

Based on the State Engineer's records, there are three privately owned diversion ditches that may be diverting water from these creeks and six water use facilities (e.g. pipelines or springs) with privately held water rights within these watersheds. The State Engineer does not regularly measure these diversions because of the relatively small volumes of water diverted; therefore, there are no recorded annual totals for these diversions. Due to the lack of recorded data, the Forest Service characterizes these diversions to account for less than 20 percent of the annual total yield (Steering Committee Report, Pathfinder Project, 2004) for purposes of evaluating in-stream flow conditions on these drainages.

Watershed Sensitivity

The natural physical properties of a watershed combined with the climatic influences determine, to a great extent, the ability of a watershed to properly function in terms of hydrologic processes (runoff, groundwater recharge, streamflow, and vegetative growth) and to provide suitable aquatic habitats. For the GMUG National Forest, ratings of natural watershed sensitivity have been determined by evaluating several physical features and climatic factors. Variables that were used to evaluate sensitivity included an index for rainfall intensity, stream density, erodible soils, depth of soils, and stream channel gradient. These variables tend to be related to sediment generation and transport since those factors are the dominant water quality and aquatic habitat impacts on NFS lands. Those watersheds where the combined influence of these variables was determined to be high or limiting in the proper function of the watershed were considered to be sensitive. As sensitive watersheds, the impacts of anthropogenic actions could cause greater degradation or loss of aquatic habitat than in watersheds with less sensitive watershed conditions.

For the IAA, the watershed sensitivity is characterized numerically as a Class 3. This is a relative rating comparing all watersheds on the GMUG National Forests- placing these watershed areas in the middle of the range of sensitivity. All of the watersheds in the IAA have very similar ratings for the variables used to evaluate sensitivity. The rainfall intensity index was the highest rated variable (in the mid 40 percentile) for these watersheds and is consistent with climatic information for this area and the frequency and intensity of convective storms that affect the IAA.

Anthropogenic Effects

The Forest Service has evaluated the level of land use activities or hydrologic regime changes that have been caused by anthropogenic action occurring within the watershed boundaries where there are NFS lands. Where it had or could access reliable and accurate data, the Forest Service evaluated those land use activities and hydrologic regime changes that had an influence on watershed function, water quality or aquatic habitat. For this analysis of anthropogenic effects, variables were evaluated to determine a rating for anthropogenic influence on watersheds throughout the GMUG National Forest; such variables included: miles of stream with

bank/sediment impacts, miles of stream flow affected by water right diversions or reservoirs, acreage of extensive vegetation removal, road and motorized trail density, road and motorized trail stream crossings, acreage of riparian area affected by road and motorized trails, active or abandoned mines, and the percentage of privately owned land within the watershed

For the watersheds within the IAA, the anthropogenic effects or activity ratings are characterized numerically as Class 3 for Clay Creek, McKenzie Creek, Albin Draw and Goodenough Creek and the lower Horsefly Creek watershed area is characterized as a Class 2. This places much of the majority of the Analysis Area in the middle (Class 3) and to a lesser extent in the lower (Class 2) on the range of anthropogenic effects. The Forest Service considers the Albin Draw watershed to be similar to a Class 4 rating for anthropogenic effects because of the effects of recent wildfire in the area. The effects of the wildfire will diminish over time.

The Forest Service uses the sensitivity and activity ratings in combination to provide some assessment of overall watershed integrity. One aspect of watershed integrity is an understanding of whether conditions in the watershed continue to function within a range of variability that could be expected for a watershed under natural variations in weather, catastrophic events, and biologic succession. For the IAA, the combination of Class 3 sensitivity and Class 3 activity ratings can be interpreted to mean that the watersheds are within the historic range of variability for conditions related to watershed function, but that from a watershed integrity perspective, these watersheds are not pristine nor are they unaffected by anthropogenic impacts.

Proper Functioning Condition Survey Results

Proper Functioning Condition (PFC) assessments have been completed along four streams within the IAA using the PFC user guide for assessing lotic areas (USDI/USDA 1998). Included are the primary reaches of the North Creek, McKenzie Creek, Clay Creek, and Craig Draw drainages. The results of these assessments are displayed in Table 3.

Table 3: Proper Functioning Condition (PFC) Assessments for Streams in the IAA

Stream	Date of Survey	PFC Rating	Miles of Stream Surveyed
North Creek	9/15/04	Properly Functioning	2.0
McKenzie Creek	7/15/97	Properly Functioning	2.1
Clay Creek Canyon	7/29/97	Properly Functioning	4.5
Lower Clay Creek	7/17/97	Properly Functioning	0.25
Upper Clay Creek	7/17/97	Properly Functioning	2.5
Lower South Fork of Clay Creek	7/29/97	Functioning at Risk	0.5
Upper South Fork of Clay Creek	7/29/97	Properly Functioning	2.0
Lower Craig Draw	7/30/97	Functioning at Risk	1.0
Upper Craig Draw	7/30 & 8/4/97	Properly Functioning	3.5

The PFC assessment includes 17 criteria related to the hydrologic, vegetative, and erosion deposition functions of the stream. The two stream reaches that are rated as functioning "at risk" are low gradient alluvial reaches associated with meadow and open park areas. Bank erosion, increases in fine sediment, changes in stream morphology, and reduction in riparian vegetation cover, composition, and vigor are consistent problems associated with each impacted reach. These impacts appear to be associated with the presence of developed stock water developments and the associated concentrated livestock grazing use of the site.

Most streams in the Uncompahgre Plateau lack suitable fish habitat to sustain large populations of trout species. Trout populations are generally limited by steep gradients, lack of spawning habitat, cold water temperatures, lack of shallow pools needed for suitable summer, lack of over-wintering habitat, and the presence of nonnative trout (Behnke 1992, Young 1995). Recent stream surveys suggest that most fish-bearing streams in the IAA have gradients ranging between 3 and 7%. Spawning habitat is very limited in these headwater systems causing trout to spawn in marginal spawning areas. This has likely resulted in poor egg-to-fry survival for trout. Laboratory studies indicate that geometric mean particle sizes from 13.8 to 15.9 mm or larger yielded the best chance of survival for cutthroat trout (Young et al. 1991). Existing information on streambed particle size distribution for the IAA suggests that particle size densities of this range comprise only 7% of the total substrate (USFS unpublished). Furthermore, measurements of percent fines less than 2 mm indicate that fine sediment may comprise 10-33% of the available spawning area depending on stream and channel morphology (USFS unpublished). In forested stream reaches, LWD densities range from 11 to 59 pieces per 100 meters of stream, indicating that habitat cover is not a limiting factor for cutthroat trout survival. (USFS unpublished).

Historic livestock use has had dramatic impacts on riparian and vegetation on the Uncompahgre Plateau over the last 100 years. However, F. Reed (pers comm.) has documented dramatic improvements in range and riparian conditions by comparing recent photographs to historic photographs of the same site. Despite significant

changes in the timing, use, and duration of livestock grazing and improvements in conditions, some stream channels continue to show impacts from historic and current use. Low gradient, meadow streams are most susceptible to livestock use and are locations where livestock practices may have the greatest risk for conflict with fisheries and other aquatic species.

Watershed Factors to be Considered in Project Planning and Design

The watersheds within the IAA, while not considered to be highly sensitive, are more sensitive than other areas on the Uncompahgre Plateau. The inherent natural features of these watersheds that affect the sensitivity ratings the most are the rainfall intensity index and the stream densities. With the existing land use activity ratings falling into the moderate range and the additional impacts associated with recent wildfire, decisions regarding future land use activities should be cognizant of past land use activities so as not to exacerbate the cumulative effects on the watersheds to further degrade conditions to a level where long-term watershed integrity is compromised.

Since the predominating factors driving watershed sensitivity are related to runoff potential (e.g. rainfall intensity and stream density), activities that would inherently induce greater surface water runoff would be of greatest concern. Activities such as road building and vegetative cover removal would have the greatest potential to cumulatively impact watershed condition. The “footprint” of such activities is the most critical element in determining how much more activity can occur without adverse impact. Increases in road density and road miles have the ability to create more acres of near impervious surface area and create greater stream densities due to road-side ditches. With vegetation removal the greatest concern would be removal of vegetative cover and the exposure of large areas (i.e. 10 acres or greater) of bare soil without adequate vegetative buffers between treatment areas and drainage channels. While these activities are of greatest concern, the acreage extent of such disturbances is the key factor in creating adverse impacts, and the incremental effects of such activities can be effectively mitigated so as not to move watershed conditions to the point where inherent watershed integrity is diminished.

Land use activities or catastrophic natural disturbance events that would denude large blocks (acreage) of the landscape in these watersheds would have the potential to further degrade watershed integrity. In contrast, activities that, over the long-term, have the ability to maintain vegetative cover and not increase surface water runoff are most compatible with watershed function within the IAA. Pre-project planning should consider field evaluations to validate those sensitivity factors that “drive” the moderate sensitivity ratings, and confirmation of existing and past land use activities should be done to better understand the level of cumulative effects that any proposed land use activity would have. Stringent adherence to Standards and Guidelines regarding the area of disturbance and road design and construction will further lessen the potential to affect watershed condition and function.

B. Soils/Geology

Soils information for the IAA is found in the Uncompahgre Soil Survey (1995) (Appendix D). This information was gathered in the late 1970s and early 1980s by the Soil Conservation Service, now the Natural Resources Conservation Service (NRCS), as part of the National Cooperative Soil Survey for the Forest Service through interagency agreements. The level of detail of this inventory is an upper Level III-Level IV and was correlated to the family level. Soil map units are usually complexes of up to three soil families.

The soils in the IAA have formed from the sandstones and shales that are found on the Uncompahgre Plateau. This landform is a large upwarded Plateau that raises gradually to the west from the Uncompahgre River Valley. It consists of smooth, gently sloping mesa surfaces that are dissected by deep, steep walled canyons. The IAA is in the southwestern portion of the Plateau. It is bounded by the San Miguel River Canyon on the southwest and the Horsefly Canyon on the north and northwest. This portion of the Plateau consists of broad mesa and tableland upland surfaces, dissected by two deep drainage canyons: Clay Creek and McKenzie Creek, and three smaller drainage canyons: Goodenough Gulch, Craig Draw and Albin Draw.

The majority of the land surface is relatively flat, with slopes generally less than 15%. The soil characteristics vary, depending on the position on the landscape, and the geologic and vegetative cover type. Generally, these soils have dark colored loam surfaces that grade into finer textured subsoils that include clay loams and clay. The soil depth on the upland areas is mostly deep and moderately deep. On the steeper canyon side slopes, the soil characteristics vary substantially, with textures ranging from sandy loams, loams and clay loams with depths ranging from shallow to deep, to bare sandstone exposures and cliffs. These steeper areas usually contain larger amounts of coarse fragments that are on the surface of the soil and are contained in the soil matrix. In these areas, this can range from less than 5% to greater than 70% by volume and occurs mostly as gravel, cobble, and stone with some occasional very large sandstone rocks and boulders on steep slopes and escarpments. The soil survey identifies these characteristics in more detail for the dominant soils of these landscapes. See the table in the Soils Appendix D for more specific soil characteristics and interpretations. Generally, this data shows that the gentle sloping mesa surfaces have low potentials for erosion but may be susceptible to rutting, and detrimental compaction as a result of vehicles or heavy equipment operating on them when moist. There are shallow soils areas scattered throughout the area that would recover very slowly if burned. The steeper drainage and canyon sideslopes generally have large amounts of coarse fragments, and because of steep topography, exhibit a greater potential for erosion and can be unsafe and inefficient for heavy equipment operation.

Large portions of the IAA have been impacted in the past through wildfire, grazing, timber management activities and dryland farming while in private ownership. As a result of past land management practices the soil can not be considered undisturbed

or intact. Typical situations relating to past activities include loss of surface soil in some areas through sheet erosion or gully processes, poor infiltration levels due to compaction and loss of soil structure, lack of soil surface protection in some areas, poor diversity and vigor of understory species, and lack of soil organic material. Roads, drainage alterations, stock pond construction, and vegetation condition are the biggest contributors to the current soil problems.

Pine Regeneration Soils Issues:

Resource managers, foresters, silviculturists and soil scientists agree that regeneration is a major concern within the ponderosa pine vegetation type on the Uncompahgre Plateau in general and specifically within the IAA. The lack of regeneration is linked to a combination of factors, but soil type and productivity play a major role.

Many of the soils in the area are fine textured with high clay content. The clayey sites dry out, and the soil surface hardens very quickly creating a harsh site and a difficult environment for seedling survival. Clay also holds the existing moisture very tightly, making seedling establishment difficult. It is relatively dense and can make root penetration difficult. Clay soils are prone to frost heaving of seedlings. A high surface content of clay increases surface runoff and decreases infiltration.

C. Vegetation

This section briefly discusses and describes the primary vegetative cover types found in the IAA and the disturbance regimes that drive the primary upland plant communities. A more comprehensive discussion of vegetative communities and the anthropogenic and natural processes that shaped them on the Uncompahgre Plateau Landscape can be found in several other excellent sources: Manier et.al., *Canopy Dynamics and Human Caused Disturbances on a Semi-arid Landscape in the Rocky Mountains, U.S.A.*; The Nature Conservancy, Southern Rocky Mountains, *An Ecoregional Assessment and Blueprint*; Foster Wheeler, *Uncompahgre Plateau Landscape Assessment*; Romme, *South Central Highlands HRV*; Romme et. al., *Vegetation Dynamics, the Uncompahgre Plateau Landscape and Historic Range of Variability in Landscape Structure and Wildlife Habitat* (RMLANDS,FRAGSTATS,Habit@outputs) for the Uncompahgre Plateau Landscape; BLM and USFS, *Spring Creek Dry Creek Vegetation Management Strategy*; and USFS (in review), *The Comprehensive Assessment and the Comprehensive Evaluation Report GMUG LRMP Revision*.

The Common Vegetation Unit (CVU) layer from the GMUG National Forest GIS database was used to determine existing vegetation conditions within the IAA. The existing conditions are based upon the calculated structural stages of the dominant cover type. Calculation of structural stage is driven by the “size-class” and “tree-cover-percent” attributes within the database. This data is mapped and summarized for each of the major forest vegetation types present. Structural stages only apply to forested cover types and are not summarized for other non-forested cover types such as sagebrush and rangelands.

Vegetation structural stages are defined in Hoover and Willis (1987). Structural stages are analogous to successional stages of forest vegetation. For the purposes of vegetation assessment, forest structural stages are defined as follows:

Table 4: Vegetation Structural Stages

Structural Stage	Tree Size Class	Percent Tree Crown Cover
1 grass-forb	N/A	N/A
2 shrub-seedling	Small	N/A
3a sapling-pole	Small-Medium	<40%
3b sapling-pole	Small-Medium	40-70%
3c sapling-pole	Small-Medium	>70%
4a mature	Large-Very Large	<40%
4b mature	Large-Very Large	40-70%
4c mature	Large-Very Large	>70%
5 old growth	Large-Very Large	N/A

The age at which forest vegetation achieves these structural stages varies with the cover type. Each cover type also has unique structural features associated with these structural stages. The CVU data does not provide information on these structural vegetation features. Where available, site-specific stand exam and inventory data was used to determine the presence of these features and further evaluate vegetation quality.

Table 5: Cover Types of the Ironhorse Analysis Area

Cover Type	Total	Percent of Analysis Area
Forbs	373	0.60%
Grasses	2,660	4.20%
Gambel Oak	12,240	19.20%
Mountain Shrub	735	1.20%
Big Sage	5,386	8.50%
Willow	19	0.00%
Aspen	5,685	8.90%
Cottonwood	228	0.40%
Douglas-fir	2	0.00%
Pinyon/Juniper	5,837	9.20%
Ponderosa Pine	27,245	42.80%
Spruce/Fir	3,200	5.00%
Water	22	0.00%
ALL	63,630	100 %

Plant Communities of Interest

This section focuses on recommendations for three primary upland plant communities in the IAA: sagebrush, pinyon-juniper woodland, and ponderosa pine. This community level focus is due to their areal extent and the potential risk of loss of significant spatio-temporal ecosystem function in the event of a large disturbance (e.g. a high mortality wildfire or insect and disease epidemic). It is also because of the important wildlife habitat they provide for species of management interest and their economic and aesthetic importance. This is not to diminish the importance of other vegetative community types on the landscape such as the mountain shrub, aspen, mixed conifer communities and the riparian systems. A genuine case can be made for the need to examine and, if necessary, to correct imbalances in the composition, structure and function of these other communities on the landscape as well. However, the need to intervene in these three communities is particularly acute where the current successional trajectories are at high risk of potential adverse ecological

consequence. This suite of three key plant communities, with the potential for loss of function or adverse disturbance outside their range of variation, creates a sense of urgency to move forward in a more focused, systematic, and prioritized fashion.

Rationale

At present there is very little known about actual applied restoration strategies and treatments at the landscape scale in southwestern Colorado and the eastern Colorado Plateau. There are also questions about long-term sustainability of systematic approaches to developing treatments that mimic spatial heterogeneity in southwestern Colorado plant communities at the landscape scale. Further, the duration of treatment effectiveness remains to be determined at the treatment unit and landscape scales. Relatively short-lived plant communities, such as mixed mountain shrub, oak and seral aspen types, are problematic in terms of duration of effectiveness. This is also true of firebreaks specifically constructed and maintained to protect WUI. At present, models and decision support tools are not adequately refined at the operational level to determine exact successional pathways for highly complex landscapes. Empirical data to determine precise successional pathways to support restoration is still lacking although experience and recent research indicates that certain forest, woodland and shrubland plant communities are outside of their historic range of variability in terms of stand structure, fire frequency, and fire behavior.

There is a reasonable expectation that we can manage for multiple use within the historic range of variability by maintaining the composition, structure, and function of the plant communities in the area. To reduce the risk to the WUI, modification of fuels has proven effective in changing fire behavior. Seeding native plants in disturbed areas or as a part of a suite of restoration practices is predicted to maintain ecological processes. Carefully tailored habitat improvement projects can provide specific benefits to the targeted species while enhancing a broader range of species with similar or nonconflicting habitat requirements. The current science indicates opportunities for reversing trends in increased forest and woodland cover, particularly where opportunities exist in the pinyon-juniper savannah and woodland and other fire adapted ecosystems including ponderosa pine and mountain shrub communities. Facilitating practices in the form of noxious weeds treatment, native plant seeding, grazing management, and prescribed burning of seedling tree regeneration show significant promise to extend the effectiveness of treatments.

General Suitability of Forest, Woodland and Shrubland Types for Fuel Reduction and Restoration Treatments

There are several suitable forest and woodland community types where fuel reduction and restoration are generally compatible. These community types are suitable for both fire hazard mitigation through mechanical thinning and

prescribed fire and forest restoration. In these areas, fuels treatments can be practically linked to broader restoration goals. The discussion focuses on ponderosa pine (see below); however, the principals of restoration and hazardous fuels treatments have similar approaches in these communities.

- 1) Ponderosa pine
- 2) Douglas-fir
- 3) Warm-dry mixed conifer
- 4) Open pinyon-juniper woodland

There are also several woodland and shrubland plant communities that are suitable for both fire hazard mitigation through mechanical thinning and prescribed fire and/or restoration, including stand replacement treatments.

- 1) Pinyon-juniper woodland
- 2) Gambel oakbrush
- 3) Mixed mountain shrubland

There are several forest community types suitable for vegetation management to alter species composition for persistence of that community on the landscape. This is due to their less flammable nature that functions to retard fire and naturally extends the fire rotation period (e.g. aspen) or in the case of spruce–fir, have inherently long fire rotation periods when maintained in healthy stand conditions.

- 1) Aspen (Prevent succession to Spruce-Fir)
- 2) Spruce-Fir (Control fir, a fire sensitive species). Alter stand structure to avoid fir decline and spruce die-off.

Sagebrush

The sagebrush cover type occupies a wide ecological range, with low elevation and high elevation differences. Big sagebrush occupies deep soils in valleys where runoff collects. Low elevation sagebrush occurs below 7,500 feet and occurs primarily on BLM and private lands. High elevation sagebrush cover types occur above 7,500 feet on NFS lands and higher private lands. The sagebrush/Gambel oak mix type is a shrubland codominated by mountain big sagebrush and Gambel oak, with patchy distribution of additional mountain shrub species and a grass/forb understory. The sagebrush/grass mix type has sagebrush shrublands of big sagebrush with perennial grasslands.

A variety of sagebrush species occur within the IAA. The dominant species include: black sage (*Artemisia nova*); Mountain big sage (*Artemisia tridentata ssp. vaseyana*); and Wyoming big sage (*Artemisia tridentata spp. wyomingensis*). These species coexist in dominate stands of sagebrush within

the IAA on the specific soil types and elevations they are adapted to. The Forest's Integrated Resource Inventory (IRI) database aggregates all of these species into one cover type - sagebrush.

The total acreage of sagebrush within the IAA is 5,386 acres. Most of the larger sagebrush parks were utilized for crop production or livestock pasture when the area was originally settled. Several parks were plowed and farmed for dryland crop production. Others were fenced and used as yearlong pastures for livestock. After the Forest Service acquired these private lands, many of these parks were plowed and seeded with pasture grasses for livestock forage. Others were sprayed with herbicides to remove or control sagebrush regrowth. Over time, these areas have recovered to native sagebrush parks.

Some inventory has occurred within the sagebrush communities. Most of this inventory is fairly old range analysis. Some areas have been looked at for conifer tree encroachment. More recently, Dr. Alan Stevens of Snow College conducted an inventory and assessment of the sagebrush communities on the Uncompahgre Plateau in 2005, and this information has been placed in the Forest database for future analysis and interpretation. Additional site-specific inventories are needed to determine the current condition of sagebrush parks within the IAA. Inventory should be directed at determining the species composition, cover, and shrub density of these communities. Following this inventory, specific plans can be developed to manage these areas for livestock and wildlife.

Historic Conditions

In larger stature sagebrush species, stand-replacing fires occurred every 40 to 60+ years with smaller fires every 20-25+ years. Historic fires created a mosaic of successional stages across the sagebrush landscape and was often driven by fires in the adjacent vegetation types. When high intensity fire occurred, sagebrush was generally killed –setting succession back to grasses and forbs. Moderate and low intensity fires would reduce the sagebrush component, usually setting the seral stage back. High elevation sagebrush communities have a slightly different disturbance regime. Fire was less common at higher elevation, but when fires occurred, they were high severity and returned stands to early seral stages; sagebrush recovery from seed could be slow depending on the size and severity of the disturbance.

Current Conditions

There are two species of sagebrush that are prevalent in the Ironhorse area and one species that is present on lower elevations surrounding the area. The most dominant species in this area is mountain big sagebrush (*Artemisia tridentata vaseyana*). Silver sagebrush (*Artemisia cana*) is also present usually at higher elevations and in areas where the soil is moist. Field observations in 2005 by Dr. Allan Stevens (pers. com.) suggest these species occur in communities that are

Findings For Sagebrush Communities:

- More vegetation inventory is needed to distinguish the various sagebrush species and their associated community types before management actions are implemented in this cover type.
- Additional species inventories are needed to determine the presence of sagebrush obligate wildlife species within the IAA.
- Grass and/or wet meadows interspersed with sagebrush should be inventoried to determine species composition, cover, and grazing use.

diverse, and there is sufficient numbers of seedlings of both species in all areas observed to maintain the current communities. In this area, there were no observations of sagebrush communities that were closed, old or decadent as other reports suggest. All communities observed were fairly heterogeneous in age structure.

At lower elevations, including BLM lands, Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) is present, and the community health of the populations observed were similar to those stated above. Dr. Stevens did not recommend remedial treatments in the sagebrush communities and recommends that the current stand conditions of these areas be maintained. Dr. Stevens cautioned that fire, whether prescribed or wildfire, would impact the sagebrush communities negatively. When posed with the question about the use of fire in ponderosa pine communities to regenerate a new cohort, Dr. Stevens expressed concern regarding fire moving into areas of adjacent sagebrush habitat. He suggests that if fire is used as a management tool in these areas, then intensive reseeding of the appropriate sagebrush species should follow the treatment. Dr. Stevens notes there is cheatgrass present in this area and that it would be critical that a reseeding effort occur after any treatment to prevent the spread of cheatgrass.

The conventional wisdom that livestock grazing and/or that fire suppression has altered the fire regime, resulting in increased shrub density and reduction in understory vegetation, may not be entirely applicable in the IAA. The complexity of the IAA disturbance history has somewhat confused the successional trajectories in the area. In addition, there is scientific disagreement as to the fire return interval in sagebrush. Estimates of the fire return interval are leaning toward the longer end (50-60 years) of the interval range discussed above. It appears that a fire return interval of 50 years or more may be more compatible with maintaining big sagebrush communities. Given the emphasis on sagebrush obligates such as Gunnison sage grouse and Brewer's sparrow, the advisability of any burning in the sagebrush community is questionable at this time. At present, management efforts may be more appropriately applied as facilitating and enhancement practices in the understory herbaceous community.

Recommended Actions for Sagebrush

Findings for Sagebrush Communities Cont'd:

- Adjust the season of use, intensity and duration of livestock grazing to improve herbaceous understory composition and production.
- Interseed with native species if the understory does not respond to adjustments in livestock grazing.
- Remove trees that encroach into sagebrush stands.
- Avoid mechanical disturbance to the sagebrush cover at this time.
- Prevent or reduce activities that promote the establishment of cheatgrass.

Despite uncertainties, several recommendations for sagebrush management strategies are emerging. Following wildfire or other disturbances with significant loss of sagebrush cover, reseeding sagebrush sites with the appropriate sagebrush species is recommended. Avoid prescribed burning in sagebrush with the objective of providing herbaceous forage for big game or livestock. Adjust grazing management to improve the composition and production of the herbaceous plant community. Based on changes to the grazing system, evaluate the response of the understory community to reduced grazing pressure. Inter-seeding of grasses and forbs may be necessary if sufficient understory recovery is not realized from adjustments to grazing pressure. In areas where pinyon-juniper or pine is encroaching into adjacent sagebrush stands, remove the encroaching trees, preferably by hand crews with chainsaws. Avoid treatments with heavy equipment that reduce sagebrush cover or create soil disturbance and the opportunity for cheatgrass establishment.

Pinyon–Juniper Woodlands

The pinyon-juniper cover type includes the following classifications: pinyon-juniper, pinyon-juniper/Gambel oak mix, pinyon-juniper/sagebrush mix, pinyon-juniper/mountain shrub mix, and sparse pinyon-juniper/shrub/rock mix. In the pinyon-juniper type, pinyon pine and Utah or Rocky Mountain juniper are the common conifer species, with varying densities of deciduous shrub components dominated by Gambel oak, mountain mahogany, serviceberry, and sagebrush. The sparse pinyon-juniper/shrub/rock mix is a low density (10 to 25 percent tree cover) woodland with a mixed understory of shrubs, grasses, and rocks. Utah juniper tends to be more dominant in drier lower elevations and pinyon pine more dominant in higher moister elevations. The proportion of pinyon pine increases with elevation. Rocky Mountain juniper transitions to the sub-dominant at mid- to higher elevations. The pinyon-juniper cover type transitions into mountain shrub and ponderosa pine. Other adjoining vegetation types include grass/forb, sagebrush, and Gambel oak. On the Uncompahgre Plateau, the elevation range for pinyon-juniper woodlands is primarily between 5,500 and 8,000

feet. Pinyon-juniper woodlands occur on all slopes and aspects.

The timeframes within which pinyon-juniper woodland potentially achieve the stand conditions characterizing each structural stage varies with site productivity. The following relationships were developed by Haines (2001) to represent average conditions on the GMUG:

Table 6: Timeframes for Stand Conditions for Pinyon-Juniper

Age	0	20	40	60	80	100	120	140	160	180	200	220	240	280	300
SS	1	2	3					4						5	

The age bar shows pinyon-juniper out to 300 years of age. It is common for individual trees to be 400 to 500 years old in this area. The reestablishment period after disturbance is reported to be 10 to 15 years. Many of the past chainings have become well reestablished in 30-40 years.

The pinyon-juniper woodland cover type is located along the San Miguel River, breaks on the west side of the IAA and transitions into the ponderosa pine forest cover type. Extensive stands of pinyon-juniper were chained and seeded with crested wheatgrass in the 1960s and 1970s to improve forage production for livestock. Many of these stands have regenerated to dense stands of pinyon-juniper trees. The shrub component has also matured to the point where shrub form is large and woody, with minimal annual leader growth.

The Horsefly fire in 1990 burned through some of the previously chained pinyon-juniper in the Dead Horse area. Two rollerchopping projects have also been recently implemented in the pinyon-juniper type to enhance vegetation diversity and big game winter range conditions. Shrub regeneration is very good, producing younger age-class shrubs with high vigor and extensive annual leader growth.

The following table summarizes existing conditions of pinyon-juniper woodland cover type within the IAA:

Table 7: Structural Conditions for Pinyon-Juniper within the IAA

Structural Stage	Number of Sites Within Analysis Area	Acres of Structural Stage Present	Percent of Total Acres of Cover Type
1	4	300	3.9
2	0	0	0
3a	22	1,408	18.6
3b	83	4,714	62.3
3c	0	0	0
4a	2	14	0.2
4b	23	783	10.3
4c	2	356	4.7
5	0	0	0
Total Acres of Pinyon and Juniper Woodland			
7,575			

As shown in the table above, the pinyon-juniper woodland type is dominated by low to moderate density stands of young trees (3a and 3b), with the remainder represented by mature stands and recently treated stands. Stands of pinyon-juniper woodland in the Dead Horse area that were burned in the 1990 Horsefly fire were typed as shrubland or grass/forb meadows, so structural stage 1 is underrepresented in this table. IRI photo interpretation does not classify old growth stands (structural stage 5). Some of the stands typed as 4b and 4c are actually in an old growth condition. Those sites are located on the face of the San Miguel River Canyon and in the deeper draws that could not be chained.

Shrub and herbaceous understory cover and production within the structural stage 3 and 4 stands are highly suppressed by the overstory trees. Tree mortality within the pinyon pine is increasing from drought stress and insect activity.

Figure 3 shows the current structural stage distribution in pinyon-juniper on NFS lands across the IAA.

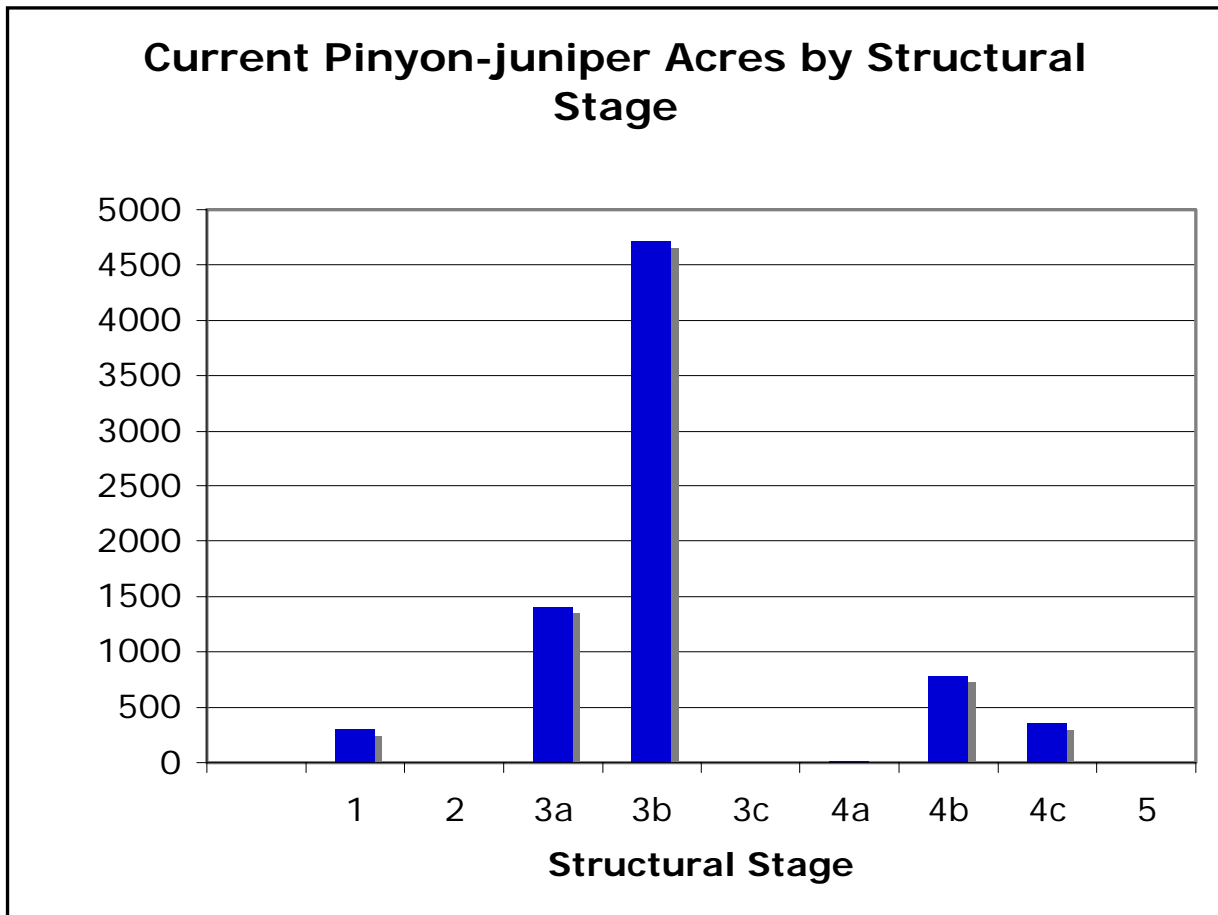


Figure 3: Current Pinyon-juniper Acres by Structural Stage for the IAA.

An analysis of pinyon-juniper woodland habitat conditions and trends was completed by Art Haines (2001) for the GMUG National Forests and by Foster-Wheeler for the Uncompahgre Plateau (2002). Those analyses indicate that the pinyon-juniper type is dominated by sapling-pole (stage 3) and mature (stage 4) conditions, with very little or no grass-forb and seedling stages. Each assessment suggests that old growth conditions are a minor portion of the total acres of this cover type.

Open road densities are high within the pinyon-juniper woodland type of the IAA. Numerous unclassified roads have developed as a result of past fire suppression activities, seismic exploration, and the development and maintenance of range improvement facilities such as fences, pipelines, and stockpounds. The density of open roads and motorized trails has a direct effect on habitat effectiveness for elk. The GMUG National Forest completed a Travel Management Plan for the Uncompahgre National Forest in 2002. The Travel Plan limits motorized and mechanized summer travel to designated routes and prescribes a reduction of open road densities through various methods of closure. Very few of the prescribed road closures have been implemented to date. The Travel Plan also includes several area closures to limit motorized winter travel in big game winter range. The Craig Point

and Dead Horse areas are included in this winter closure area, but the closure has not been implemented by the Forest Service.

Historic Conditions

The historic fire regimes in pinyon-juniper woodlands are thought to have been variable over the Plateau, depending on site condition and the presence of understory vegetation. In the following discussion, it is important to note that historic fire regimes in pinyon-juniper woodlands on the Uncompahgre Plateau remain uncertain until more research is completed (Romme, Baker, Eisenhardt personal communication).

In rocky areas or topographical protected areas with sparse pinyon-juniper communities, limited continuity of fuels would have resulted in minimal fire occurrences. On dry pinyon-juniper woodlands, soil and moisture limitations regulated vegetation composition and structure. Fire intervals may have ranged from 10 to 600 years depending on pinyon-juniper woodland type. Most fire starts would have been dependent upon understory grass continuity to carry fires. Frequent low intensity fires would have killed small juniper trees but not thicker barked larger trees that had crowns out of the reach of the fire, resulting in fire-maintained open canopy savannahs. Fires killed overstory trees and shrubs, stimulating growth of the herbaceous understory and sprouting shrubs. In other areas, dense stands of pinyon pine and juniper with very old trees would have persisted on the landscape.

Two major insect and disease agents operate in the pinyon-juniper woodlands cover type, although junipers are not affected. Black stain root rot would have created patchy mosaics of various successional stages of pinyon-juniper and juniper woodlands. The pinyon ips beetle (*Ips confusus*) is a bark beetle that kills predominantly large or medium sized trees. At endemic levels, infestations begin with a single tree or small patch of trees and spread outward creating semi-circular patches of dead trees. Large areas of formerly pinyon-juniper woodlands could be changed to juniper woodlands.

Findings For Pinyon-Juniper Communities:

- A majority of the pinyon - juniper woodland type within the IAA currently occurs as moderately dense sapling-pole stands that have regenerated after being chained in the 1960s and 1970s. Tree cover is maturing and increasing on these sites while shrub cover is maturing and decreasing in productivity.
- The quantity, patch size, and arrangement of mature/old-growth structural stage pinyon-juniper woodland within the IAA currently meet forest plan standards.
- Younger age class pinyon-juniper sites have significantly higher forage and browse production than the old chainings and mature/old-growth stands.

Current Conditions

On NFS lands, the majority of the pinyon-juniper is in sapling-pole and mature stages. There are no acres of grass-forb or shrub-seedling pinyon-juniper cover type on the NFS. A BLM vegetation survey found average ground cover in pinyon-juniper woodlands included only 5 percent plant basal area. The majority of the ground cover in the pinyon-juniper woodlands consisted of 34 percent plant litter, 31 percent bare ground, 26 percent rock, and 7 percent cryptogams (microbiotic crusts) (USDI BLM, unpublished data).

Pinyon-juniper woodlands are used as winter range by elk and mule deer. Past chaining treatments removed the larger trees, leaving the smaller trees on site through incomplete treatment or regeneration from seed. These trees have been released from competition and will reestablish a dense pinyon-juniper stand within 30 to 40 years. Today, many of these sites are again dominated by pinyon-juniper overstories.

On the Colorado Plateau, the pinyon-juniper woodlands have increased in tree density and areal extent, expanding into areas formerly dominated by shrublands and grasslands. Management emphasis on fire suppression has also influenced the expansion of pinyon-juniper into sagebrush and grasslands, allowing growth of conifer seedlings that would normally be killed in low intensity fires.

Most of the pinyon-juniper has dense stand conditions. As a result, understory vegetation has been suppressed, affecting the susceptibility of a site to crown fire. Approximately 18,600 acres of pinyon-juniper burned in 2002 within the Naturita Creek and Tabeguache Creek watersheds just north of the IAA. The proximity of Wildland-Urban Interface (WUI) areas intensifies the risks associated with intense wildfires in the pinyon-juniper cover type.

Pinyon black stain root disease is found in pinyon-juniper stands in the southern and southeastern portions of the Geographic Area. The pinyon-juniper woodlands are experiencing some reduced vigor due to a combination of black stain, Ips beetle and drought (pinyon decline). Mistletoes are found in juniper trees in the pinyon-juniper

Findings For Pinyon-Juniper Communities Cont'd:

- The south end of the Uncompahgre Plateau provides a large area of big game winter range on public lands. The pinyon-juniper woodland cover type comprises a significant portion of the big game winter range available within the IAA.
- Existing open road densities within the IAA exceed those prescribed in the Travel Management Plan for the Uncompahgre National Forest. Full implementation of the Travel Plan would improve elk habitat effectiveness and help to meet GMUG Forest Plan general direction. As previously noted, very few of the actions specified in the Travel Plan have been implemented since 2002.

woodlands (Godfrey, personal communication); however, mistletoe appears to be present at endemic levels and is not likely to be a significant factor in pinyon-juniper.

Recommended Actions for Pinyon-Juniper

Dr. Romme generally recognizes three broad categories of pinyon-juniper woodland. These categories differ from the sites where the areal extent of pinyon-juniper has increased, expanding into areas formerly dominated by shrubland (i.e., sagebrush) and grasslands as a result of fire suppression. The first type is the pinyon-juniper grass savanna expressed on fine textured soils on gentle topography. The second type is the pinyon-juniper shrub woodland on deep soils that support a shrub layer of oak or sagebrush. Dr. Romme identifies both of these types as suitable for fire hazard mitigation through mechanical thinning and prescribed fire (some stand replacing). In these areas, fuels treatments can be practically linked to broader restoration goals. The third broad type is the persistent pinyon-juniper forest. These areas of pinyon-juniper forest are left intact from disturbance for long periods of time on the landscape (Romme, Baker, Eisenhart). In addition, there are areas of pinyon-juniper forest where topographic isolation and lack of fuel continuity prevent extensive stand replacing fires from occurring over long periods of time. There are areas where shallow, coarse textured soils prevent grasses from developing the fine fuel to carry frequent fires. Recovery of the pinyon-juniper forest would be predictably slow following a fire. The distinct soil and rugged topographic sites that are associated with the pinyon-juniper forest type described above should be avoided in restoration and fuels treatments.

Ponderosa Pine

The ponderosa pine cover type includes classifications of: ponderosa pine, ponderosa pine/Gambel oak, and ponderosa pine/aspens/oak mix, ponderosa pine/Douglas-fir mix, and ponderosa pine/blue spruce mix. The ponderosa pine type is a lower montane conifer forest dominated by ponderosa pine with common associate conifer species including pinyon pine and Utah or Rocky Mountain juniper at the lower elevations and aspen, Douglas-fir, blue spruce and Engelmann spruce at the higher elevations. Ponderosa

pine/Gambel oak type is codominated by conifer forest and tall shrubland, with Gambel oak as the dominant understory species. The ponderosa pine/aspens/oak mix is codominated by mixed coniferous-deciduous forest and tall shrubland. The ponderosa pine forest type occurs predominantly between 7,000 and 9,000 feet in the Geographic Area. Ponderosa pine occurs on all slopes and aspects.

The timeframes within which ponderosa pine potentially achieves the stand conditions characterizing each structural stage varies with site productivity. The following relationships were developed by Art Haines (2001) to represent average conditions of unregulated stands on the GMUG:

Table 8: Timeframes for Stand Conditions for Ponderosa Pine

Age	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
SS	1	2		3			4					5				

The following table summarizes existing conditions of the ponderosa pine cover type within the IAA.

Table 9: Structural Conditions for Ponderosa Pine within the IAA

Structural Stage	Number of Sites Within Analysis Area	Acres of Structural Stage Present	Percent of Total Acres of Cover Type
1	0	0	0
2	0	0	0
3a	17	1,219	4.7
3b	19	1,596	6.1
3c	1	29	0.1
4a	99	11,665	44.9
4b	89	11,406	43.9
4c	1	90	0.3
5	0	0	0
Total Acres of Ponderosa Pine		26,005	

As demonstrated in the table above, ponderosa pine forest habitat is dominated by mature stands with low to moderate crown closure. There is only one site in the IAA that is typed as a mature stand with dense canopy closure. The remainder of the pine type is within the sapling-pole stages. These sapling-pole sites represent the various tree plantations within the IAA.

The mature forest type occurs predominantly as large even-aged stands of pure ponderosa pine growing in association with a moderate to high density understory of Gambel oak. Patchiness and horizontal diversity between stands and across the landscape is relatively low.

Figure 4 shows the current structural stage distribution in ponderosa pine on NFS lands across the IAA.

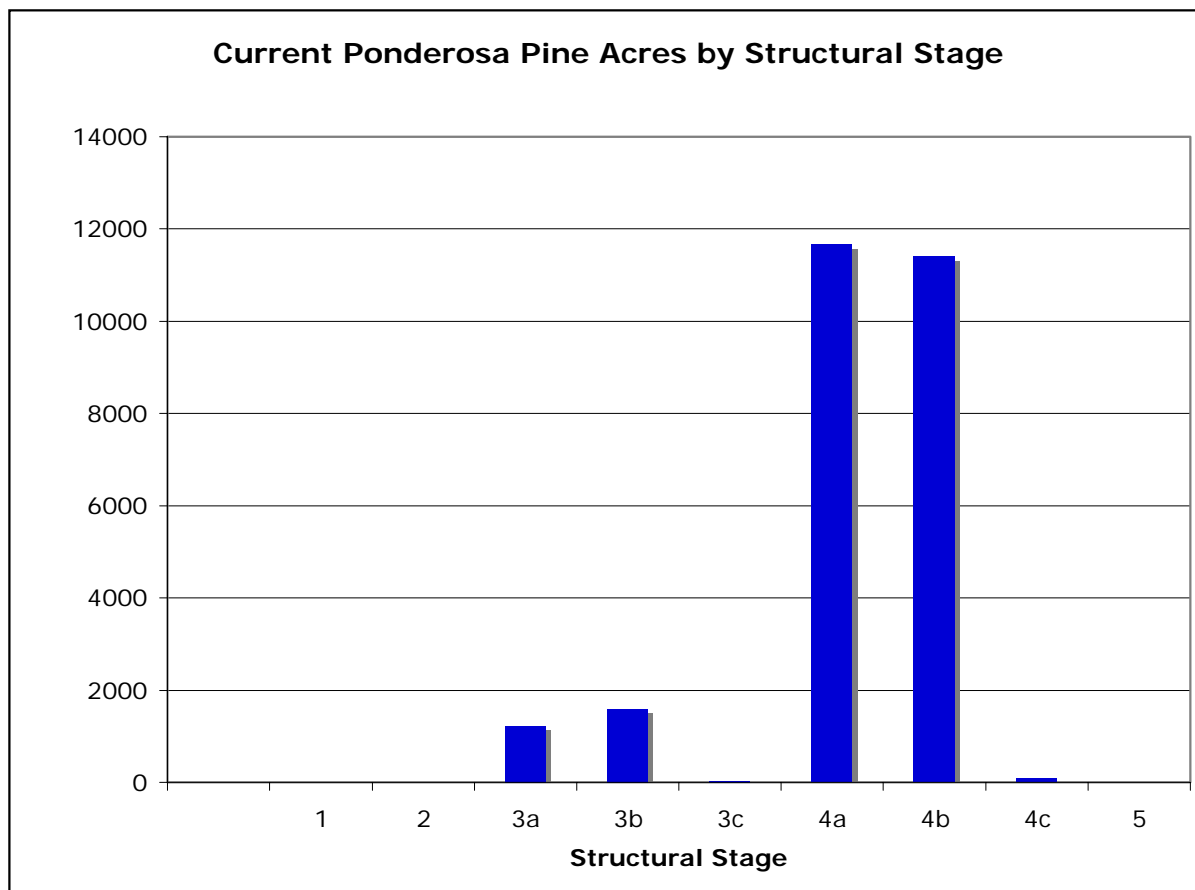


Figure 4: Current Ponderosa Pine Acres by Structural Stage for the IAA.

The IAA does not contain any grass-forb or shrub-seedling stages. There is also an absence of any old growth ponderosa pine forest within the IAA. Although the CVU database does not classify structural stage 5 within any cover type, other stand exam and habitat inventory data conducted within the IAA confirm the absence of any old growth habitat.

The habitat condition and trend described above reflect the overall condition and trend of ponderosa pine forest on the GMUG National Forests. This is not unusual considering most of the ponderosa pine cover type on the Forest is located on the south end of the Uncompahgre Plateau (Haines 2001, Foster-Wheeler 2002).

The IAA has a very high density of open roads, especially within the ponderosa pine forest type. The density of open roads and motorized trails have a direct effect on habitat effectiveness for elk. The GMUG National Forest completed a Travel Management Plan for the Uncompahgre National Forest in 2002. The Travel Plan limits motorized and mechanized summer travel to designated routes and prescribes

a reduction of open road densities through various methods of closure. Very few of the prescribed road closures have been implemented to date. The Travel Plan also includes several area closures to limit motorized winter travel in big game winter range. The Craig Point area is included in this winter closure area, but the Forest Service has not implemented the closure at this date.

Historic Conditions

Management activities and natural events have occurred within most of the ponderosa pine type to further influence existing structural stage conditions. Most of the ponderosa pine type within the IAA was harvested for timber during the time the area was settled and divided up into numerous homesteads. Insect and disease activities from bark beetles and dwarf mistletoe caused tree mortality throughout the IAA. After the Forest Service acquired these homesteads, commercial and pre-commercial thinning and salvage harvest continued to have cumulative effects on stand density and the percent tree crown cover (Haines 2001, Foster-Wheeler, 2002). At this same time, there was also a significant reforestation effort by the Forest Service. Another major event was the Horsefly fire of 1990, which burned approximately 5,000 acres near Sanborn Park.

The historic fire pattern in the ponderosa pine cover type tended to be frequent fires with low to moderate intensity surface fires depending on vegetation conditions. Infrequent high intensity fires at any structural stage would return a stand to early seral grass/forb conditions. Frequent low intensity fires in this fire regime maintained a diverse mix of open stands with grass and forb understories, which could carry low intensity surface fires. The forest structure consisted of widely spaced trees with clumpy dispersion and multiple age classes. Dominant trees were big and old, having survived many surface fires. Studies of fire frequency in ponderosa stands in the southwest indicate fires burned in ponderosa pine stands as frequently as every 2 to 10 years (Dietrich 1980). Fire intervals in the San Juan National Forest ponderosa pine stands were 5 to 33 years on lower elevation sites and 6 to 47 years on higher elevation sites (Romme et al. 1997). Dr. Sheppard (RMRS) has studied fire history on the Uncompahgre Plateau Geographic Area. Dr. Romme notes that Sheppard's findings are generally consistent with those in the adjacent San Juan mountains. Sheppard (personal communication) estimates somewhat longer fire intervals of 30 to 50 years in the low elevation ponderosa stands. These fires were characterized by considerable variability between individual fires. Experts agree that high mortality fires occurred in these types but seldom exceeded 5% of the landscape (Romme).

Prior to 1990, all snags were removed from timber sale areas as part of the timber sale contract for fire hazard reduction. Past fire management practices also involved removing large diameter snags outside timber sale areas. This practice of snag removal through timber sale contracts and fire management has been compounded by public and commercial firewood cutting and resulted in a significant reduction in the number of large-diameter snags per acre in the ponderosa pine type.

Ponderosa Pine and Pine –Oak Community Disturbance on the Uncompahgre Plateau

Dr. Romme suggests the stands on the west side of the Uncompahgre Plateau resemble the ponderosa pine/Gambel oak forests that are so extensive in the San Juan Mountains, especially in the "Glade" country north and west of Dolores and north of Mancos, Colorado. The west-side stands were probably characterized by a "typical" ponderosa pine fire regime prior to 1880, i.e., frequent (10-30 year intervals) low-severity fires that maintained a dominant pine canopy (though it was a fairly open canopy) and an understory of low Gambel oak and herbs. In contrast, ponderosa pine seems much less prominent on most of the east side of the Uncompahgre Plateau, especially as one moves northward. The east side, in fact, appears to be an oak vegetation type with scattered large pines, rather than a true pine forest. The vegetation structure on the east side is reminiscent of the vegetation at the north end of Mesa Verde, where scattered large pines remain amidst predominantly mountain shrubland vegetation. The shrublands in Mesa Verde have been maintained in part by fires recurring at an average interval of about 100 years; in the absence of fire, these sites could eventually develop pinyon-juniper forest. When fires do occur in Mesa Verde, they tend to be high-severity -- sufficient to kill almost any small ponderosa pine and even some of the large old pines. However, a few ponderosa pines do manage to grow to large size and develop some degree of fire resistance simply because the fires are patchy and some locations are missed by a sequence of fires that burn the surrounding areas. The fire regime is not surface but rather a crown fire regime in which a few trees survive because of patchy fire spread.

Dr. Romme adds that the situation at the north end of Mesa Verde characterizes the oak - pine vegetation on the east side of the Uncompahgre Plateau. Although pre-1880 fire intervals on the Uncompahgre Plateau were probably shorter than in Mesa Verde because Mesa Verde has so many topographic barriers to fire spread that its intervals would tend to be on the long side, the eastern Uncompahgre Plateau (at least at the southern end) doesn't have such pronounced topographic barriers. He is uncertain, however, what the actual fire intervals were in this area without further research.

Dr. Romme advances two hypothesis: (i) Climate hypothesis: the east side of the Uncompahgre Plateau is in a partial rain shadow, especially for winter storms that generally come from the west. Ponderosa pine may simply grow better where it receives more reliable winter moisture (i.e., west side), such that the east side is somewhat marginal pine habitat, and hence ponderosa pine is less prominent on the east side; and (ii) Disturbance hypothesis: fire starts appear to be more frequent on the west side, and total area burned per decade appears to be greater on the west side. Ponderosa pine thrives under a disturbance regime of frequent fires, but doesn't do so well with longer fire intervals because the longer fire intervals usually result in more severe fires when they occur. Oak, on the other hand, can thrive under both long and short fire intervals. It is suppressed by the pine on the west side

but has little competition on the east side. The general consensus of the local fire managers and ecologists is that the Uncompahgre Plateau west side ponderosa pine communities are a result of a combination of both these factors.

The historic fire regime of frequent low intensity fire ended abruptly around 1880 in most of the ponderosa pine forests throughout the southwest (Swetnam and Baisan, 1996). Early accounts of fires in ponderosa pine forests indicated that crown fires were rare. However, recent fires in ponderosa pine forest elsewhere and on this landscape have been destructive crown fires. Fires of the intensity and extent of some recent burns probably are unprecedented compared to historic conditions (Romme et al. 1997). Most recently, the Bucktail, 47, and Burn Canyon fires of 2002 burned over 35,700 acres. The Burn Canyon Fire was a hot intense fire in primarily ponderosa pine and pinyon-juniper. The Bucktail and 47 fires also burned in ponderosa pine and pinyon-juniper with similar fire intensities. The Bucktail fire burned into an area that had been burned with a prescribed fire within the last five years, reducing the fire behavior significantly. The prescribed burning occurred in conjunction with salvage of pine beetle-killed trees and commercial thinning to reduce the vulnerability of ponderosa pine stands to beetle outbreak. Prescribed burning has reintroduced fire to areas of ponderosa pine forest type reducing dead and live understory fuels. However, the combined areas of prescribed burn (completed and planned) represent only 2.5 percent of the ponderosa pine on the Plateau. Although the treated stands are now at lower risk of catastrophic fire, the vast majority of the ponderosa pine still remains vulnerable.

Timber Harvest

Many of the ponderosa pine forest types on the Uncompahgre Plateau are on flat ground and are easily accessible. Timber harvest was common, and there are few large green trees and snags (standing dead trees) remaining. Shelterwood is the most common silvicultural treatment for ponderosa pine followed by selection and seed tree harvests. A significant number of acres have been commercially thinned to reduce the risk of bark beetle outbreaks by reducing stand density (USDA Forest Service 2001b). Sanitation harvesting to reduce insect activity and/or risk for insect attack in ponderosa pine forests began in the 1970s and continues today. Pre-commercial thinning or timber stand improvement activities have occurred to provide improved growing conditions for the residual trees. A ponderosa pine forestation project planted plantations in the 1960s and 1970s. These plantations were established in nonforested areas (Gambel oak and sagebrush cover types) adjacent to ponderosa pine stands.

Insects and Disease

In addition to fire, mountain pine beetle (*Dendroctonus ponderosae*) has had the greatest insect-induced impact on ponderosa pine stands. At endemic levels, beetles kill occasional trees or small patches, preferring trees greater than 8 inches in diameter in more dense stands. Root disease and dwarf mistletoe increase

susceptibility of individual trees to beetles (Romme et al. 1997). Larger outbreaks occur when many simultaneous smaller outbreaks grow together. Other disturbance factors in ponderosa pine include armillaria root disease, ponderosa pine dwarf mistletoe (*Arceuthobium vaginatum* ssp. *cryptopodum*) and windthrow.

The increased density and homogeneity of the ponderosa pine forests have increased their vulnerability to beetle attack. At endemic levels, bark beetles typically kill individual or small groups of pine trees. However, when stand conditions are favorable for increases in the beetle population, epidemic levels may result, and tree mortality can be extensive. Optimum stand conditions for beetle outbreaks include continuous areas of pine stands, dense stands, and trees with an average diameter of over 8 inches within a similar age group. These conditions increase the competition for light, nutrients, and moisture, stressing the trees. The stress increases the trees' susceptibility to successful insect attacks. Populations of insects are also influenced by the availability of host trees.

In the 1980s, a significant bark beetle outbreak occurred in the southern Plateau area. Three bark beetle species were attacking trees in the Norwood outbreak—mountain pine beetle (*Dendroctonus ponderosae*), roundheaded pine beetle (*Dendroctonus adjunctus*), and western pine beetle (*Dendroctonus brevicomis*). Over 67,000 acres were affected and over 214,000 trees killed. Some areas had extensive mortality. The most severely impacted region was located in the Ute area and encompassed 1,660 acres. In this area, nearly 1,000 acres of formerly dense ponderosa pine stands now have only scattered trees remaining (USDA Forest Service 1992). These areas were subsequently planted with ponderosa pine in part to reduce the risk that these sites would convert to Gambel oak. This outbreak of bark beetles on the Uncompahgre Plateau was followed by salvage logging and prescribed burning. The prescribed burning reduced fuels buildup and reintroduced fire to the forest ecosystem.

In 1992, a risk assessment study was completed to determine the susceptibility of stands on the Uncompahgre Plateau to bark beetle attack (USDA Forest Service 1992). This study modeled growth to predict future forest stand conditions and associated risk factors to forest insects and diseases. The study encompassed 100,800 acres of the ponderosa pine stands on the Plateau, including 77 percent of the ponderosa pine stands on the Plateau. Stand structure, size/diameter, and density were the criteria used to determine the potential risk for beetle outbreak. For example, single-storied stands with trees averaging greater than 10 inches in diameter (diameter breast height) and stand density greater than 150 square feet basal area were considered at the highest risk for beetle outbreak.

Table 10 summarizes the result of this study. For the year 2000, 15,800 acres (16 percent of the 100,800 acres analyzed) were projected to be at high risk for pine bark beetle outbreak. The forested area projected at moderate risk of bark beetle outbreak was 45,600 acres (or 45 percent of the total area analyzed). By 2010, the projections increased to 24,700 acres (or 25 percent of total area) at high risk and

52,800 acres (or 52 percent of total area) at moderate risk. However, since these projections were made, over 6,300 acres of these ponderosa pine stands have been commercially thinned (USDA Forest Service, RMACT database). Commercially thinning the ponderosa pine stands was designed to reduce stand densities and improve tree age diversity to lessen the potential risk of bark beetle outbreaks. Thinning to a growing stock level (the relationship between basal area and average stand diameter after cutting) of 60 to 80 sq. ft. of basal area is the recommended treatment to reduce ponderosa pine forest type susceptibility to pine bark beetle outbreaks. Thinning targeted the moderate to high risk stands and therefore reduced the area that remains at risk (in the original 100,800 acres studied) by approximately 6 percent (see Table 10).

Table 10: Assessment of Risk of Bark Beetle Attack in the Uncompahgre Plateau Area

Risk of Bark Beetle Attack	Year 2000	Year 2010
Area at High Risk (% of area studied) ¹	16	25
Area at Moderate Risk (% of area studied) ¹	45	52
Reduction in high or moderate risk due to thinning (% of area) ¹		-6
Area that remains at moderate to high risk (% of area studied) ¹		71

¹ These percentages apply only to the 100,800 acres of ponderosa pine that were included in the 1992 USDA Forest Service Assessment

Extending this study to the remainder of the geographic area, it is assumed that similar levels of moderate to high risk stands remain in the areas of ponderosa pine that were not included in the 1992 assessment. Approximately 70 percent of the ponderosa pine stands in the geographic area would therefore be considered to be at moderate to high risk of beetle attack. This relative risk of insects and disease in the geographic area has been recently reduced for areas with wildfire occurrence (i.e., Bucktail Fire, 47 Fire, and Burn Canyon Fire) that were dominated by ponderosa pine forest type. However, mountain pine beetle populations have been increasing on the northern portion of the Uncompahgre Plateau, particularly on Kelso Mesa and Campbell Point.

Dwarf mistletoe is found throughout the ponderosa pine cover type, generally occurring in patches of several acres. Mistletoe is a parasitic plant that taps into the tree's resources, slowing growth and causing branch deformities. Mistletoe can kill trees in extreme cases. Thinning and selective timber harvest of affected trees in the ponderosa pine stands keep infestations in check. At this time, it appears that mistletoe exists at endemic levels on the Plateau with the exception of the Cartwheel area of the IAA.

Current Conditions

Large areas of ponderosa pine are in even-aged dense stand conditions increasing the potential of large stand replacing fires and heavy mortality from insects. Soil types that are most suitable for ponderosa pine restoration treatments are well drained fine to coarse loamy soils that are shallow to moderately deep in the 15-20 inch precipitation zone. Although ponderosa pine will tolerate skeletal soils and soils with root restrictions, these should be avoided due to windthrow potential and poor site.

Most of the ponderosa pine in the IAA is between 101 and 140 years of age. The younger age classes (0 to 60 years) correspond to ponderosa pine plantations. Ponderosa pine is codominant with aspen at higher elevations, and at lower elevations, ponderosa pine is mixed with pinyon and juniper. There are limited areas where ponderosa pine is mixed with spruce-fir and Douglas-fir.

Timber

Table 5 (page 45) shows the IAA acres by vegetation cover type. Non-commercial forest cover types cover about 43 percent of the area. The four commercial cover types--spruce/fir, aspen, ponderosa pine, and Douglas-fir-- total over 36,000 acres. Ponderosa pine, the cover type of greatest interest in this analysis, accounts for most of this acreage.

As noted, the ponderosa pine cover type characteristics have been largely shaped by two distinct disturbances: fire and timber harvest. There is ample evidence across the landscape of large-scale, stand-altering fire. Frequent low and moderate intensity fire discriminated against small-diameter trees and “pruned” the lower branches on live trees, reducing the likelihood of fire spreading from the forest surface into the main tree canopy. As a result, pre-settlement forests were more open than those that exist in the area today and were comprised mostly of large-diameter, older, thick-bark trees that were better able to withstand fires.

The terrain across most of the IAA is gentle and most of the area has been roaded. Because of easy access, virtually all ponderosa pine stands have been commercially harvested in the past, most having been entered several times. Harvest began when this area was first settled in the latter part of the 19th century and has continued through the 1980s. Harvest has considerably altered stand structure in this type. Historically, timber cutting was focused on the older, larger trees (fire survivors). With those now gone, most trees remaining today are relatively young – generally less than 120 years old. Many date from the first two decades of the 20th century when favorable pine-seed crops occurred, accompanied by a period of ample precipitation.

It is this cohort of trees that serves as the focus of management today. In pre-settlement stands, fire served as a tree-thinning agent, but with fire exclusion,

thinning has not occurred. As a result, this cohort is often found in groups or thickets ranging to over 200 ft² of basal area per-acre. Diameters vary from about 8-inches to about 22-inches DBH, depending upon stand density. Where trees are the densest, that is where they are in greatest need of thinning, they have the smallest diameters.

Timber Quantity and Quality

Stand exams (2003) were conducted on stands that were identified on aerial photos as being potentially overstocked and in need of density management. This data is summarized in Table 11. The data indicates significant overstocking and commercial timber opportunities. However, subsequent field observations indicate otherwise, and this appears to be an artifact of the data. The data accurately describes stand characteristics that are not area based, for example average diameter and height and stand productivity. The per-acre density data, for example trees per-acre, volume per acre, and basal area per-acre differs substantially from on-the-ground conditions. There are commercial timber opportunities within the IAA. They are, however, significantly less than the 3,700 mbf estimated from stand exam data. Total commercial volume is estimated at no more than 750 mbf.

Table 11: FY 2003 Stand Exam Data

FY 2003 Stand Exam Data																			
polynum	Acres	prod	origin	qmd 5+	ba 5+	tpa 0+	tpa 5+	site index	bfs w	cubic saw	cubic pole	cubic sound dead	gross cubic growth	beetle risk	bf cut-vol/ac (live)	"max" cut dia	Potential total vol (MBF)	Comments	
164	55	40	1913	12.0	140	179	178	71	13,754	2,671	447	274	81	5	5,289	14.0	290.9	dead standing	
165		36	1970	5.8	107	784	584	87	109	12	650	0	57	1	-			PCT opportunity	
166	329	82	1936	13.4	82	111	84	87	7,995	1,655	70	64	27	5	1,212	11.0		marginal commercial	
167	356	46	1931	12.2	98	130	121	82	9,162	1,946	189	69	45	5	2131	12.0		small-dia cut vol	
168	174	41	1914	15.2	80	170	64	74	8,355	1,765	0	0	26	5	1,610	13.0		marginal commercial	
169	78	41	1925	14.7	78	141	65	69	8,092	1,670	44	71	31	3	1,484	12.0		marginal commercial	
170	224	46	1934	12.4	140	167	167	75	11,911	2,530	170	86	54	5	5,850	14.0	1,310.4		
245	44	36	1890	14.9	111	92	92	66	10,864	2,284	72	0	41	5	3,670	15.0	161.5		
246	283	29	1885	15.5	88	101	67	57	8,629	1,796	32	0	23	5	1,619	13.0		marginal commercial	
247	185	36	1908	15.0	147	153	120	67	12,971	2,764	73	0	46	5	6,714	17.0	1,242.1		
248	44	36	1911	13.1	114	208	123	69	11,095	2,324	152	71	49	5	4,472	13.0	196.8		
249	167	30	1911	12.4	114	167	135	59	8,740	1,942	104	12	42	5	3,262	13.0	544.8		
TOTAL																	3,746		

There are two concerns related to timber quality. The first is the small diameter of much of the material in need of thinning. The market for pine sawlogs has been weak for some time, and with the closure of the LP mill in Olathe, the market for small sawlogs and products other than logs is extremely weak. The second concern is the significant effect of porcupine feeding on stem form. Defect from porcupine damage could run as high as 35 percent. This defect not only results in less volume for the timber purchaser, but also results in more activity fuels left in the woods.

Bark Beetle

All stands inventoried during 2003 were assigned a beetle risk rating of “5-High” by an algorithm in the Region 2 Stand Exam program. Stand susceptibility to mountain pine beetle attack is a function of average stand diameter and stocking –the greater the stocking level and the greater average diameter, the greater is the potential for MPB attack. During field reviews, several small, older mortality groups were observed that appeared to be beetle kill, most likely from the 1980s beetle outbreak that occurred on the eastern end of the Plateau; however, no groups of currently or recently affected trees were observed, rather only a few individuals. The mountain pine beetle currently seems to be functioning in an opportunistic manner, attacking severely-damaged trees, for example those struck by lightning. The potential exists,

as noted by the 5-High risk rating, for an outbreak, and stand density reduction should be implemented in areas either through commercial harvest, noncommercial or pre-commercial thinning, or through prescribed fire.

Diseases

Most stands are generally young by ponderosa pine standards and in relatively good timber health. This is evidenced by the lack of snags, although from a wildlife standpoint, the area is snag-deficient. Field reviews noted no stem decay fungi. Tom Eager, Entomologist, and Jim Worrall, Forest Pathologist, with the Region 2 Forest Health Management Group suspect, but could not find, armillaria root disease in some areas. Relatively small dwarf-mistletoe infested areas exist in several stands, but dwarf mistletoe is generally not a serious silvicultural concern with one exception: the Cartwheel area. The Cartwheel area is located between Goodenough and McKenzie Creeks on Iron Springs Mesa. In a partially successful attempt to control dwarf mistletoe, about 1,000 acres of contiguous ponderosa pine stands were harvested under the selection cutting method in the Cartwheel sale, which ended in 1996. Additional treatments are recommended for the control of dwarf mistletoe in the Cartwheel area.

Pine Plantations

A number of ponderosa pine stands were established within the IAA through tree planting between 1960 and the present. In most cases, non-forested stands, usually Gambel oak/ponderosa pine cover type, with the potential to sustain pine were selected, severely site-prepared and machine planted with ponderosa pine bare-root stock. Many of these attempts were successful and currently support 20+-year-old thrifty, over-stocked ponderosa pine large-sapling and small-pole timber stands. These plantations represent a considerable public financial investment and should be considered for protection in the planning and implementation of fuels projects. About 1,194 acres are high priority for thinning and about 700 acres are moderate priority for thinning. This was determined from an assessment based on aerial photo interpretation followed by field review. Only the plantations established between 1960 and 1989 were considered.

Table 12: Plantation Age and Acres in the Ironhorse Analysis Area

Decade	Acres Planted
1960 - 1969	705
1970 - 1979	0
1980 - 1989	2529
1990 - 1999	341
2000 - Present	79
TOTAL	3654

During field review of some of the high-priority stands, several symptoms of potential insect and disease problems were observed in the high-priority stands. Tom Eager,

Entomologist, and Jim Worrall, Forest Pathologist, with the Region 2 Forest Health Management Group in Gunnison, visited several of these stands. They found twig beetles, the western pine tip moth (*Rhyacionia bushnellii*), cenangium canker caused by the fungus *Cenangium ferruginosum*, and an unidentified biological agent causing yellowing and deformation of foliage on branch tips. Because of this damage, the possibility remains that some plantations were established using trees grown from off-site seed. This general concern was also raised during a visit to the forest in 2002 by the Regional Geneticist. Trees grown from off-site seed are often less thrifty and more susceptible to insect and disease related ailments than trees originating from site-adapted seed. Planting records for the pre-1990 plantations do not indicate seed origin; however, seed collection protocols were in place in the early 1980s when most of the Ironhorse plantations were established. These protocols establish geographic and elevational zones of relatively uniform site and climate conditions in which seed can be collected for reforestation activity occurring within the zone. While it is likely that most plantations were established with stock grown from site-adapted seed, the presence of the insect and disease problems noted by Worrall and Eager suggest that an effort be made to locate seed origin data for the pre-1990 plantations to determine whether they were planted with genetically adapted trees. If this effort does not yield results, tissue samples should be sent to the National Forest Gel Electrophoresis Laboratory at the University of California, Davis to determine the genetic origin.

Plantation overstocking is not severe. Pre-commercial thinning is desirable but if necessary, could be delayed for 5 to 7 years. Because of the small size and dense canopy in these stands, they cannot be considered candidates for underburning due to the high mortality expected with prescribed fire. Similarly these plantations are at risk from wildfire.

Pine Regeneration

Resource managers, foresters, silviculturists and soil scientists agree that regeneration is a major concern within the ponderosa pine vegetation type on the Uncompahgre Plateau in general and specifically within the IAA. The lack of regeneration is linked to a combination of factors. The climate on the Uncompahgre Plateau is at the margin of the distribution of the ponderosa pine type on the Western Slope. As both latitude and elevation increase ponderosa pine begins to drop out of the plant communities and to be replaced by other species such as aspen, Douglas fir and lodgepole pine.

Other components that have been identified in the regeneration issue are soil type and soil productivity. Most of the soils in the area are derived from Dakota sandstone. There are also problems associated with areas that are derived from Mancos shales due to the salinity. Salts need to be flushed from the soil profile for successful seedling establishment. The very western edge of the Ironhorse area has very fine wind deposited sand and is also poorly suited to regeneration. One notable exception to the general soil characteristics of the IAA described above is in the

