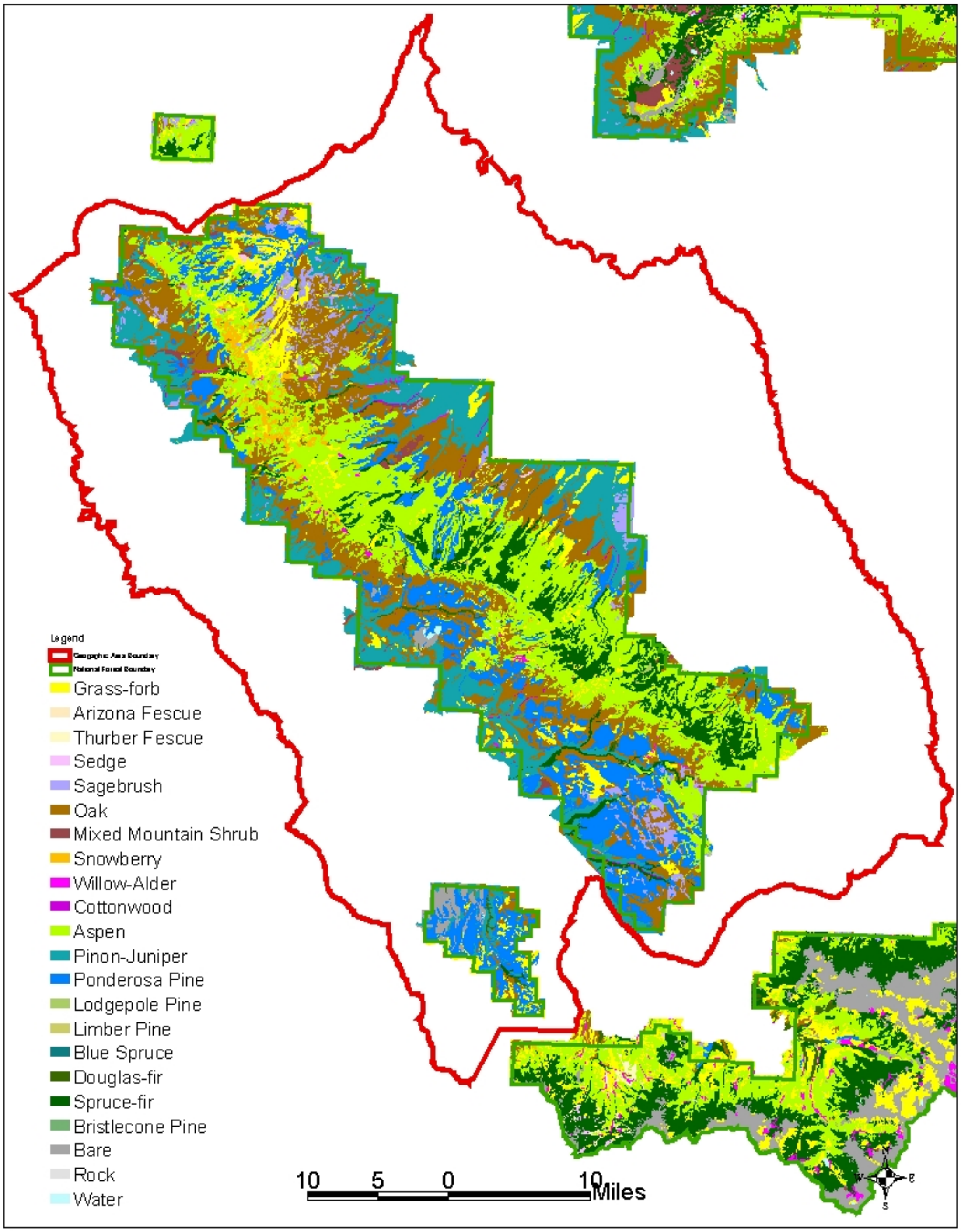


Figure 2. Map of Current Vegetation



Habitat Structural Stages

Vegetation is also characterized by structure. Structure is described by habitat structural stages. Habitat structural stages are defined by size class, tree diameter, and canopy closure (or canopy density measured as crown cover percent). Table 1 displays habitat structural stage definitions (Hoover and Wills, 1987).

Table 1. Habitat Structural Stage Definitions

Habitat Structural Stage	Size Class	Diameter	Crown Cover Percent
1T[1]/1M[2]	Grass-Forb	Not applicable	0 – 10%
2T[1]/2S[3]	Shrub-Seedling	< 1 inch	0 - 10%
3A	Sapling-Pole	1 – 9 inches	11 – 40%
3B	Sapling-Pole	1 – 9 inches	41 - 70%
3C	Sapling-Pole	1 – 9 inches	71 - 100%
4A	Mature	9+ inches	11 – 40%
4B	Mature	9+ inches	41 - 70%
4C	Mature	9+ inches	71 - 100%

1 Opening in forest cover type created by some type of disturbance
2 Natural meadow
3 Shrub cover type

Habitat structural stages can be used as indicators for:

- *Wildlife habitat* - Different wildlife species have different habitat requirements. For example, species that require large diameter trees in dense stand conditions find habitat in areas with 4B and 4C habitat structural stages.

- *Potential risk for future fire, insect and/or pathogen activity* - Trees growing in dense stands can be stressed by competition for water, nutrients and sunlight, making them more *susceptible* to insect attack.

- *Time since disturbances (fire, harvest, etc.) affected an area*. Age of vegetation is not directly linked to habitat structural stage; however, relative stages of succession can be implied. Early stages of succession are shown as habitat structural stages 1 or 2; later successional stages are usually in habitat structural stage 4A/ 4B/4C. Sometimes structural stages 3A/3B/3C may be the same age as 4A/4B/4C.

Current habitat structural stages for NFS lands within the Uncompahgre Plateau Geographic Areas are shown in Figure 3. Please note, on this map natural meadows in grass-forb cover types are shown as structural stage 1M, and shrub cover types are shown as structural stage 2S.

Figure 3. Current Habitat Structural Stages, Uncompahgre Plateau Geographic Area

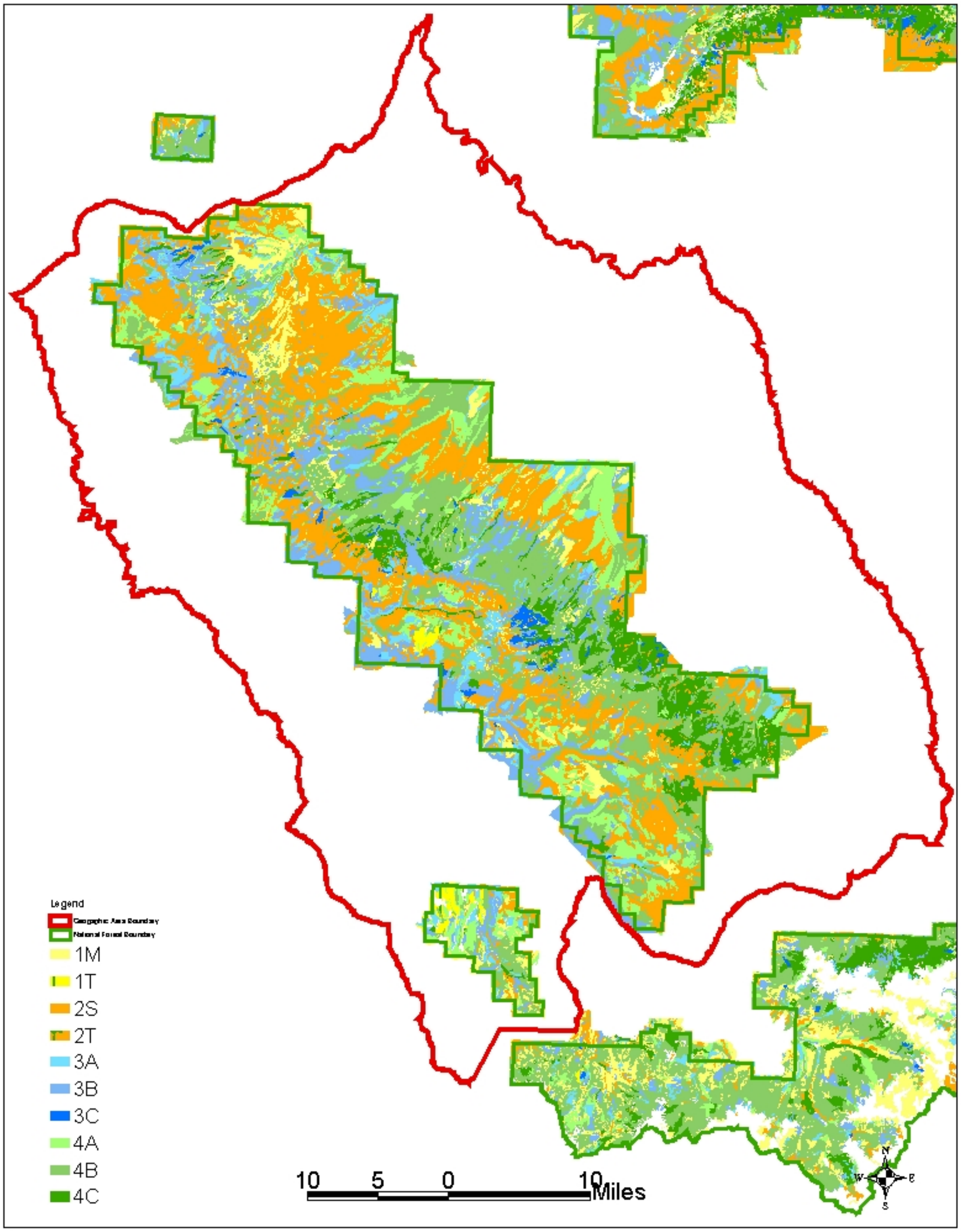
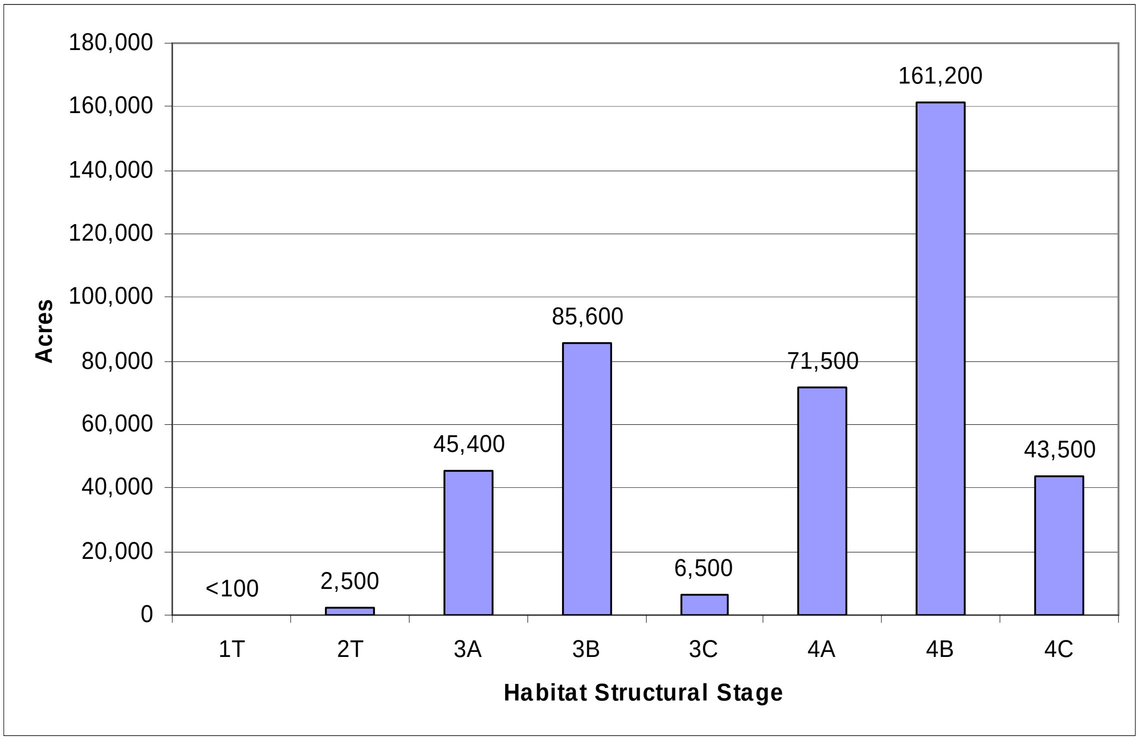


Figure 4 displays the distribution of habitat structural stages for the forest and woodland cover types (spruce-fir, aspen, Douglas-fir, ponderosa pine, blue spruce, cottonwood, lodgepole pine, pinyon-juniper) on the NFS portion of the Uncompahgre Plateau

Geographic Area. Note: Natural meadows and shrublands are not included in the chart below.

Figure 4. Habitat Structural Stage Distribution of Forest and Woodland Cover Types



This information can also be summarized by looking at the distribution of size classes (Figure 5) and densities or canopy closure (Figure 6) of forest and woodland cover types on NFS lands within the Geographic Area. Again, natural meadows and shrublands are not included in the data shown in Figures 5 and 6.

Figure 5. Size Class Distributions of Forest and Woodland Cover Types

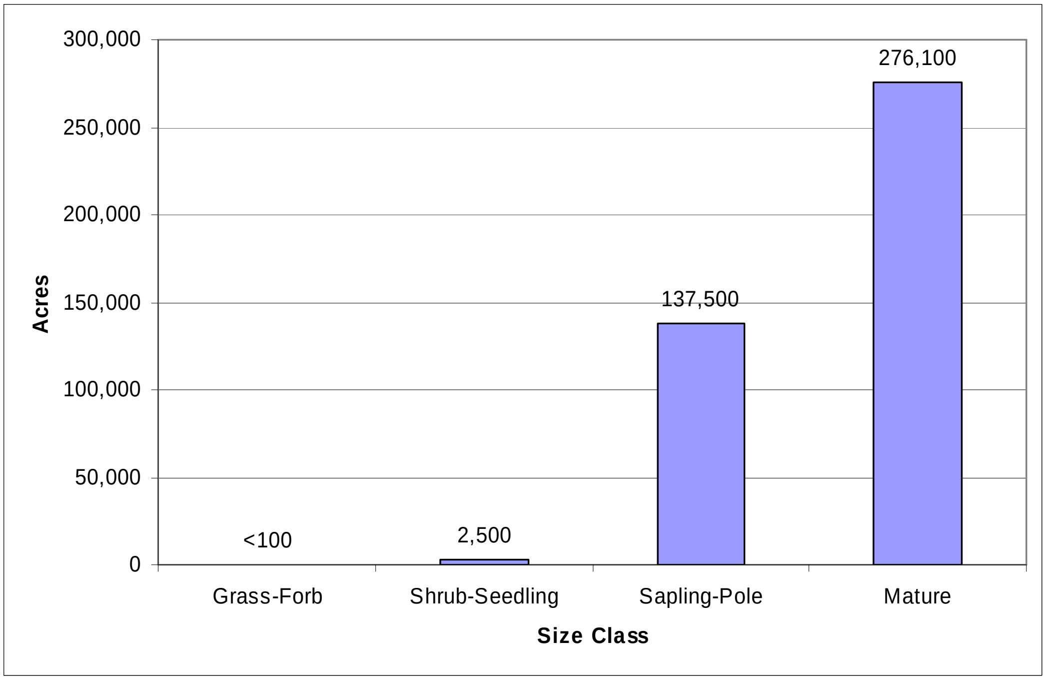
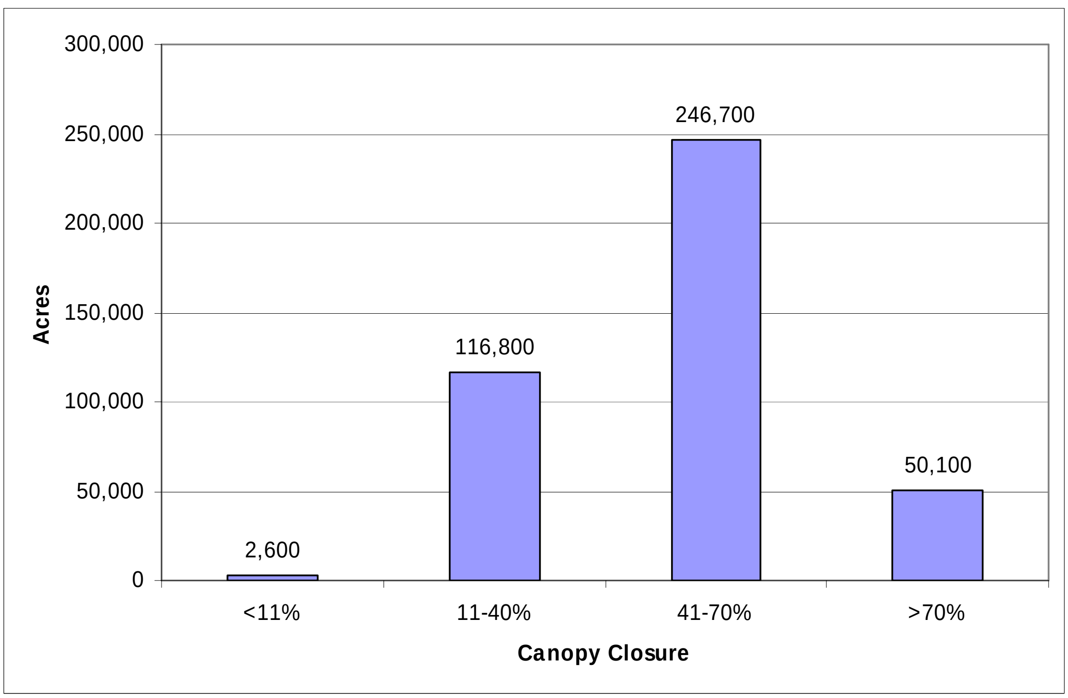


Figure 6. Canopy Closure Distributions in Forest and Woodland Cover Types



Characterization of Current Vegetation Conditions

Additional information on current conditions of different cover types is summarized in Table 2. (Also see timber, range and fire management sections.)

Table 2. Current Vegetation Characterization for NFS lands on Uncompahgre Plateau Geographic Area

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Spruce-fir	43,100 acres 7% of NFS lands 7% of total GA 91% of spruce-fir is on NFS land.	Most spruce is between 80–140 yr. old Most subalpine fir is between 40-120 yr. old.	1%-3A 7%-3B 3%-3C 4%-4A **47%-4B** 37%-4C	54% - single-storied 46% - multi-storied 92% - continuous canopies	39% of type has been affected by timber harvest	94% of type is within ½ mile of an existing road or trail. Includes: 130 miles roads 37 miles trails
Aspen	160,100 acres 25% of NFS lands 4% of total GA 71% of aspen is on NFS land.	Most aspen is between 80-120 yr. old.	1%-2T 9%-3A 25%-3B 3%-3C 2%-4A **44%-4B** 16%-4C	65% - single-storied 35% - multi-storied 86% - continuous canopies	6% of type has been affected by timber harvest	91% of type is within ½ mile of an existing road or trail. Includes: 330 mile roads 168 miles trails
Mixed Conifer (Douglas-fir, blue spruce, lodgepole pine)	3,000 acres <1% of NFS lands <1% of total GA 84% of mixed conifer type is on NFS land.	Most Douglas-fir is between 80-140 yr. old.	4%-3A 18%-3B 11%-4A **42%-4B** 26%-4C	29% - single-storied 71% - multi-storied 88% - continuous canopies	17% of type has been affected by timber harvest	86% of type is within ½ mile of an existing road or trail. Includes: 3 miles roads 4 miles trails
Ponderosa Pine	102,500 acres 15% of NFS lands 9% of total GA 79% of ponderosa pine type is on NFS land.	Most ponderosa pine is between 100-140 yr. old.	<1%-2T 8%-3A 10%-3B <1%-3C 38%-4A **42%-4B** 1%-4C	39% - single-storied 61% - multi-storied 93% - continuous canopies	38% of type has been affected by timber harvest.	93% of type is within ½ mile of an existing road or trail. Includes: 312 miles roads 54 miles trails
Pinyon-Juniper	106,000 acres 16% of NFS lands 34% of total GA 16% of pinyon-juniper type is on NFS lands	Age data not available	21%-3A **30%-3B** 1%-3C 24%-4A 24%-4B 1%-4C	68% - single-storied 32% - multi-storied 95% - continuous canopies	11% of type has been affected by mechanical treatments. 2% of type has been treated with fire.	69% of type is within ½ mile of an existing road or trail. Includes: 120 miles roads 56 miles trails

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Cottonwood	1,500 acres <1% of NFS lands <1% of total GA 37% of this type is on NFS lands.	No age data available.	7%-3A **61%-4A** 32%-4B	69% - single-storied 31% - multi-storied 88% - continuous canopies	None recorded.	60% of this type is within ½ mile of an existing road or trail. Includes: <1 miles roads <1 miles trails
Gamble Oak – Mixed Mountain Shrub	173,100 acres 27% of NFS lands 16% of total GA 60% of these shrub types are on NFS lands.	No age data available.	100% 2S Oak: 55% large (>6.5') 43% med. (2.5-6.4') 2% small (<2.5') Mixed Shrub: 19 % large 73% medium 7% small	Oak: 23% - single-storied 77% - multi-storied 75% - >40% cover 25% - <= 40% cover Mixed Shrub: 53% - single-storied 47% - multi-storied 50% - >40% cover 50% - <= 40% cover	6% of these types have been mechanically treated. 20% of these types have been treated with fire.	86% of these types are within ½ mile of an existing road or trail. Includes: 335 miles roads 159 miles trails
Sagebrush	21,800 acres 3% of NFS lands 9% of total GA 13% of this type is on NFS lands.	No age data available.	100% 2S 43% med. (2.5-6.4') 57% small (<2.5')	57% - single-storied 43% - multi-storied 50% - >40% cover 50% - <= 40% cover	2% of this type has been mechanically treated.	86% of type is within ½ mile of an existing road or trail. Includes: 98 miles roads 14 miles trails
Willow	1,500 acres <1% of NFS lands <1% of GA (Cannot determine percent of willow in GA that is on NFS lands.)	No age data available	100% 2S 28% large (>6.5') 71% med. (2.5-6.4')	53% - single-storied 47% - multi-storied 50% - >40% cover 50% - <= 40% cover	None recorded.	93% of these types are within ½ mile of an existing road or trail. Includes: 3 miles roads 5 miles trails

Cover Type[1]	Composition of GA[1]	Age Distribution[2]	Habitat Structural Stages[1]	Canopy Conditions[1]	Past Activities (1955 – 2003)[3]	Effects of Roads/Trails[4]
Grass/Forb	42,200 acres 6% of NFS lands 10% of total GA 19% of these types are on NFS lands.	No age data available.	100% 1M	Not applicable	2% of this type has been mechanically treated.	87% of these types are within ½ mile of an existing road or trail. Includes: 171 miles roads 45 miles trails.

1 Common Vegetation Unit/R2VEG database
2 Stand exam data for Grand Mesa Geographic Area.
3 RMACT database
4 INFRA transportation data related to R2VEG data. Includes all inventoried roads and trail, not just routes open to public use.

Comparison of Current Conditions to Historic Conditions

Environmental factors such as soils, slope, aspect, climate, and elevation determine the plant communities that potentially can grow on a given area. The stable plant community that establishes in the absence of any disturbances (i.e., fire, insect/pathogen mortality, windthrow, drought, harvest) is called the climax plant community. The area where a given climax plant community can grow is classified as a Potential Natural Vegetation (PNV) type, and is named for the climax plant community. For example, spruce-fir forests are the climax plant community at elevations from 10,000 to 12,000 feet, in the subalpine climatic zone (30-40 inches of precipitation annually, 50-70 frost free days, 30-40ºF mean annual air temperature) (Johnston et al. 2001). Areas where spruce-fir is the climax plant community are classified as the spruce-fir PNV type.

Draft PNV type classification has been completed for this Geographic Area. The PNV type composition on NFS lands within the Uncompahgre Plateau Geographic Area is shown in Figure 7. (PNV types with <0.1 percent composition are not included in Figure 7.) A map of PNV for the Uncompahgre Plateau Geographic Area is shown in Figure 8.

Figure 7. Distribution of Potential Natural Vegetation Types on NFS lands within the Uncompahgre Plateau Geographic Area

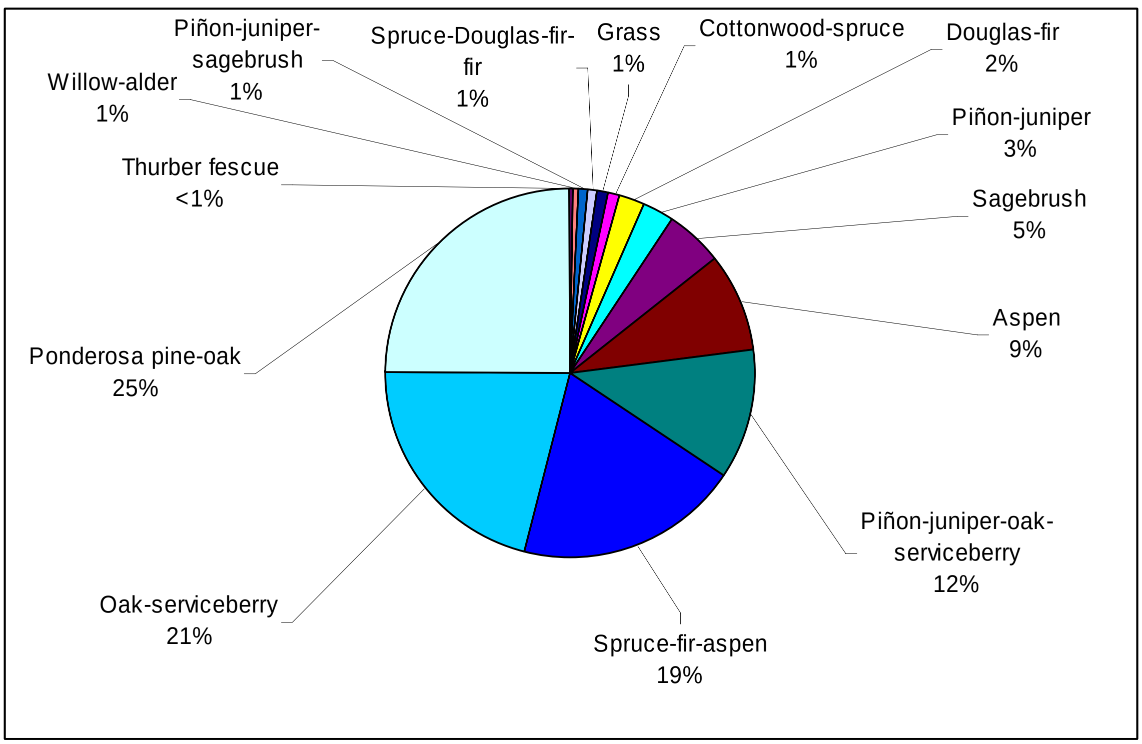
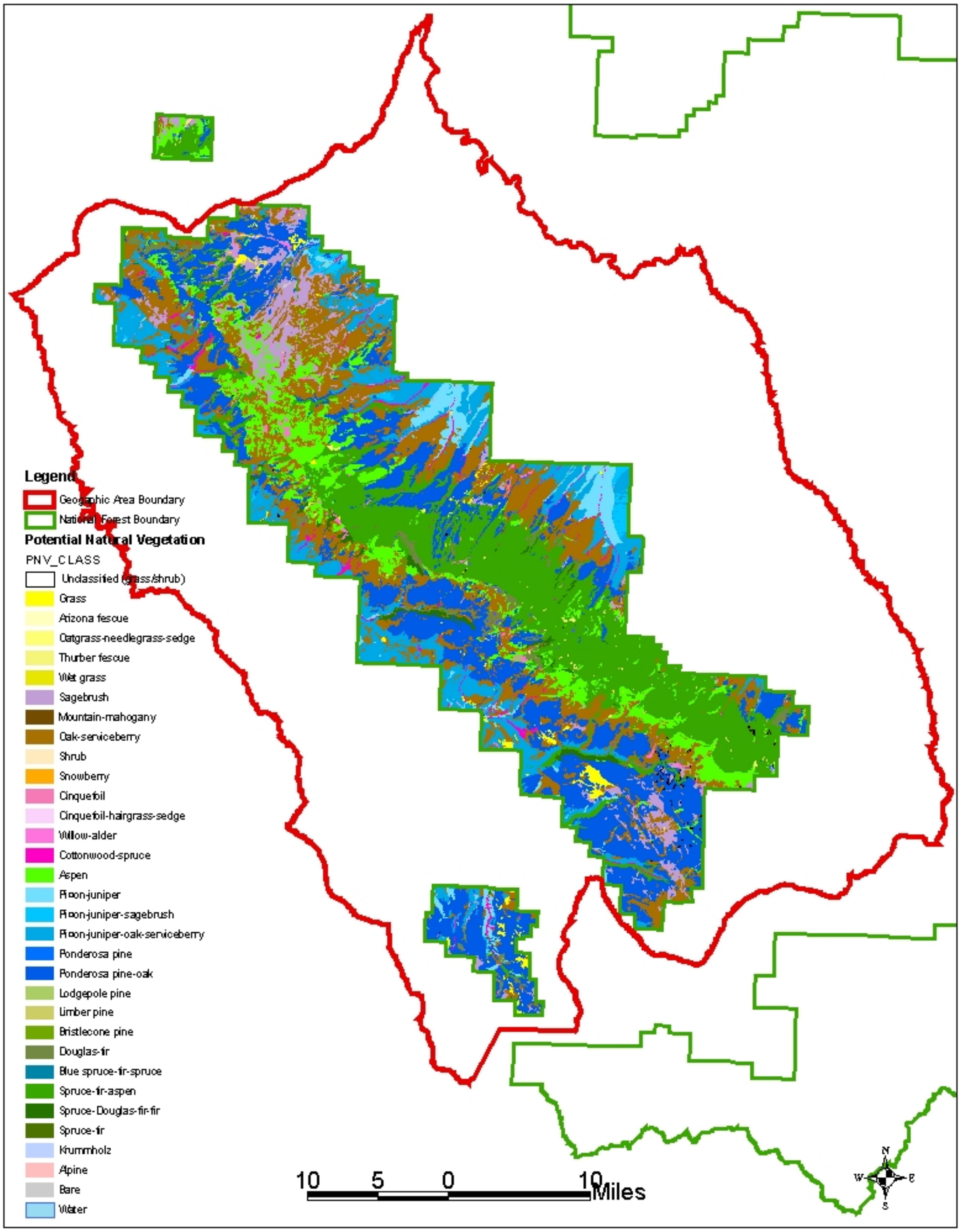


Figure 8. Map of Potential Natural Vegetation



Historically, for any given PNV type, natural disturbances (i.e., fires, insect outbreaks) occurred at characteristic intervals and intensities, called regimes. When a disturbance was intense enough to change the existing plant community (e.g., some or all of the overstory was killed), the remaining vegetation followed a natural progression, or succession, of plant communities that changed over time. If no further disturbances occurred, an area eventually returned to the climax plant community. However, if multiple disturbances occurred on the same area earlier seral plant communities would be perpetuated on a site for extended periods. The natural disturbance regimes and succession cycles resulted in shifting mixtures (or ranges) of different seral plant communities (or stages) within any given PNV type at any point in time.

The Vegetation Dynamics Development Tool (VDDT) (Beukema et al. 2003) was used to model the expected range in seral conditions that would have existed under historic disturbance regimes for forest, woodland and shrub PNV types. The results displayed in the following tables are conditions that would have been distributed across an entire PNV type on the Geographic Area. Results are scale dependant. For example, if a large fire burned an entire watershed, all of a given PNV type in that watershed could be set back to an early seral condition. However, when the watershed is considered as part of the Geographic Area, the mixture of seral conditions for that PNV type would be within the expected ranges. Both situations would have occurred naturally.

The next sections include comparisons of current conditions to historic conditions for the most common PNV types on the Uncompahgre Plateau Geographic Area, to see where differences occur. This information can be used to identify future management opportunities.

Spruce-Fir-Aspen PNV Type

The spruce-fir-aspen PNV type is mapped on 19 percent of the Uncompahgre Plateau. The climax community in this PNV type includes Englemann spruce and subalpine fir as the dominant overstory species with aspen occurring in all seral stages. The spruce-fir-aspen PNV type is comprised of the current spruce-fir cover type, and approximately 48 percent of the current aspen cover type.

Table 3 describes the seral stages and timeline for succession in the spruce-fir-aspen PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages) within the spruce-fir-aspen PNV type.

Table 3. Succession (Seral Stages) in Spruce-Fir-Aspen PNV Type

	Early	**Early-Mid**	**Late-Mid**	**Late**
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 30-50 years	Dense pole-sized aspen, grass and forb understory, lasting up to 100 years	Mature aspen overstory with conifer trees growing in the understory. May take 100 to 200 years for conifers to dominate stand.	Mature conifer, scattered mature aspen in overstory. New trees can become established in gaps in canopy. Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	13-19%	22-29%	13-16%	35-49%
Current Seral Conditions	3%	45%	52% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

Most of the spruce-fir-aspen PNV type is currently dominated by aspen (62 percent) which regenerated after extensive fire(s) in 1879. This is shown by the high percentage in mid seral stages (includes both early-mid and late-mid), above. Conifer is becoming more dominant in these stands and in the absence of disturbance, these stand will succeed back to spruce-fir dominated conditions (Smith and Smith, 2004). Currently 36 percent of this PNV type is dominated by spruce-fir (included in the late-mid to late percentage, above).

The historic fire regime for this type is very infrequent (200 years +), stand replacing fires affecting large areas, mixed with very small low intensity fires that occur at shorter intervals. Since 1971, 98 fires have burned in this PNV type, affecting 90 acres. Fifty-six percent of the fires were lightning caused, the rest were human-caused. Most fires affected less than ¼ acre. These fires have not altered the seral condition

The spruce-fir-aspen PNV type is also host to a variety of insect and pathogens (see Forest Health section). Insect and disease activity over the past eight years in this PNV type includes western spruce budworm (affecting 54,800 acres) and subalpine fir mortality (affecting 18,700 acres). The result has been a reduction of subalpine fir in the understories of much of this PNV type, which perpetuates many stands in mid seral conditions.

Approximately 18 percent of this spruce-fir-aspen PNV type has been treated with some type of silvicultural method since 1955. Clearcuts in spruce-fir affected approximately 2,300 acres in the 1960s-1970s. Clearcutting in aspen has affected 2,400 acres since the mid 1980s. Shelterwood harvests in spruce-fir have treated 14,800 acres between 1970 and the mid 1990s. An additional 1,600 acres have been treated with thinning, selection or salvage treatments, mostly in the 1980s. Harvest activities have occurred throughout the extent of the spruce-fir-aspen PNV type.

Earlier seral conditions exist in areas that were harvested by clearcuts. All the other silvilcultural practices used in this PNV type reduced stand density, but they did not alter the seral condition, because the age of the dominant overstory was not changed.

Aspen PNV Type

In the aspen PNV type, pure aspen is the climax plant community, with no conifer species present. The aspen PNV type is mapped on nine percent of the Uncompahgre Plateau. Approximately 29 percent of what is currently shown as the aspen cover type is included in the aspen PNV type. (The rest of the aspen cover type is seral to a conifer PNV type.)

Table 4 depicts the seral stages and timeline for this PNV type as well as a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages).

Table 4. Succession (Seral Stages) in Aspen PNV Type

	Early	Early-Mid	Late-Mid	Late
Seral Stage Descriptions*	New stand of aspen seedlings/suckers with grass and forb understory lasting 10 to 20 years	Dense pole-sized aspen, grass and forb understory, lasting 50 to 80 years	Mature aspen overstory, aspen regeneration in the understory where overstory gaps results from individual tree mortality, lasting up to 80 years	Stable multi-storied, multi-aged aspen stand, predominantly forb understory.Lasts until next stand replacing disturbance
VDDT Modeled Range of Seral Conditions	8-14%	23-26%	17-24%	23-43%
Current Seral Conditions	13%	41%	46% (Limited age data makes it difficult to differentiate between late-mid and late seral conditions.)	

*Romme et al. 2003

As with the previous PNV type, most of the aspen in this type regenerated after extensive fire(s) in 1879, and are in the late-mid seral condition. Very few areas of aspen were not affected by the 1879 fire(s).

Fire studies in aspen from the San Juan National Forest indicate a historic fire regime with fire intervals ranging from less than 70 years to 100 years (Romme et al. 2003). Fires were mostly surface, low intensity fires; however because aspen are such thin-barked the overstory was usually killed. Fires often burned into this PNV type from pondererosa pine-oak PNV type areas, below (Romme et al. 2003). Only 11 fires have occurred in this PNV type on the Uncompahgre Plateau Geographic Area since 1971. All but two were lightning starts, each affecting less than ¼ acre. One human-caused fire in 1991 burned 120 acres of this PNV type. These acres are accounted for in the early seral condition, above.

Approximately six percent of the aspen PNV type has been harvested using clearcuts since 1984. These areas are mostly in the early seral condition shown above, with some of the older clearcuts in the early-mid seral conditions. Aspen quickly moves out of the early into the early-mid stage (within 10 years).

Ponderosa Pine-Oak PNV Type

Ponderosa pine mixed with a Gambel oak understory is the climax plant community in this PNV type. The ponderosa pine-oak PNV type has been mapped on 25 percent of the NFS land on the Uncompahgre Plateau. This includes approximately 95 percent of the current ponderosa pine cover type. Table 5 depicts the seral stages and timeline for succession in this PNV type. This table also displays a comparison of the modeled historic range of seral conditions to the current seral conditions (as percentages) within the spruce-fir-aspen PNV type.

Table 5. Succession (Seral Stages) in Ponderosa Pine - Oak PNV Type

	Early	Early-Mid	Late-Mid	Late	Fire-Maintained Open
Seral Stage Descriptions*	Aspen and Gambel oak regeneration, grass and forb understory lasting 20 to 40 years	Pole-sized aspen, oak shrub, grass and forb understory, may include some ponderosa pine seedlings. Ponderosa pine seedlings eventually codominate with aspen, lasting up to 100 years	Mixed aspen and ponderosa pine overstory, , ponderosa pine regeneration in the understory where gaps results from individual tree mortality, lasting 100 to 200 years	Stable multi-storied, multi-aged mixed stands with ponderosa pine dominant, and remant mature aspens, oak, grass/forb understory. Conditions last until a disturbance kills a large percentage of the overstory.	Low density of large ponderosa pine trees. Dense ground cover in grass, forb with oak/serviceberry shrub understory. Open stands maintained by frequent low-intensity fires.
VDDT Modeled Range of Seral Conditions	14-16%	11-14%	2-10%	7-12%	48-65%
Current Seral Conditions	<1%	25%	55%	1%	19%

*Romme et al. 2003

Currently ponderosa pine dominates 62 percent, aspen dominates 17 percent and oak dominates 16 percent of this PNV type. Most of the ponderosa pine cover type is in the late-mid, late and fire-maintained open seral conditions. The aspen is in the early-mid seral condition, and the oak areas fall into both the early mid and fire-maintained open seral conditions.

The fire regime in this PNV type is frequent, usually low intensity fires (Romme et al. 2003). Under this historic fire regime a fifth seral stage usually developed and occupied a large percent of the landscape. The current lack of fire-maintained open conditions on the Uncompahgre Plateau is the result of several factors. Heavy livestock grazing prior to the 1950's and active fire suppression efforts over the last 100 years have prevented frequent fires in this PNV type, allowing denser stands to develop than would have occurred historically.

Large diameter ponderosa pines were heavily harvested off the Uncompahgre Plateau before the National Forest was established in 1905, and this practice continued into the mid-1900s. Pine remaining after these harvests is currently in late-mid seral conditions.

Since 1955 approximately 26 percent of this PNV type has been harvested. Selection harvests were used mostly in the 1970s (2,300 acres, <2 percent of PNV type). Shelterwood harvests occurred in the 1980s (9,000 acres, <6 percent). A mountain pine beetle epidemic in the mid to late 1980s resulted in thinning harvests (10,000 acres, 7 percent) followed by sanitation and salvage harvests (17,600 acres, 12 percent) in the late-1980s to mid-1990s which also removed larger diameter trees. In some cases the majority of the overstory was affected and many of these sites have been planted to reestablish ponderosa pine. In other cases, overstories were just opened up and natural regeneration has occurred in the understory. These areas are currently in the early and mid seral conditions.

Since 1971 there have been approximately 200 fires in this PNV type, 82 percent were lightning caused, and 93 percent affected less than 5 acres, each. However, 13,300 acres (nine percent) of this PNV type have been burned by larger fires, most occurring in 2002. The 2002 fires were larger and more intense than normally expected for this PNV type, due to uncharacteristically dense stand conditions described above. The burned areas are included in the early seral condition above.

Prescribed burning has been done on approximately 9,000 acres (six percent) of this PNV type since the early 1990s. These treatments have been designed to reduce understory fuels so that when natural fires occur, fires are less intense. Some of these treated areas are included in the fire-maintained open seral condition listed above.

Pinyon-Juniper PNV Types

Three different pinyon-juniper PNV types have been identified on the Uncompahgre Plateau: pinyon-juniper-oak-serviceberry (12 percent) is located in an elevational band below 8,000 feet all around the Uncompahgre Plateau; pinyon-juniper woodland (three percent) is located on steeper canyon areas, like Escalante, Roubideau, and tributaries to the Dominguez drainages; and pinyon-juniper-sagebrush (one percent) is located on areas with deeper soils. Table 6 displays the seral stages and timeline for the pinyon-juniper-oak-serviceberry PNV type.

Table 6. Succession (Seral Stages) in Pinyon-Juniper-Oak-Serviceberry PNV Type

	Early	Mid	Late
Seral Stage Descriptions*	Dominant shrubs re-sprout and form dense cover. Grasses and forbs occur in the understory. Persists from 50-70 years	Shrubs still dominate site but young pinyon pine and juniper trees become established. Persists from 100 to 150 years.	Dominated by mature, often dense pinyon and/or juniper trees, some shrubs present in the understory. Persists until next stand replacing disturbance.
VDDT Modeled Range of Seral Conditions	28-51%	39-43%	9-29%
Current Seral Conditions	3%	2%	95%

*Romme et al. 2003

The vast majority of the pinyon-juniper-oak-serviceberry PNV type is currently in late seral tree dominated conditions. This is partly a result of past fire suppression not allowing fires to periodically burn in this type. Heavy livestock grazing that persisted until the mid-1950s also contributed to the current tree dominated conditions by removing competing understory species, which allowed the woody overstory species to prosper (Manier et al. 2003). The limited amounts of mid and early seral conditions exist where chaining activities occurred in the 1960s and where many of these areas have been retreated with rollerchopping within the past ten years.

Pinyon-juniper communities experienced small fires every 10-30 years with larger fires every 150-450 years (Manier et al. 2003). Between 1970 and present, 55 fires have started in the pinyon-juniper-oak-serviceberry PNV type, and several additional fires have burned 3,800 acres of this type. As with the ponderosa pine-oak PNV type, most acres were burned in 2002.

The pinyon-juniper PNV types have been experiencing a large amount of mortality of pinyon trees over the past five years, caused by a combination of Ips beetle, drought and black stain fungus. Approximately 15,300 acres of pinyon-juniper PNV types on NFS lands within the Uncompahgre Plateau Geographic Area have been affected since 1997. The largest increase was seen in 2003 when approximately 94,100 acres in the total Geographic Area was inventoried, mostly on public lands managed by the BLM, and private land below the forest boundary. Approximately 12,900 acres of pinyon mortality occurred on NFS lands within the Geographic Area in 2003. The effect of this dieoff varies from 10-100 percent of the pinyon trees being killed within a given stand. Juniper trees are not affected. Pinyon mortality appears to be lower as elevation increases. The changes to seral conditions are not reflected in Table 6, above.

Oak-Serviceberry PNV Type

The oak-serviceberry PNV type has been mapped on 21 percent of NFS lands on the Uncompahgre Plateau. Table 7 compares current conditions in this PNV type to the modeled historic mix of seral conditions.

Table 7. Succession (Seral Stages) in Oak-Serviceberry PNV Type

	Early	**Mid**	**Late**
Seral Stage Descriptions*	Stands are dominated by resprouting shrubs with grasses and forbs in the understory. Persists to 20 or 30 years	Dense clumps of shrubs, usually < six feet high. Grassa and forbs between clumps. Persists from 30 to 40 years.	Shrubs > six feet high, more open canopy. Grass/forbs between and beneath shrub canopies. Persists until next stand replacing disturbance.
VDDT Modeled Range of Seral Conditions	30-70%	28-34%	0-36%
Current Seral Conditions	4%	48%	48%

*Romme et al. 2003

The majority of the oak-serviceberry PNV type is in mid to late seral conditions, indicating a lack of recent disturbances. Historically, fires occurred in this PNV type at frequent intervals (every 15-30 years). The dominant shrub species, Gambel oak and serviceberry, resprout following fire so areas quickly returned to shrubs. This type transitioned from one seral condition to another at approximately 30 year timesteps.

This PNV type has been treated with both mechanical (approximately 8,200 acres) and prescribed fire methods (approximately 31,800 acres). The majority of the prescribed burning occurred in the 1980s and 1990s. Mechanical treatments were used in the 1960s and areas were retreated in the last five years. The recent treatments are accounted for in the early seral conditions.

Since 1970, approximately 100 fires have burned in this PNV type. Over half of these fires burned less than ¼ acre. As with other PNV types with more frequent fire regimes mentioned above, the more recent fires have burned 4,400acres (three percent of this PNV type).

Sagebrush PNV Type

The Sagebrush PNV type is mapped on five percent of the NFS land on the Uncompahgre Plateau. Range management in the past (pre 1950s) altered much of this type by spraying to eradicate sagebrush, seeding non-native grass and forb species, and heavy grazing. This PNV type also historically had a frequent fire occurrence (15-30 year intervals).

Sagebrush currently occupies less area than it did historically, due to these past range treatments. Fire suppression has also removed the frequent disturbance interval that historically created patches of multi-aged stands. As shown in Table 2, the majority of the sagebrush on the Uncompahgre Plateau is in single-storied, single-aged stands.

Key Findings

- Gambel oak and mixed mountain shrub cover types currently occupy just over a quarter of the NFS lands.
- Aspen currently dominates a quarter of the NFS lands.
- Conifer forest and woodland cover types (pinyon-juniper, ponderosa pine, spruce-fir, Douglas-fir, blue spruce, lodgepole pine) combined make up 38 percent of the current vegetation cover on the Uncompahgre Plateau. Lodgepole pine does not naturally occur on the Uncompahgre Plateau, but was planted in the 1960s.
- Most of the spruce-fir, aspen, mixed conifer, ponderosa pine, Gambel oak and mixed mountain shrub cover types within the total Geographic Area occur on NFS lands.
- Most of the pinyon-juniper, cottonwood, sagebrush, willow and grass/forb cover types within the total Geographic Area occur off NFS lands on either BLM or private land.
- Current vegetation conditions are a result of the disturbance history on the Uncompahgre Plateau. Large fire(s) in 1879 burned over much of the Uncompahgre Plateau Geographic Area. The majority of the forest cover types regenerated following this fire event. This is reflected in the average age of all types (80 to 120 years old), their habitat structural stages (66 percent are in mature size class) and their current seral conditions (the majority of all forest types are in mid seral conditions).
- The lack of fire disturbance that has resulted from approximately 100 years of fire suppression efforts is also reflected in current vegetation conditions. Seventy-one percent of the forest and woodland cover types have dense canopy closures (> 40 percent canopy closure). There are very little early seral conditions in any cover type on the Uncompahgre Plateau. This imbalance is most pronounced in cover types that had a history of more frequent fires, such as ponderosa pine, oak-serviceberry and pinyon-juniper-oak-serviceberry types.
- When comparing the compositions of current vegetation cover types to PNV types (Figure 1 through Figure 7), it appears that aspen and oak currently occupy more area than would have been expected historically. This is somewhat misleading, however; because aspen and oak are both earlier seral stages to conifer dominated forest types (i.e., spruce-fir-aspen, ponderosa pine-oak), and given time, these deciduous cover types will succeed to conifer cover types.

Vegetation Trends

- The trend across all vegetation cover types on the Uncompahgre Plateau is to continue successional progress predominantly with the absence of either natural or human-caused disturbances. Structural and compositional conditions in each cover type will progress along successional timelines. Forest and woodland cover appears to be increasing at the expense of formerly, open shrub and grasslands (Manier et al. Draft 2003). A shift from aspen dominated forests to conifer dominated forests is also occurring as a result of successional changes (Smith and Smith 2004).

Vegetation Management Implications

Management implications of vegetation conditions relate to differences between current and historic vegetation conditions. Where landscape conditions are within the historic range of variability landscapes are more resilient following disturbances, suitable habitat is provided for all species that evolved there, and ecosystems are productive and sustainable over time. Where current conditions deviate from historic ranges, there are increased risks for natural disturbances to be of higher intensities and affect larger areas than in the past; some habitats may become very limited or lost, threatening species viability; and loss of productivity can result in both ecological and economic losses. Management activities that can include both human and natural disturbances can be used to alter vegetation conditions. Management implications for specific cover types are discussed below.

Spruce-Fir

- Current stand conditions (age, density, canopy structure) in the majority of the spruce-fir cover type are susceptible to outbreaks of various insects and pathogens. Outbreaks of western spruce budworm and subalpine fir decline have been increasing over the past decade. (See Forest Health section.)

- The spruce-fir cover type comprises the late-mid to late seral stages of the spruce-fir-aspen PNV types (approximately 52 percent of the PNV type). These late-mid seral conditions are ripe for fire and insect and pathogen outbreaks (see Forest Health and Fire Management sections). Because so much of the landscape is in the same condition, there is a high probability that large areas can be affected at the same time. Large scale disturbances (both fire and insect outbreaks) are the natural regimes for this PNV type. Management activities that increase diversity in age, size and seral condition, could be used to reduce the potential effects of natural disturbances.

- At endemic or low levels of insect/pathogen activity, individual trees killed by insects and diseases can provide a variety of habitats for different wildlife species (snags, downed logs). However, if a large outbreak should cause heavy mortality across a large area, the result would be a shift from mature spruce-fir forests to young aspen stands. It could take almost two centuries for mature spruce-forest conditions to return.

- Recent timber management activity in the spruce-fir cover type was the first step of a three step shelterwood silvicultural system. (See Timber Management section.) Second step entries typically follow at 30 year intervals. Many previously treated stands are nearing the time for this second entry. Second step shelterwood entries usually remove 40 to 60 percent of the volume present, which would open up stand conditions, allowing for both aspen and spruce regeneration. The resulting changes in stand conditions would lessen the risk for future fire, insect and/or pathogen infestations.

Aspen

- The aspen cover type occurs in most of the conifer PNV types (i.e., spruce-fir-aspen, ponderosa pine-oak, Douglas-fir, as the early through mid seral conditions), and the aspen PNV type (all seral stages). Aspen is currently the most dominant forest cover type on the Uncompahgre Plateau.

- Aspen stands become very susceptible to cankers and root rots above the age of 110 years. A large percentage of the aspen cover type on the Uncompahgre Plateau is between the age of 80 and 120 years. An increasing amount of mortality caused by these agents is expected in the future.

- Over 60 percent of the aspen stands on the Uncompahgre Plateau include conifer species in the understory or as codominant species (Smith and Smith, 2004). In the absence of some disturbance, these stands will eventually succeed to conifer dominated cover types. A shift from an aspen cover type to various conifer cover types will change the types of habitat available on the Uncompahgre Plateau.

Ponderosa Pine

- The majority of the ponderosa pine cover type is mature (80 percent). These stands are the late-mid seral stages of the ponderosa pine-oak PNV type.

- Historic timber harvest practices in the late 1800s into the early 1900s removed most of the old, large diameter trees in the ponderosa pine type. The current overstory is much younger (an average age between 100 and 140 years) and smaller than would have existed in historic stands. Habitat is limited for species that require large diameter ponderosa pine.

- Fire suppression and grazing over the past 100 years interrupted the natural fire regime in ponderosa pine. The result has been an increase in understory vegetation. Current conditions increase the potential for high-intensity stand replacing fires when fire does occur in this type. Before fire can be reintroduced into many of these stands, the amount of vegetation may need to be reduced by some means other than fire.

- Thinning, sanitation and salvage harvests associated with the mountain pine beetle outbreak in the late 1980s have resulted in stand conditions that are more uniform in nature than would have existed historically. Stands are less dense (80 percent of the stands have < 70 percent canopy closure) than other forest types, and snags and downed woody material have been reduced as a result of salvage operations.

Pinyon-Juniper Woodlands

- A comparison of conditions between 1937 and 1994 (Manier et al. 2003) indicates that pinyon-juniper has expanded into areas formerly dominated by shrubland and grasslands only in localized areas; however, the density of pinyon-juiper stands has increased. These changes have caused a decrease in the amount of available forage for both wildlife and domestic livestock.

- Historically this cover type had a patchy distribution of different aged stands (see Table 6). Currently most of the pinyon-juniper on the Uncompahgre Plateau is in late seral conditions of continuous dense even-aged stands. These conditions will alter the effects of future natural disturbances on the landscape. There is a increased risk of stand-replacing crown fires that may burn larger areas. (See Forest Health and Fire Management sections.)

- Past mechanical treatments (i.e., chainings) done in the mid 1960s to increase forage for both livestock and wildlife changed the amount of habitat available for species like mule deer and elk. As trees have become reestablished in these areas, the type of habitat provided by these areas has changed from foraging areas to cover.

- The proximity of wildland-urban interface areas intensifies the risks associated with intense wildfires in the pinyon-juniper cover type. Increasing development on private lands within this cover type is increasing the risks.

- The ongoing pinyon pine mortality has the potential to remove most of the pinyon trees from this cover type. This will greatly alter the habitat available for wildlife species, especially for pinyon obligates (See Wildlife section.)

Gambel Oak and Mountain Shrubs

- Table 7 indicates that current conditions in the Gambel oak and mixed mountain shrub cover types have less patchiness and structural stage diversity than would have occurred historically. The result is current conditions are more susceptible to higher intensity fires that may affect larger areas of land than would have occurred in the past. There is also less diversity in the types of habitat provided by these cover types than would have been present.

Sagebrush

- Past range treatments and livestock grazing altered the understory species composition in this cover type. Lack of disturbance in the past 30 years allowed shrub density to increase, reducing understory vegetation. Structural stage diversity has become more uniform and less patchy across the landscape. These combined changes have altered the habitat that historically would have been provided by this cover type.

- Only 13 percent of the sagebrush cover type currently found in the Geographic Area is located on NFS lands. The importance of these areas on Forest for species conservation may increase, depending on the condition and future management of this cover type off Forest.

Grass-Forb

- The species composition in grass-forb cover types on the Uncompahgre Plateau has been altered from historic conditions through livestock grazing, seeding of non-native species, and introduction of noxious weeds. These cover types may be candidates for future restoration efforts.

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