Kaibab National Forest

Vegetation and Fire Ecological Need for Change

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INTRODUCTION

This report evaluates the vegetative conditions of the Kaibab National Forest (Forest) and the surrounding area using Potential Natural Vegetation Types (PNVTs). It provides comparisons between historic, or reference, conditions, current conditions, and projected future conditions. Natural and anthropogenic disturbance processes are considered. Because they are so closely intertwined, fire & fuels, invasive plants and insect & disease conditions and trends are integrated in this report to conduct an assessment of risk and the threats contributing to it for each PNVT.

Bailey's Ecoregions (Bailey, et al., 1994) classifies different areas in the United States based on ecological characteristics in a hierarchal pattern. Part of this hierarchy (Sections) is used to evaluate the spatial niche of the Forest in the larger landscape. The Kaibab National Forest is entirely within the "Dry Domain" that covers most of the Western United States. Domains are subdivided into Divisions, Provinces, Sections, and Subsections based on similar climate and land surface form. The entire Forest is within the Tropical/Subtropical Steppe or the Tropical/Subtropical Desert Divisions. Most of the Forest, including the northern portion is within the Colorado Plateau Semi-Desert Province. A small portion of the Forest is contained in the American Semi-Desert and Desert Province or the Arizona-New Mexico Mountains Semi-Desert-Open Woodland-Coniferous Forest-Alpine Meadow Province.

The Forest consists of 1.56 million acres in north-central Arizona. The Forest is mostly within Coconino County, although small amounts are within Mohave County (<0.1%) and Yavapai County (<1%). The Forest is broken into three geographically distinct administrative units. The Williams and Tusayan Ranger Districts are separated by private and state lands. The North Kaibab and Tusayan Ranger Districts are separated by the Colorado River and Grand Canyon National Park.

The Forest has state and private lands within the designated forest boundaries. The North Kaibab Ranger District has the least, with only four parcels totaling about 100 acres. The Tusayan Ranger District has 23 parcels totaling about 4,100 acres. The Williams Ranger District has more than 120 parcels totaling about 35,800 acres. The Williams District also contains about 17,400 acres that are managed by the Department of Defense at Camp Navajo. The area would revert to the National Forest System management if the Department of Defense no longer needed the facilities. Approximately half of the Williams District is in wildland urban interface. The wildland urban interface on the Tusayan Ranger District is around the settlement of Tusayan and the part of the district bordering the Grand Canyon National Park. Community Wildfire Protection Plans are in place for both Williams and Tusayan Ranger Districts.

Vegetation on the Forest ranges from desert communities in very hot arid sites to montane/sub-alpine grasslands on cooler moister sites. The Forest has significant amounts of pinyon-juniper, ponderosa pine, mixed conifer, spruce fir, and montane grassland vegetation within it.

The term "reference conditions" refers to the ecological characteristics of a PNVT that existed prior to European settlement. The period is defined for this assessment as between 1000 and 1880 AD.

Fire has long played a role in shaping the vegetation on the Forest. "Fire regime" is the term used to describe the role fire would play in a vegetation type during reference conditions. (National Interagency Fuels Coordination Group 2008) Fire regimes are classified by the frequency and the severity of these fires. At least 44 percent of the Forest is classified as Fire Regime I, with a historic fire return interval less than 35 years and having non-lethal to mixed severity fire effects on the vegetation. Forty-three percent of the forest is classified as Fire Regime III with a historic fire return interval between 35 and 200 years with mixed to low severity effects on the vegetation. Less than ten percent is classifieds as Fire Regime II, with canopy replacement return interval of less than 35 years. The science of disturbance is rapidly evolving for the Pinyon Juniper Woodland PNVT – the most frequent type on the Forest – and the amount of Fire Regime I is expected to increase some with the amount of Fire Regime III decreasing.

Fire regime condition classes (FRCCs) measure the degree of departure from reference conditions often resulting in key changes to ecosystem components such as vegetation characteristics, fuel composition, fire frequency, severity and pattern; and other associated disturbances. FRCC 1 represents a low departure from reference conditions; FRCC 2 represents a moderate departure; and FRCC 3 indicates a high departure. Eighty-three percent of the Forest is in FRCC 3, which means that the vegetation is greatly departed from conditions that existed during the reference period. These departures are often the result of having missed several fire return intervals, but can have other causes such as the introduction of invasive plants, insect and disease epidemics, intensive grazing, or drought. Only 3.6 percent of the forest is classified as FRCC 1 where there is little to no departure from reference period conditions.

ECOSYSTEMS OF THE PLANNING UNIT (PNVTs)

"Potential natural vegetation types (PNVTs) represent the vegetation type and characteristics that would occur when natural disturbance regimes and biological processes prevail" (Schussman et al. 2006). PNVTs combine potential vegetation and historic fire regime to form ecosystem classes useful for landscape assessment**.**

PNVTs are similar to the *biophysical settings* conceptualized in the Interagency Fire Regime Condition Class Guidebook (2005). Biophysical settings are defined by their vegetation, physical characteristics, and historic fire regime. Vegetation includes the area's native species and associated successional stages, determined according to our best understanding of the historical or natural range of variation. Physical characteristics include climate, geology, geomorphology, and soils**,** and the "characteristic ecological processes of fire frequency and severity". Biophysical settings incorporate both classification (taxonomic) and map unit concepts, and ecosystems can be classified based on integrated attributes, as with ecological types (Winthers et al. 2003), so that R3 Terrestrial Ecosystem Survey data, with careful interpretation of disclimax classes, are an appropriate source for delineating biophysical settings and PNVTs. The Forest Service Southwestern Region has since developed a one-to-many crosswalk between PNVTs and their associated biophysical settings. The crosswalk also indicates those biophysical settings central or peripheral to the concept of the PNVT (see following PNVT descriptions).

A PNVT has successional states that range from an herbaceous state to a fire maintained climax state. States are a mosaic of populations that represent different positions along a complex environmental gradient. Uncharacteristic states can occur as the result of an introduction and spread of invasive species, or a change in the frequency of natural disturbance processes. Process oriented ecological models have been built for the ponderosa pine, mixed conifer with aspen, semi-desert grasslands, pinyon-juniper, interior chaparral, and the Madrean Pine Oak PNVTs by the Nature Conservancy. Additional models have been developed by the LANDFIRE project (see http://www.landfire.gov/national_veg_models_op1.php and http://frcc.gov). PNVT mapping generally represents patches of 20 acres in size or larger. Each PNVT that exists on the Kaibab National Forest is briefly discussed and quantified by acreage in Table 1 below. The original descriptions can be found in the Nature Conservancy PNVT assessments at www.azconservation.org (The Nature Conservancy 2006).

The area of each PNVT was derived from the Potential Natural Vegetation classification that was part of the Terrestrial Ecosystem Survey of the Kaibab National Forest. (USDA-FS 1991)

Table 1 - Potential Natural Vegetation Type distribution on the Kaibab National Forest from the Mid-Scale Vegetation Assessment, May 2007 Update (ordered by frequency (acres) on the Forest)

PNVT	Acres of PNVT on KNF	Percent of KNF	Acres on North Kaibab District	Percent of North Kaibab	Acres on Tusayan District	Percent of Tusayan	Acres on Williams District	Percent of Williams
Pinyon-juniper Woodland	647,604	40.5	248,242	37.9	188,961	57.0	210,4010	34.3
Ponderosa Pine	553,310	34.6	155,209	23.7	104,881	31.6	293,219	47.8
Mixed Conifer Forest*	127,738	8.0	113,620	17.3	0	0.0	14,1178	2.3
Sagebrush Shrublands	89,450	5.6	57,836	8.8	31,614	9.5	0	0.0
Montane/Subalpine Grasslands	48,584	3.0	6,545	1.0	2,211	0.7	39,828	6.5
Great Basin Grassland	44,181	2.86	0	0.0	3,761	1.1	40,419	6.6
Spruce-fir Forest**	29,146	1.8	29,002	4.4	0	0.0	144	0.0
Semi-desert Grasslands	25,115	1.6	25,115	3.8	0	0.0	0	0.0
Desert Communities	13,773	0.9	13,773	2.1	0	0.0	0	0.0
Gambel Oak Shrublands	5,364	0.3	3,931	0.6	0	0.0	1,433	0.2
Wetland/Cienega	1,479	0.1	608	0.1	0	0.0	871	0.1
Cottonwood Willow Riparian Forest	1,197	0.1	1,197	0.2	0	0.0	0	0.0
Mixed Conifer w/aspen*	110	0.0	0	0.0	0	0.0	110	0.0
Interior Chaparral	7	0.0	0	0.0	0	0.0	7	0.0
Madrean Pine Oak Woodland	2	0.0	0	0.0	0	0.0	2	0.0
Other (No PNVT)	12,907	0.8	0	0.0	0	0.0	12,907	2.1
Total	**1,599,965**	**100.0**	**655,078**	**100.0**	**331,428**	**100.0**	**613,459**	**100.0**
Private Lands	39,944		98		4,060		35,786	
Grand Total	**1,639,908**		**655,176**		**335,488**		**649,245**	

* - Mixed Conifer Forest includes both Dry Mixed Conifer and Mixed Conifer with Aspen PNVTs. Refer to the description of the PNVTs below.

The PNVT descriptions that follow are adapted from The Nature Conservancy's Southwest Forest Assessment Project (2006) to the Forest-specific conditions.

Pinyon-Juniper Woodland – This PNVT is mostly found on lower slopes of mountains and in upland rolling hills from 4,500 to 7,500 feet in elevation. The most common pinyon pine is the Colorado pinyon (*Pinus edulis*), with singleleaf pinyon (*Pinus monophylla*) occurring in limited areas. One-seed juniper (*Juniperus monosperma*) is most common in Arizona and New Mexico; however, there are areas with Utah juniper (*J. osteosperma*), alligator juniper (*J. depenna*) and Rocky Mountain juniper (*J. scopulorum*).

There are three sub PNVTs of pinyon-juniper: PJ grasslands, PJ shrublands, and persistent PJ woodlands (Romme et al. 2007). All three types exist on the Kaibab. The PJ grassland PNVT has a canopy cover of less than 30 percent with an expansive herbaceous understory. This type has Fire Regime I. A PJ shrubland PNVT is found in cooler climates and on less productive soils. This type has Fire Regime 3. The persistent PJ woodland PNVT is found in areas of fire refugia, where the historic fire return interval is significantly longer than the surrounding woodlands. This occurs due to topographic features that prohibit the natural spread of fire, or because of very poor soils that will not sustain herbaceous growth.

Ponderosa Pine Forest – The ponderosa pine forest is widespread in the Southwest occurring at elevations from 7,000 to 9,300 feet on igneous, metamorphic, and sedimentary parent soils with good aeration and drainage, and across elevation and moisture gradients. It occurs extensively on all three Ranger Districts. The dominant species in this system is ponderosa pine (*Pinus ponderosa*) and makes up 80 percent or more of the overstory. Other trees, such as quaking aspen (*Populus tremuloides*), Gambel oak (*Quercus gambelii*), Douglas-fir (*Pseudotsuga menziesii*), pinyon pine (*Pinus edulis*), and juniper (*Juniperus spp*.) may be present. Aspen may occur in patches, or as a nearly co-dominant species as on the North Kaibab. There may be a shrub understory mixed with grasses and forbs, although this type also occurs as savannah with extensive grasslands interspersed between widely spaced clumps or individual trees. This system is adapted to drought during the growing season, and has evolved several mechanisms adapted to frequent, low intensity surface fires.

Mixed Conifer Forests – Mixed conifer that occurs on the Forest was classified as Dry Mixed Conifer in the PNVT product. If it occurred off the Forest, it was classified as Mixed Conifer with Aspen. However, this is simply a naming convention; it may not be possible to distinguish between these two types in the PNVT product. A check of FIA data shows that 10 of 12 (83%) plots on-Forest are in dry habitat types, with the remainder falling into mesic (mixed conifer with aspen) types. A check with neighboring Forests shows a similar pattern; there is a mix of both types. From this point forward, the two mixed conifer types will be combined in analysis and, where important, assumed to follow a proportion similar to that presented here. A more concerted effort to spatially differentiate between these two PNVTs will be made in the CER II phase.

These PNVTs span a variety of dominant and co-dominant species in dry environments. Montane conifer forests are found at elevations between 8,400 and 10,418 feet, situated between ponderosa pine, pine-oak, or pinyon-juniper woodland and spruce-fir forests. Dominant and co-dominant vegetation varies by elevation and moisture availability. In the lower and drier elevation portions of this PNVT, ponderosa pine (*Pinus ponderosa*) dominates, making up approximately 57 to 80 percent (Fulé et al. 2002, 2003b) of the overstory. Other species present are Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*) and aspen (*Populus tremuloides*). Aspen may be present either in patches, or more continuously as on the North Kaibab. The understory vegetation is comprised of a wide variety of shrubs, grasses, graminoids, and forbs; the composition depends on soil type, aspect, elevation, disturbance history and other factors. Mixed Conifer Forest PNVTs occur on the North Kaibab Ranger District and on the north facing aspects of Bill Williams, Kendrick and Sitgreaves Mountains as well as on a few other tall cinder cones on the Williams Ranger District. During the pre-settlement period, fire was a major disturbance factor. Mixed Conifer Forest PNVTs pre-settlement fire regime has been documented to be similar to that of ponderosa pine (Fulé et al. 2003c). The historic size of stand replacement fires has been documented to be less than 240 acres on the Grand Canyon National Park with a median size of 15 acres (Vankat 2004).

Sagebrush Shrubland – This PNVT is dominated by big sagebrush (*Artemisia tridentata*). In the Southwest, sagebrush shrubland primarily occurs in northern Arizona and northwestern New Mexico adjacent to Great Basin grassland and pinyon juniper woodland PNVTs. While big sagebrush is the dominant species other shrubs such as broom snakeweed (*Gutierrezia sarothrae*) and shadscale (*Atriplex confertifolia*) are common, as are grassland species such as blue grama (*Bouteloua gracilis*). Shrubland sites are found on deep well-drained valley bottom soils or rocky soils between 4,800 and 7,800 feet with precipitation ranging from 10 to 18 inches per year. This PNVT occurs on the North Kaibab and Tusayan

Ranger Districts. The Forest manages approximately 50 percent of the sagebrush shrublands that occur within the Southwest National Forest System Lands.

Montane / Sub-alpine Grassland - This system occurs at elevations ranging from 8,000 to 10,418 feet, and often contains several plant associations with varying dominant grasses and herbaceous species. Trees may occur along the periphery of the meadows. Some shrubs may also be present. These meadows are seasonally wet, which is closely tied to snowmelt. They typically do not experience flooding events. This PNVT may be under represented by as much as 40,000 acres in the survey: a significant portion of this is currently classified in the Ponderosa Pine and higher elevation Pinyon Juniper Woodlands PNVTs, but appears to historically have had a canopy closure of less than 10 percent. Most of this is on the Williams RD.

Great Basin / Colorado Plateau Grassland and Steppe – This PNVT is found at lower elevations between desert communities and pinyon juniper woodlands. Vegetation coverage consists of grasses and interspersed shrubs. This PNVT occurs on the Williams and Tusayan Ranger Districts. Many of the areas shown as montane grasslands on the Williams District exist at an elevation below 7,200 feet and should probably be classified as Great Plains grasslands. This PNVT could occur on the North Kaibab, but none is currently shown: some valley bottoms that are mapped as a sagebrush shrubland PNVT may be Great Basin grasslands.

Spruce-Fir Forest – Also known as sub-alpine conifer forests, spruce-fir forests range in elevation from 8,400 to 10,418 feet along a variety of gradients including gentle to very steep mountain slopes. Englemann spruce (*Picea engelmannii*) and corkbark fir (*Abies lasiocarpa var. lasiocarpa*) dominate this PNVT either mixed or individually. Douglas-fir along with ponderosa pine, mixed conifer and quaking aspen stands are also present in this system for long periods without regeneration. Fire adapted trees make up to 65 percent of the overstory depending on site conditions (Fulé et al. 2002, 2003c). Natural disturbances in this PNVT are blow-downs, insect outbreaks and stand replacing fires. This PNVT occurs on the North Kaibab Ranger District and the north facing aspects of Kendrick Mountain on the Williams Ranger District. Research by Fulé, et al (2003b) seems to indicate that up to 50 percent of this PNVT on the North Kaibab Ranger District should possibly be classified as the Mixed Conifer with Aspen PNVT, which has a fire regime with mixed severity high frequency fire.

Semi-desert Desert Grassland – Semi-desert grassland occurs at elevations ranging from 3,000 to 5,600 feet. These grasslands are bounded by desert at the lower elevations and woodlands or chaparral at the higher elevations. Species composition and dominance varies across the broad range of soils and topography that occur within the two states. Shrubs also occupy these grasslands and their abundance and species composition also varies. This PNVT occurs on the east side of the North Kaibab Ranger District at elevations less than 5,600 feet. This PNVT may exist on the Williams Ranger District, but none is currently mapped on there.

Desert Communities – Vegetation types and density vary with geographic location, precipitation, and topography. Some areas within this PNVT may be barren. Other areas may have sparse to dense vegetation cover that includes succulent species, desert grasses, desert scrub, and some herbaceous cover. This PNVT occurs at the lower elevations of Kanab Creek on the North Kaibab Ranger District. This PNVT may exist on the western edge Williams Ranger District, but none is currently shown.

Gambel Oak Shrubland – This PNVT is associated with relatively steep, rocky, south-facing slopes. Adjacent PNVTs are Pinyon-Juniper Woodland, Ponderosa Pine and Dry Mixed Conifer. It occurs on the Williams and North Kaibab Ranger Districts. On Williams RD, it is associated with the southern flank of Bill Williams Mountain. On the North Kaibab RD, it lies along the East Rim break in Saddle Mountain Wilderness.

Wetland/Cienega – This PNVT is associated with perennial springs or headwater streams where groundwater intersects the surface and creates pools of standing water, sometimes with channels flowing

between pools. Often soils in the area are highly saline. Distribution and types of vegetation vary due to a gradient in saturated soils and salinity. This PNVT also includes high elevation (6,500 to 10,418 feet) meadows with subsurface flows dominated by herbaceous cover. This PNVT occurs on the Williams and North Kaibab Ranger Districts. About 50 percent of Demotte Park and Pleasant Valley on the east side of Highway 67 are mapped as wetland/cienega.

Cottonwood Willow Riparian Forest – This system is typically found at lower elevations along rivers and streams in unconstrained valley bottoms. Dominant woody species include cottonwood (*Populus spp*.), willow species (*Salix* spp.), and mesquite (*Prosopis* spp.). Various grasses and forbs are also present. The vegetation is dependent upon seasonal flooding and high water tables for germination, growth and survivorship of the woody dominants. This PNVT occurs in Kanab Creek on the North Kaibab Ranger District.

Mixed Conifer with Aspen Forest – This PNVT spans a variety of dominant and co-dominant species in more mesic environments. Montane conifer forests are found at elevations between 8,400 and 10,400 feet, situated between ponderosa pine, dry mixed conifer and spruce-fir forests. Dominant and co-dominant vegetation varies in elevation and moisture availability. In higher and more *mesic* areas, ponderosa pine will co-dominate with Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*) and aspen (*Populus tremuloides*). Ponderosa makes up 15 to 56 percent of the overstory (Fulé et al. 1997, 2002, 2003b). Other vegetation that may be present but does not co-dominate in these higher mesic areas include Englemann spruce (*Picea engelmannii*) and Colorado blue spruce (*Picea pungens*). Aspen may be present either in patches, or more continuously, as on the North Kaibab. The understory vegetation is comprised of a wide variety of shrubs, grasses, graminoids, and forbs; the composition depends on soil type, aspect, elevation, disturbance history and other factors. The mixed conifer with aspen PNVT is mapped erroneously on the Williams Ranger District near Garland Prairie. This site is at an elevation below 7,200 feet and is likely a Gambel Oak PNVT. This PNVT exists on the Forest, but is not distinguishable from the Dry Mixed Conifer. This PNVT will be included with the Dry Mixed Conifer PNVT in further discussion except when it should be explicitly separated.

The following PNVTs are described for information, but are not carried forward for further analysis, because their extent on the Forest is deemed to be too limited or otherwise unsuitable for effective analysis or planning. Further, besides being too small to map as PNVTs, vegetation around many seeps and springs do not fit the definitions of any described PNVTs. The condition and trend for these areas is discussed separately in the aquatic report.

Interior Chaparral – This PNVT is typically found on mountain foothills and lower slopes where low-elevation desert landscapes transition into wooded evergreens. Interior chaparral consists of mixed shrub associations that include manzanita (*Arctostaphylos spp*.), antelope bushes (*Purshia spp*.), silktassles (*Garrya spp*.), Stansbury cliffrose (*Purshia stansburiana*), shrub live oak (*Quercus turbinella*), and sumacs (*Rhus spp*.). This PNVT occurs on seven acres on the Williams and North Kaibab Ranger Districts.

Madrean Encinal Woodland – This PNVT occurs in foothills, canyons, bajadas and plateaus between semi-desert grasslands and Madrean pine-oak woodlands. Vegetation is dominated by oaks such as Arizona white oak (*Quercus arizonica*), Emory oak (*Quercus emoryi*), gray oak (*Quercus grisea*), Mexican blue oak (*Quercus oblongifolia*), and Toumey oak (*Quercus toumeyi*). Ponderosa pine, pinyon and juniper trees, and interior chaparral species may be present, but do not co-dominate. The ground cover is dominated by warm-season grasses. This PNVT occurs on the Williams Ranger District near Sycamore Canyon.

Madrean Pine-Oak Woodland – This PNVT is dominated by open to closed canopy of evergreen oaks, juniper, and ponderosa pine with a grassy understory. Madrean pine-oak woodlands usually occupy foothills and mountains ranging from approximately 4,000 to 7,000 feet in elevation. Climate generally consists of mild winters and wet summers with mean annual precipitation ranging from about 10 to 25

inches; half of the precipitation typically occurs in summer, with the remainder occurring during the winter and spring. This PNVT occurs on two acres of the Williams Ranger District.

Disturbed/Altered – These areas that are barren or have relatively low vegetation cover due to some type form of human alteration or management regime.

SPATIAL NICHE - COMPARISON OF THE FOREST TO THE SURROUNDING LANDSCAPE

The Kaibab National Forest, along with the Coconino National Forest and the Grand Canyon National Park, are "islands" at the edges of the Mojave and Sonoran deserts and the Great Basin. Vegetation on the Forest ranges from desert communities in very hot arid sites to montane/coniferous forest on cooler moist sites. The Forest has significant amounts of pinyon-juniper, ponderosa pine, mixed conifer, spruce-fir, and montane grassland vegetation within it.

The Forest is surrounded by lower elevation desert communities, shrublands, or pinyon-juniper woodland vegetation communities on all sides except on the east side of the Williams District, where it is bordered by the ponderosa pine and grassland vegetation.

The North Kaibab Ranger District is surrounded by public lands administered by the Bureau of Land Management on north, east, and west, and Grand Canyon National Park on the south. The Tusayan Ranger District is bordered by the Grand Canyon National Park on the north, the Navajo Nation on the east, private and state lands to the south and west, and the Havasupai Indian Reservation on the west. The Williams Ranger District is bordered by private and state lands to the north and west, the Coconino National Forest to the east, and the Prescott National Forest to the south. The majority of the land base in northern Arizona is public or Tribal lands.

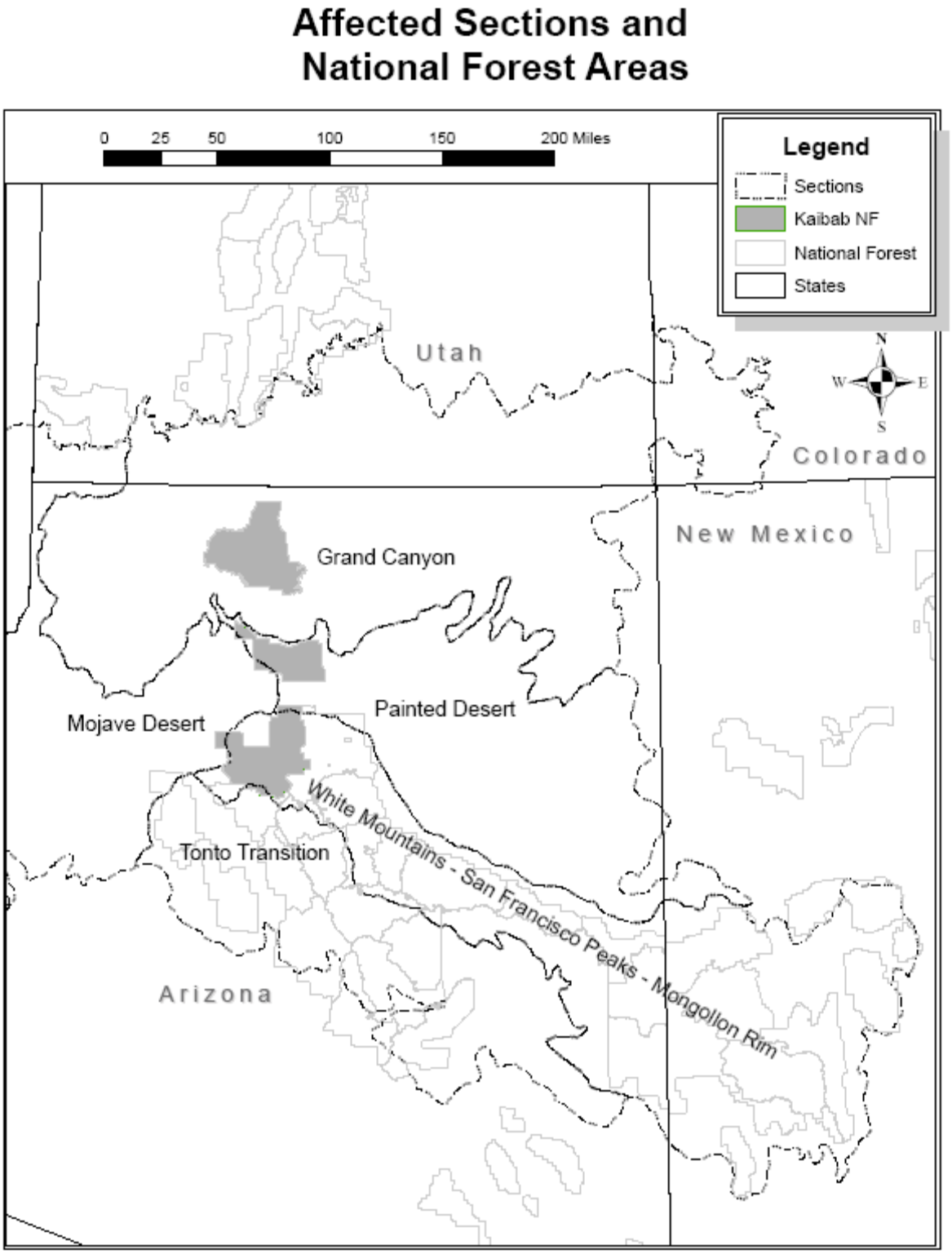

Figure 1- Bailey's ECOMAP Sections, containing the Kaibab NF. Other NF lands in or near the Sections are also shown.

The Forest contributes to ecological diversity within the Colorado Plateau Semi-Desert Province. The forest is located within the Grand Canyon, Painted Desert and White Mountains-San Francisco Peaks Sections, as described by Bailey (1994) (Figure 1). The Forest is a significant portion of three Sections (shaded rows). Each Ranger District lies primarily within one section each. Spatial niche will be evaluated for those three Sections.

The purpose of the spatial niche analysis is to identify PNVTs that are disproportionately over-represented on the Forest within each Section. A second look is also taken to identify PNVTs moderately or highly departed off the Forest and are also mostly off the Forest, but that also have enough area on-Forest that the Forest can make a difference in contributing to ecological diversity in the Section by providing refugia or a reservoir – as long as the PNVT is less departed on the Forest or could be restored..

Table 2 - Comparison of the Kaibab NF and its Ranger Districts to Bailey's ECOMAP Sections

SECTION	Section as % Forest	Importance
Grand Canyon - 313A	40.90%	100 % of North Kaibab RD
Tonto Transition - 313C	1.00%	< 3% of Williams RD
Painted Desert - 313D	20.60%	95% of Tusayan RD; < 3% of Williams RD
Mojave Desert - 322A	2.60%	5% of Tusayan RD; < 4 % of Williams RD
SF Peaks - White Mountains - Mogollon Rim - M313A	34.90%	91% of Williams RD
Total	100.00%	

Eco-map sub-sections were considered in defining the Forest niche but not used because an adequate definition can be developed at the section level and there appear to be significant mapping accuracy concerns that would confuse rather than focus the niche. Appendix 1 discusses this choice in detail.

For the three Sectional tables that follow, "disproportional overrepresentation" for the Forest is evident when the percent in the Section (RD) column in Table 1 above is substantially greater than the percent in the "percent of Section" column. The final column in the following tables displays the percent of the PNVT in the Section that is on the Forest. The greater this percent, the greater the Forest's potential contribution to ecological sustainability for the PNVT in the Section. These two factors work together to create a "representativeness value" when considering the Forest niche. Rows deemed to have a high representativeness value are shaded in these tables.

Grand Canyon Section (North Kaibab Ranger District) - The Grand Canyon Section is located in Arizona, Utah, Colorado and New Mexico. Within Arizona, it is north of the Colorado River and Highway 264. It includes lands administered by the Navajo Nation, Hopi Tribe, Southern Utah Paiute Tribe, Arizona Strip BLM, Grand Canyon and other Parks, state and private lands as well as the Dixie and Kaibab Forests. Within the Arizona Strip there are small amounts of state and private land. The North Kaibab RD is located on the Kaibab Plateau and is bordered on the south by the Grand Canyon National Park and by the BLM Arizona Strip on the other three sides.

The North Kaibab Ranger District (NKRD) makes up about 3.3 percent of the Grand Canyon Section (Table 3). The Forest is part of a sky island, with high representativeness of all forested PNVTs, Gambel Oak Shrublands, and Wetland/Cienega, as well as Montane/Subalpine and Semi-Desert Grasslands.

Table 3 - Comparison of PNVTs within the Kaibab NF (North Kaibab Ranger District) and the Grand Canyon Section

PNVT	KNF (NKRD)	Grand Canyon Section	% of Section	Outside KNF	KNF (NKRD)
Pinyon-juniper Woodland	248,242	6,194,022	31.5%	96.0%	4.0%
Ponderosa Pine	155,209	563,101	2.9%	72.4%	27.6%
Mixed Conifer Forests	113,620	292,558	1.5%	61.2%	38.8%
Sagebrush Shrublands	57,836	1,670,758	8.5%	96.5%	3.5%
Montane/Subalpine Grasslands	6,545	26,400	0.1%	75.2%	24.8%
Great Basin Grassland	0	8,944,852	45.5%	100.0%	0.0%
Spruce-fir Forest	29,002	66,364	0.3%	56.3%	43.7%
Semi-desert Grasslands	25,115	29,952	0.2%	16.1%	83.9%
Desert Communities	13,773	854,498	4.3%	98.4%	1.6%
Gambel Oak Shrublands	3,931	4,003	0.0%	1.8%	98.2%
Wetland/Cienega	608	4,060	0.0%	85.0%	15.0%
Cottonwood Willow Riparian Forest	1,197	67,335	0.3%	98.2%	1.8%
Other	0	936241	4.8%	100.0%	0.0%
Total	655,077	19,654,144	100%	96.7%	3.3%

Painted Desert Section (Tusayan Ranger District) - The Painted Desert Section is located in Arizona and New Mexico south of the Colorado River and Highway 264. It includes the Tusayan Ranger District, the Navajo Nation, the Hopi Indian Reservation, a small portion of the Coconino National Forest, and state and private lands. The Tusayan Ranger District is located north of the Coconino Plateau along with the Grand Canyon National Park. The Tusayan Ranger District (TRD) makes up about 3.7 percent of the Painted Desert Section (Table 4). The Forest occupies an elevated area in the Section, with high representativeness of Pinyon-Juniper Woodland, Ponderosa Pine, Sagebrush Shrublands and Montane/Subalpine Grasslands..

Table 4 - Comparison of PNVTs on the Kaibab NF (Tusayan Ranger District) to the Painted Desert Section

PNVT	KNF (TRD)	Painted Desert Section	% of Section	Outside KNF	KNF (TRD)
Pinyon-juniper Woodland	188,961	1,698,039	19.0%	88.9%	11.1%
Ponderosa Pine	104,881	134,470	1.5%	22.0%	78.0%
Mixed Conifer Forests	0	176	0.0%	100.0%	0.0%
Sagebrush Shrublands	31,614	298,006	3.3%	89.4%	10.6%
Montane/Subalpine Grasslands	2,211	2,211	0.0%	0.0%	100.0%
Great Basin Grassland	3,761	6,708,256	75.2%	99.9%	0.1%
Spruce-fir Forest	0	412	0.0%	100.0%	0.0%
Semi-desert Grasslands	0	1,562	0.0%	100.0%	0.0%
Desert Communities	0	948	0.0%	100.0%	0.0%
Gambel Oak Shrublands	0	0	0.0%	100.0%	0.0%
Wetland/Cienega	0	374	0.0%	100.0%	0.0%
Cottonwood Willow Riparian Forest	0	19,510	0.2%	100.0%	0.0%
Other	0	58,830	0.7%	100.0%	0.0%
Total	331,428	8,922,794	100%	96.3%	3.7%

White Mountains-San Francisco Peaks-Mogollon Rim Section (Williams Ranger District) -This Section is located on the Mogollon Plateau, north of the Mogollon Rim. It includes the Williams Ranger District, the Apache-Sitgreaves and Coconino National Forests, the Fort Apache Indian Reservation, and state and private lands. Lands to the north and west of the District are about equally divided between private lands and lands managed by the State of Arizona.

The Williams Ranger District (WRD) makes up about 4.6 percent of the San Francisco Peaks-White Mountains-Mogollon Rim Section (Table 5). It has a high representativeness of Pinyon-Juniper Woodland, Montane/Subalpine Grasslands and Gambel Oak Shrublands in this Section.

The Apache-Sitgreaves and Coconino Forests contribute significantly to the forest and woodland PNVTs.

The District has three Mexican spotted owl protected activity centers, Arizona bugbane plant habitat, and the proposed Garland Prairie Natural Research Area.

Table 5 - Comparison of PNVTs within the Kaibab NF (Williams Ranger District) and the San Francisco Peaks-White Mountains-Mogollon Rim Section

PNVT	KNF (WRD)	SFP - WM - MR Section	% of Section	Outside KNF	KNF (WRD)
Pinyon-juniper Woodland	293,219	2,917,761	21.8%	90.0%	10.0%
Ponderosa Pine	210,401	4,568,209	34.1%	95.4%	4.6%
Mixed Conifer Forests	14228	762415	5.7%	98.1%	1.9%
Sagebrush Shrublands	0	22137	0.2%	100.0%	0.0%
Montane/Subalpine Grasslands	39828	170547	1.3%	76.6%	23.4%
Great Basin Grassland	40419	1780569	13.3%	97.7%	2.3%
Spruce-fir Forest	144	126034	0.9%	99.9%	0.1%
Semi-desert Grasslands	0	759763	5.7%	100.0%	0.0%
Desert Communities	0	49275	0.4%	100.0%	0.0%
Gambel Oak Shrublands	1433	1433	0.0%	0.0%	100.0%
Wetland/Cienega	871	15161	0.1%	94.3%	5.7%
Cottonwood Willow Riparian Forest	0	5093	0.0%	100.0%	0.0%
Other	12916	2228340	16.6%	99.4%	0.6%
Total Acres of all PNVT's	613459	13406736	100%	95.4%	4.6%

Contribution To Sectional Ecosystem Sustainability (Niche)

Table 6 shows an analysis of departure by PNVT within the key Sections. This is based upon a classification of vegetation structure within PNVTs as typical or atypical relative to reference conditions and the risk of a negative outcome from disturbance by identified threats. With one exception, departure represents both a departure in vegetation structure and a similar departure in FRCC. The exception is Cottonwood Willow Riparian Forest PNVT, where flooding is the primary disturbance agent outside reference condition. The details of the rating process are presented in Appendix 2.

Cells with a high representativeness on the Forest are shaded. Cells with a high departure (H) or, with moderate departure (M) and also over-represented are shaded and in bold. These are important to the Forest niche. Bold face, unshaded departures may represent opportunities for the Forest to provide a reservoir role or refugia for species with the Sections. Unshaded cells with a low (L) departure may not be an important part of the Forest's niche. If a PNVT does not occur on the Forest in the Section, it is left with a "-".

Table 6 – Departure (Risk of Negative Outcome) of PNVTs in Key Sections

PNVT	Grand Canyon	Painted Desert	SFP – WM - MR	Notes
Pinyon Juniper Woodland	**M**	**M**	**M**	Assumes most of this PNVT is PJ/Grass - as is 2/3 of the KNF.
Ponderosa Pine	**H**	**M**	**H**	
Mixed Conifer Forests	**H**	-	**H**	Assumes most of this PNVT is Dry MC - as is > 80% of KNF.
Sagebrush Shrubland	L	**M**	-	
Montane / Subalpine Grassland	L	L	L	
Great Basin Grassland	-	**H**	M	
Spruce Fir Forest	L	-	L	
Semi-desert Grasslands	L	-	-	
Desert Communities	M	-	-	
Gambel Oak Shrubland	L	-	L	
Wetland/Cienega	**H**	-	L	
Cottonwood Willow Riparian Forest	**H**	-	-	Departure Summary adjusted to "H" from "L" based upon assumption that most vegetation in this PNVT is dominated by invasive species and that the disturbance regime is greatly altered by impoundments.

TEMPORAL ECOSYSTEM SUSTAINABILITY

The following analysis considers the contribution to sustainability of ecosystems on the Forest over time. It uses comparisons between historic, current and projected future conditions, including threat/risk assessments to evaluate needs for change. Evaluations are done at the level of each PNVT. An analysis of where the greatest need for change is by PNVT within the Forest is shown by Ranger District. A Subsectional analysis of the need for change is problematic and is discussed in Appendix 1.

Historic Natural Disturbances

The periodic extent of historic fires in Ponderosa Pine and Mixed Conifer Forests was likely much greater than currently. (Fulé 2003c) has documented fires on the north rim of the Grand Canyon that covered at least 14,000 acres in one summer. He has suggested that in some years the entire coniferous forest on the Kaibab Plateau may have burned with low intensity surface fire, perhaps from a single event in one summer. Evidence from many studies, including several on the KNF, suggests that all of the vegetation classified as fire regime 1 had frequent fire and burned every 1 to 25 years. This may have occurred elsewhere on the Forest as well but the site-specific research is less robust. The majority of the Forest (52 percent) has PNVTs with a short fire return interval (FRI). It is likely that half of the Pinyon-Juniper Woodland on the forest was a savannah and also had a fire return interval of less than 25 years (see Table 9).

On the Kaibab Plateau, no evidence for forest-canopy replacing events larger than 100 acres exists for the 100 year period prior to 1900. (Lang 1910) A study in a limited area at the highest elevations of the Plateau found no evidence for stand-replacing fire larger than two to five acres. (Fulé 2003c)

Insect, disease, and invasive plants are included in the assessment of each individual PNVT from Lynch 2007 and Phillips 2007).

Fire Regime

Historically, frequent wildland fire played a major role in shaping vegetative composition and structure across most of Kaibab NF. The fire return intervals were disrupted in the early 1900's by new human

activities. The result is about 2/3 of the Forest is well outside the Historical Range of Variation (HRV) and 90% of the rest is probably outside HRV to some degree.

The following tables display two possible pre-settlement fire regime scenarios. Fire regime is a characterization of the historic fire frequency and its effects on vegetation. The first scenario comes from the LANDFIRE Rapid Assessment Project (2001). LANDFIRE uses readily available plant association data to assign a biophysical setting to represent pre-settlement conditions. The biophysical setting, succession class and potential vegetation type are then used together to assign a fire regime to a spatially defined area.

The data from the LANDFIRE Rapid Assessment was compared with on the ground conditions on the Forest. It is believed that the amount of frequent non-lethal fire is understated by up to 25%. Large areas were assigned fire regimes of III, IV, or V that are typical of Pinyon-Juniper Woodlands or Spruce-fir Forest that have longer fire return intervals. These areas are actually currently are composed of Ponderosa Pine PNVT that is a classic fire regime I, with frequent low intensity fires. The discrepancy is due to misclassifying vegetation as Spruce-fir Forest, Mixed Conifer w/ Aspen, and Pinyon-Juniper Woodlands that should have been classified as Ponderosa Pine, and due to the coarse scale of the Rapid Assessment Project. Fire regime V is also overstated as none of the PNVTs with a fire regime interval longer than 200 years are known to exist on the Forest.

Table 8-LANDFIRE Rapid Assessment fire regime distribution on the Forest

Rapid Assessment Reference Fire Regime (FR)	Forest	
	%	Acres
FR 1 - 0-35 year frequency; low and mixed severity	33.4	520,334
FR 2 - 0-35 year frequency; replacement severity	45.0	701,848
FR 3 - 35-200 year frequency; low and mixed severity	8.3	129,162
FR 4 - 35-200 year frequency; replacement severity	1.8	28,429
FR 5 - 200+ year frequency; replacement severity	11.3	176,268
Bare Rock/Sand/Clay	0.2	3,170
Water	0.0	338
Total	100.0	1,559,550

Table 8 displays one coarse-scale assessment of fire regimes on the Forest. A second method for determining fire regime distribution is to use PNVT as a base. Fire regimes for different PNVTs that occur in the Southwest have been determined by The Nature Conservancy (Schussman et al. 2006). Tables 9 and 9a display fire regimes using this approach. Field checking indicates this scenario better fits actual on the ground conditions on the KNF.

Table 9 - Distribution of fire regimes by PNVT, using TNC fire regime determination

PNVT	Fire Regime Class	Historic Fire Return Interval (years)	Acres	Fire Regime Acres by Class	% of Forest in Fire Regime Class
Ponderosa Pine	1	2 - 17	553,309	706,164	44
Semi-Desert Grasslands		2.5 - 10	25,115		
Madrean Pine Oak Woodland		3 - 8	2		
Dry Mixed Conifer		3 - 20	127,738		
Mixed Conifer w Aspen	2	10 - 22	110	139,111	8
Colorado Plateau/Great Basin Grassland		10 - 30	44,181		
Sagebrush Shrubland		12 - 70	89,450		
Interior Chaparral		20 - 100	7		
Gambel Oak Shrubland			5,363		
Pinyon Juniper Sagebrush	3	6 - 400	647,604	696,188	44
Montane/Sub-alpine Grassland		10 - 400	48,584		
Spruce Fir Forest	4	150 - 400	29,147	45,595	3
Desert Communities		> 250	13,773		
Cottonwood/Willow Riparian Forest		Infrequent	1,197		
Wetland/Cienega		Infrequent	1,478		
Urban & Other	N/A	N/A	12,907	12,907	1
Totals:			**1,599,965**	**1,599,965**	**100**

Condition Class

LANDFIRE Rapid Assessment fire regime condition classes (FRCCs) delineate a standardized, interagency index to measure the departure of current conditions from reference conditions. FRCC is defined as a relative measure describing the degree of departure from the reference fire regime (Schmidt et al. 2002). This departure results in changes to one or more of the following ecological components: vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern), fuel composition, fire frequency, fire severity, fire pattern, and other associated disturbances such as insect and disease mortality, grazing, and drought. FRCC as computed in the Rapid Assessment only measured the departure of current vegetation conditions from reference conditions. Areas classified as Condition Class I are generally functioning within the natural range of variability. Areas classified as Condition Class III are functioning outside the range of natural variability. Areas classified as Condition Class II are functioning in between and could easily go either way.

Table 10-LANDFIRE Rapid Assessment fire regime condition class distribution on the Forest by PNVT

PNVT	LANDFIRE Acres of PNVT on Forest	Fire Regime Condition Class 1	Fire Regime Condition Class 2	Fire Regime Condition Class 3	Departure from Historic Condition
Pinyon Juniper Woodland	638,321	2%	16%	81%	High
Ponderosa Pine	541,010	6%	35%	59%	High
Dry Mixed Conifer	127,718	2%	88%	10%	Moderate
Sagebrush Shrublands	79,862	2%	27%	71%	High
Montane / Subalpine Grassland	40,855	1%	62%	37%	Moderate
Great Basin Grassland	44,199	0%	29%	71%	High
Spruce Fir Forest	29,142	0%	100%	0%	Moderate
Semi-desert Grasslands	25,043	1%	35%	64%	High
Gambel Oak Shrublands	5,366	0%	72%	28%	Moderate
Totals		4%	33%	63%	

Current Natural Disturbances

An average of 200 wildland fires occur annually on the KNF, with about 90% of these started by lightning – a natural cause.

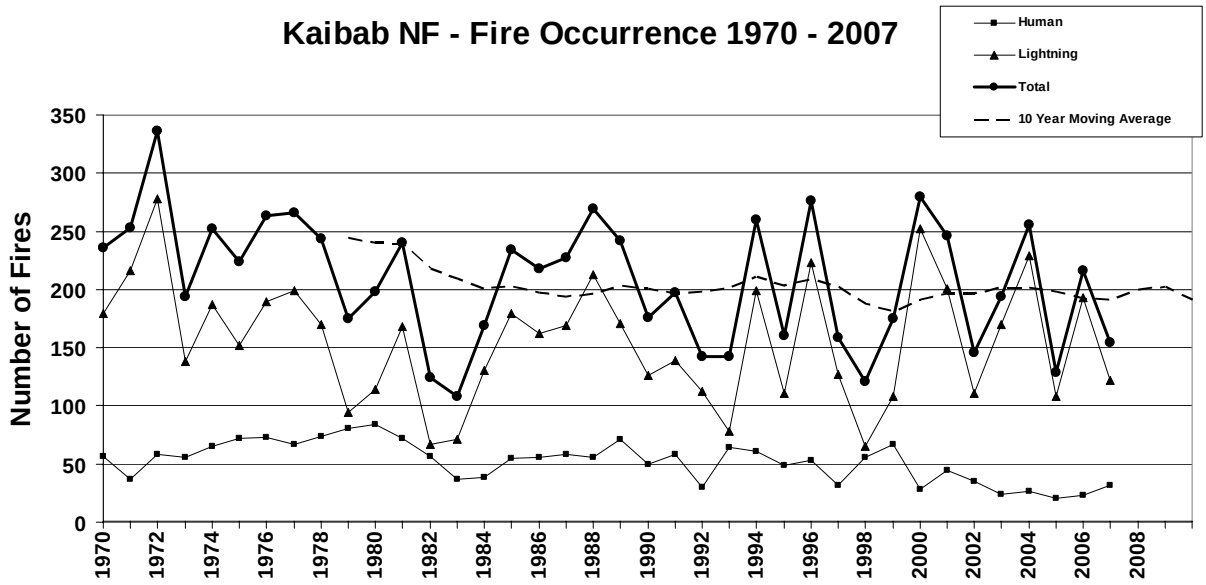

Figure 2 - Annual fire occurrence for the Kaibab National Forest by cause

Since the turn of the century, most wildland fires are suppressed during initial attack, and do not become large fires. Less than 1/10th of 1 percent are not contained with initial attack actions. Increasingly, since the 1960s, when large fires do occur, they are creating conditions that are even further departed from reference conditions than the current vegetation, killing most old growth, greatly simplifying stand structure and predisposing burned areas to rapid colonization by invasive plants and loss of soil productivity. On the Kaibab and Grand Canyon National Park, large fires in the ponderosa pine and dry mixed conifer have caused 40 to 70 percent stand replacement, which did not occur historically (Saddle Fire – 1960, Hells Fire – 1963, Summit Fire– 1966, Sanderson Fire– 1974, Moquitch Fire – 1974, Demotte Fire– 1977, Point Fire– 1993, Bridger Knoll Fire– 1996, Pumpkin Fire– 1996, Outlet Fire– 2000, Warm Fire- 2006).

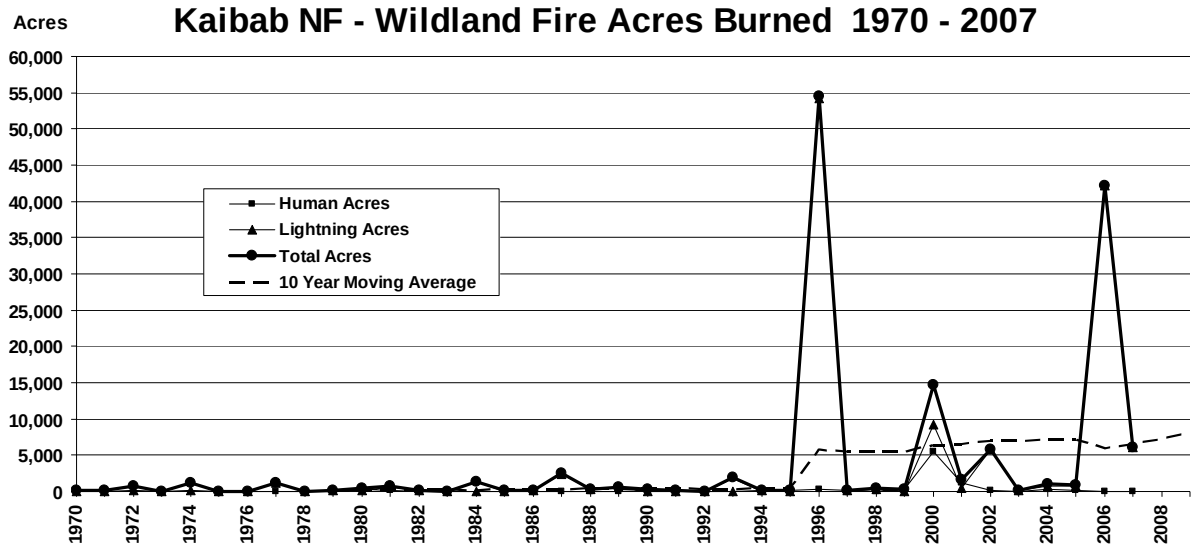

Figure 3 - Annual acres burned by unwanted wildland fires

Since 2003 some naturally-occurring fires have been allowed to burn; most of these grow to 100 to 500 acres, with the largest growing to 19,570 acres.

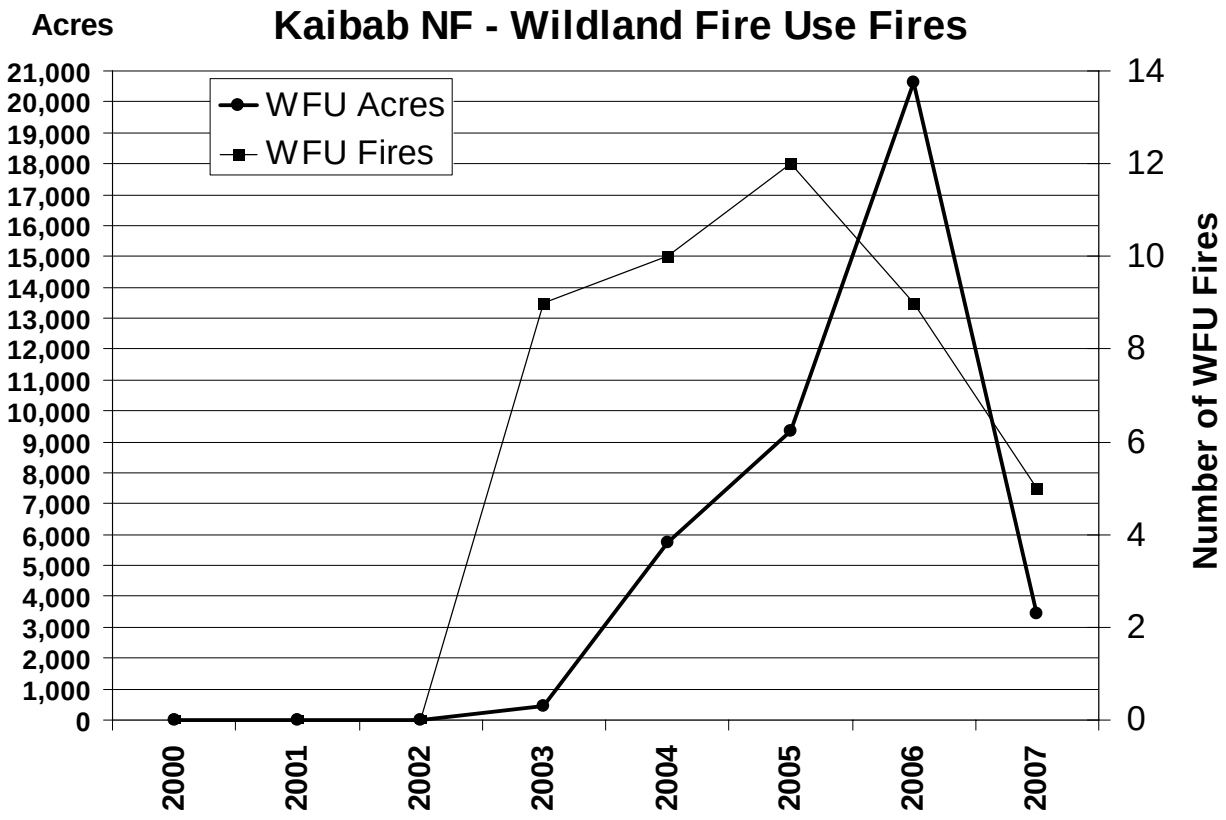

Figure 4 - Wildland Fire Use annual acres treated and number of fires managed

Prescribed fire is used as a tool to reduce fuel loading and the potential fire severity of a resulting wildland fire. The majority of funding and work goes to reducing fuel loading in the wildland urban interface. The target for fuels reduction is expected to grow by 10% every year for the next 10 years. The following chart displays the annual amount of fuels reduction accomplishments. The majority of this work has occurred within the ponderosa pine PNVT.

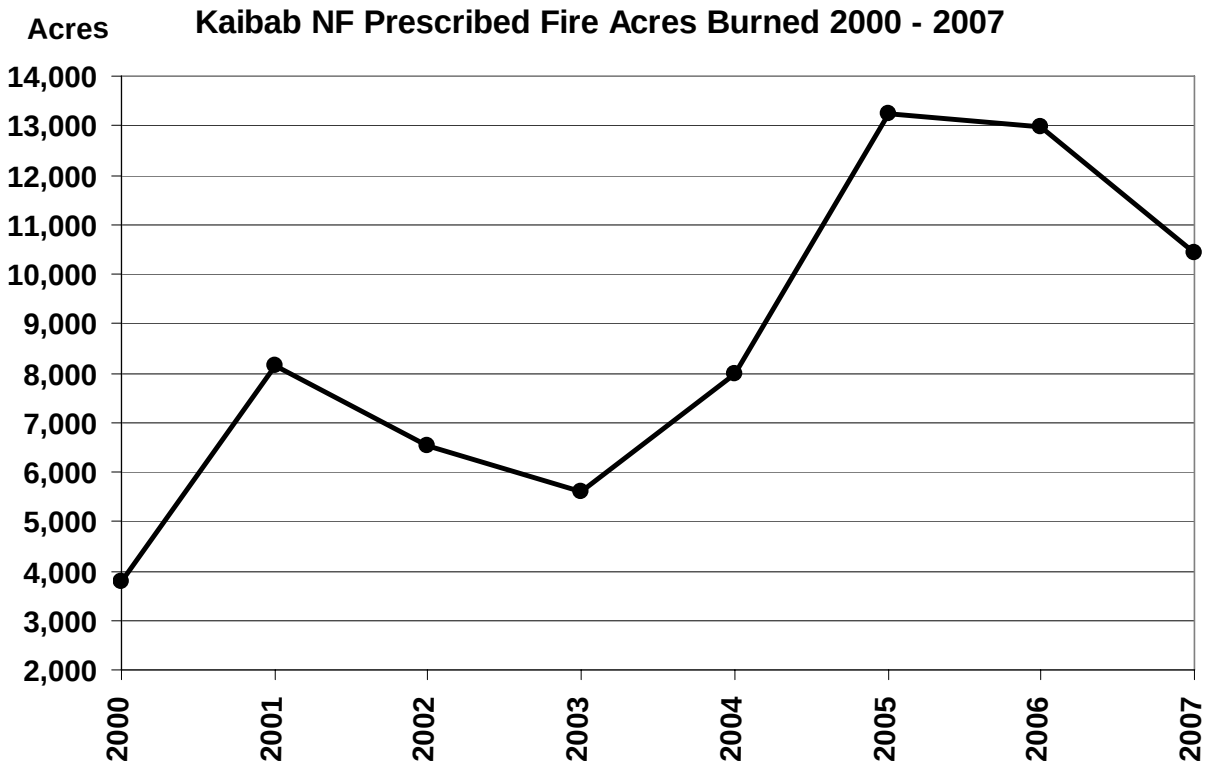

Figure 5 - Annual number of prescribed fires and acres treated

Mechanical treatments also occur each year. In forest PNVTs, thinning of trees of all sizes is used. In PJ, agra-axe treatments are used to create openings. In sagebrush, mowing occurs to create a mosaic of age classes.

ECOLOGICAL SUSTAINABILITY METHODOLOGY

Historical Range of Variation (HRV) describes the components of ecological diversity and the natural disturbance processes that occurred prior to modern human activities. When HRV or reference conditions are cited, the information comes from assessments for PNVTs that were completed by the Nature Conservancy (TNC) for the Southwest Region or research that applies specifically to the Coconino or Kaibab Plateau. Additional information is drawn from studies and reports that are specific to the Forest, or northern Arizona. These assessments discuss a broad range of conditions for a PNVT because each PNVT exists under a variety of conditions throughout the southwest.

State and Transition models depict the ecological pathways of succession. Disturbance pathways determine that if a specific disturbance occurs in a structural state, either natural or human caused, that the resultant stand moves to specific states, interrupting the natural succession path to a climax state. State and transition models were developed for five PNVTs by the Nature Conservancy including: ponderosa pine with bunchgrass, mixed conifer with aspen, interior chaparral, semi-desert grasslands, and Madrean pine oak woodlands. Specialists from the Regional Office and the three Northern Arizona forests developed a model for pinyon juniper with sagebrush. This model was based on research published by

David Huffman, Peter Fulé, Kristen Pearson, Joseph Crouse, Wally Covington, and others. A model for PJ grasslands was also completed based on work completed for the FRCC Interagency Handbook reference conditions as described by Doug Havlina. (National Interagency Fuels Coordination Group 2008) These specialists also developed disturbance pathways including current management activities and natural disturbances. Inputs for various contemporary disturbances were developed by the Forest. For example, the average annual number of acres of ponderosa pine treated by prescribed fire was determined. This was entered into a spreadsheet that calculated the frequency of the event. Frequencies were determined for non-lethal, mixed severity, and stand replacement wildland fire; for low, moderate and high severity insect outbreaks; for prescribed fire, thinning, regeneration cuts, regeneration planting, and fuels treatments. Screen captures of model inputs were saved in a separate document. Model outputs were recorded in a spreadsheet designed for that purpose by Regional Office staff. Only PNVTs with models standardized with the SW Regional Office staff were modeled.

The Vegetation Dynamics Development Tool (VDDT) developed by ESSA Technologies LDT uses these models and disturbance pathways to project future conditions and determine how much of a PNVT will occur in each structural state after different time periods.

For the Kaibab, the R3 VDDT Protocols for Ecological Sustainability Analyses of the Southwestern Region (May 2007 version) were used. Models were run for the ponderosa pine, dry mixed conifer, spruce-fir and pinyon-juniper PNVTs to project future conditions and determine trends.

The Southwest Region undertook the Mid-Scale Mapping Project in 2006. This project uses satellite imagery from September 2005 to delineate the current state of vegetation on the National Forests in the region. Interpretation of the image has resulted in data at a scale of 1:100,000 for vegetation dominance type, size class, and canopy cover. Mid-scale vegetation generally represents patches of 40 acres or larger. This data represents a sample of what current forest conditions are and was used to proportion each PNVT into the appropriate model state.

An interdisciplinary team of Forest specialists examined a list of natural and anthropogenic threats to determine the level of risk that those threats posed to each PNVT. Wildlife biologists examined species to determine if they used habitat on the Forest or not. They associated a PNVT, and at times a structural state as critical habitat for specific species.

Where possible, desired conditions from the current forest plan are included in the discussions below. These are included for reference, and not used to determine if a PNVT is sustainable.

PNVT ASSESSMENTS

Pinyon Juniper Woodlands

Introduction - The pinyon-juniper woodlands PNVT covers about 638,000 acres on all three districts of the Forest. Most (about 2/3) is PJ Grasslands with most of the rest PJ Shrublands. Pockets of persistent PJ woodlands with an understory of needle litter exist, usually on sites with very poor soils.

The PNVT is in GA's 1, 3, 8, 11, 12, 16, and 19 in the current Forest Plan. General Desired Conditions for PJ in the plan call for created openings to be less than four acres in size, unless the opening is being created for wildlife habitat. Other Desired Conditions are to provide at least 40 percent cover for wildlife, provide both thermal and hiding cover, and maintain a cover forage ratio of at least 40:60.

Table 11-State and transition model for the Pinyon-Juniper Shrubland PNVT

State	Estimated Age (yrs)	Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	0 to 59	< 15%	Early development – grass with few	N/A

			shrubs and seedlings	
B	60 to 179	20 to 45%	Mid development – shrub cover 10 – 15%	N/A
C	60 to 159	<20 %	Mid development – shrub cover >10%	N/A
D	160 plus	20 to 30%	Late development – shrub cover 10 – 15%	N/A
E	180 plus	>45%	Late development – shrub cover 10 – 15%	N/A
F	Young		Adventive (Chained & seeded) shrub cover 15 – 35% most common grass is crested wheatgrass	N/A
G	Young		Invaded – uncharacteristic state due to the presence of invasive grasses that shortens the FRI or out competes native grasses	N/A

The PJ Shrubland model was used because, at this time, there is no way to distinguish between the three subsets that make up the PJ Woodlands PNVT and it is intermediate between PJ Grasslands and Persistent Woodlands disturbance regimes.

Information developed subsequent to the risk assessment assigns various P-J habitat types to different fire regimes. A query of FIA plots for habitat types shows about 1/3 of the type may be fire regime III, while about 2/3 may be fire regime I. The proportions are shown in the table 11a below. The departure in Table 12 is summarized as Low and Toward (at 50 years) for this type. For the Pj-grass type, the current condition of 40 – 60 % closed canopy represents a moderate departure from reference condition. Without frequent fire, this will likely trend away. The overall evaluation for P-J is also moderate departure, with static to away trend. – bjh 8/15/08

Table 11a – Summary of FIA plot data habitat classes for pinyon-juniper vegetation.

Habitat class	# Plots	% of Plots
PJ or Ju Grass	65	67
PJ Oak	22	23
PJSage	10	10

Without disturbance State A would transition to State C, except if tree initiation occurs during a period of both high seed production and above average precipitation. If that occurs the initiated stands would be denser than normal and transition to State B. Stands in State C would develop to an older open state (D) after 160 years. Without any disturbance the stands in State D would have reproduction establish within the interspaces and transition to State E.

If drought related mortality, an insect outbreak, or a mixed severity fire occur State B would transition to State C. If not, disturbance occurs then the stand would transition to State E. If the same events happened in State E the stand would move to a more open state (D). Stand replacement fire in any state starts stand initiation, State A. The historic average fire size was 10 acres with a minimum of one acre and a maximum of 1,000 acres.

States F and G are uncharacteristic states that can occur in contemporary landscapes. State F represents places where PJ was pushed in the past to create more forage. In some cases these areas have been re-treated. State G represents areas where invasive plants are occurring and could shorten the FRI. The

model used in VDDT only has States A through E. States F and G were added by the regional team studying the effects of herbivory.

Table 12-Reference conditions from LANDFIRE BPS 251016 Model using a 435 year FRI for stand replacement fire and 196 year FRI for mixed severity fire. Desired conditions from the current plan & Projected conditions from VDDT modeling. Current conditions from Mid-scale Assessment.

	Ecosystem Characteristic -- Vegetation State						
Vegetation State	A	B	C	D	E	F	G
Reference Condition	10	20	25	35	10		
Current Plan Desired Condition	15		15	20-40	40-60		
Current Condition	2.86	25.05	11.9	58.91	1.28		
Projected Trends							
20 Years	10.23	18.71	10.84	51.61	8.61		
40 Years	17.04	17.08	8.64	45.79	11.45		
50 Years	18.89	16.24	8.04	43.75	13.08		
100 Years	21.37	19.17	12.81	33.77	12.88		
250 Years	22.43	27.93	19.88	20.18	9.58		
500 Years	22.59	31.86	21.43	15.4	8.72		
1000 Years	22.66	32.2	22.18	14.97	7.99		

Reference Conditions - PJ Savannah – an open woodland with grass understory, few shrubs, and a frequent FRI (less than 25 years). PJ Sage – a mosaic of age classes across the landscape with patch size likely less than 100 acres (Huffman 2006) with a FRI of approximately 46 years. Persistent woodlands – a mosaic of patches within the woodlands matrix where poorer soil conditions exist. Historic fires would have burned with stand replacement fire effects and the FRI would likely be greater than 250 years.

Current Conditions - Wildland fire is common in this PNVT. Most fires are started by lightning. Since 1996 approximately 33,697 acres (5 percent of the PNVT) of stand replacement fire have occurred (Bridger and Warm Fires). Several fires have been managed for resource benefits and have burned about 6,800 acres, half of which has been stand replacement fire. The area burned by the Bridger Fire (37,000 acres) has three to five fires a year that burn about 50 to 500 acres each. The whole fire area has the potential to re-burn.

Two extensive mortality events have occurred in this type recently – 1996 and 2004. Both coincided with very dry years in a drought period and an Ips beetles outbreak accompanied the second event. The net effect was to open the affected areas up, shift species composition toward juniper and create a lot of dead pinyon that could predispose these areas to severe fires. The events on the Forest seem to be part of widespread events that were concentrated on sites that are quite marginal for pinyon. (Greenwood et al. 2008) Indeed, pinyon may not have rare (juniper woodlands) and some mortality areas may actually be within grassland PNVTs.

Invasive plants occur on about 4 percent of the PNVT. The most common is cheatgrass, although other species including Scotch thistle, Dalmatian toadflax, diffuse knapweed, yellow starthistle, Malta starthistle, bull thistle, and Russian knapweed have been found.

Livestock grazing occurs in most of the PNVT with the exception of Kanab Creek. Some recreation activities occur; fuel and ceremonial wood and pine nut gathering occur. About 1,000 acres of PJ are cut per year to improve wildlife habitat and forage. Little to no prescribed burning occurs. The current woodlands are more closed than the mid-scale data suggests. The majority of the area classified as State C should be classified as States D and E. Field observations show that the average age of the stands is higher and that the canopy closure is denser. A large percentage of the current woodlands in State B are old pushes (State F).

The current woodlands are more closed and less diverse than during the reference period. There is an over abundance of States B and D, and States A, C, and E are under represented.

Projected Trends - In the future, under current disturbance regimes the woodlands becomes younger (19 – 21 percent versus a desired condition of 10 percent) and denser than the desired conditions (46 percent versus a desired condition of 30 percent) after 20 years. The trend continues through year 100 and then stabilizes. The woodlands would lack 19 to 23 percent of the late development open woodland that is desired. The younger woodlands are the result of stand replacement fire occurring over larger areas than during the reference conditions. This VDDT model did not include an invaded state. It is likely that under the current management scenario that the amount of area invaded by cheatgrass will increase. This would shorten the FRI.

Threats/Risk Assessment Results –

The primary threat to this PNVT is the lack of fire disturbance. This is especially true in the PJ-grassland portion that makes up about 2/3 of the PNVT, but also seems to apply to PJ-shrubland portions to some degree as well. Fire disturbance at this point often leads to negative outcomes for structure and species composition often shifts to invasive plants that increase the FRI. For the 1/3 of the type in PJ-shrubland, this would represent a further departure from reference conditions. Therefore, Uncharacteristic Wildfire Effects represents a significant threat. Also for this reason, the secondary threat of invasive species is also carried forward for this PNVT.

Tree density and associated loss of understory plant cover and diversity within the type is the primary characteristic that is departed, especially in the PJ-grasslands. In the PJ-shrublands, the continuity of high tree density represents a departure. Lowering tree densities in characteristic patterns would reverse or mitigate the threats. This is more difficult to do on steep slopes and in wilderness, but is still technically feasible; most of this PNVT is easily accessible.

Ponderosa Pine Forest

Introduction - The ponderosa pine forest PNVT covers about 541,000 acres on all three districts of the Forest. Aspen occurs in patches on the Williams District and in common in the overstory on the North Kaibab RD. Extensive railroad logging occurred on the Williams District in the early 1900s. As a result the forest is mostly a young to mature forest with occasional old to very old trees. On the Tusayan District railroad logging occurred later, and lasted for a shorter period. As a result, there is more old to very old pine than on the Williams District. Logging on the North Kaibab District consisted of cutting the occasional over mature tree. Harvest was over a widespread area, so there are numerous old to very old pine left. Shelterwood harvests did occur in the mid 1970s through the early 1990s.

In the current Plan desired conditions are the Goshawk Guidelines as outlined in the Regional Amendment to the Plan in 1996. Under the Plan the proportion of states would be: State A – 10 percent, State B – 20 percent, State C – 30 percent, and State D 40 percent. All of these states are in parts of the desired condition (State E) at scales of 20 acres and more. The maximum opening size in the current Plan is 2 acres.

Table 13-States and transitions for the contemporary TNC Ponderosa Pine Bunchgrass PNVT Model. VSS relationships are from the current forest plan.

State	Estimated Age (yrs)	Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	0 to 39	< 10%	Grass, seedling, or sapling state; or pine savannah	1
B	40 to 79	10 to 30%	Young forest	2
C	80 to 119	10 to 30%	Mid-Age forest	3 – 4

D	120 to 159	10 to 30%	Mature to old forest	5 – 6
E	160 plus. A-D included.	< 32%	Mature to old forest with regeneration	6
F	0 to 39	> 10%	Grass, seedling, or sapling state	1
G	40 to 79	30 to 60%	Young forest	2
H	80 to 119	30 to 60%	Mid-Age forest	3 – 4
I	120 to 159	30 to 60%	Mature to old forest	5 – 6
J		30 to 60%	Uncharacteristic – presence of re-sprouter species that shorten the FRI and prevent the re-establishment of pine	None

State E would be the desired condition in the current Plan under the Goshawk Guidelines. A forest in this state would consist of States A through D in clumps within larger patches. The canopy closure in State A would be less than 10 percent and between 10 and 30 percent in States B through D. State E has a canopy closure of 32 percent or less. States F through J represent conditions that exist in the contemporary forest. State J represents pine forests where either dense grass or re-sprouting shrub species dominate and are maintained by stand-replacing fire. The initial conditions for State J have occurred extensively on the Forest, but artificial reforestation and fire suppression have reset most areas to State A within a few years after the fire. Unplanted areas within uncharacteristic fires are in State J. This occurs because the large size of the fire places available seed sources long distances from all but the edge of the fire area and perhaps a change in site conditions that make it difficult for seedling to reestablish even when seeds to germinate.

Without disturbance, a patch would start in State A and could move through States B, C, D and E until it reached a mature or old closed forest condition in State I. Depending upon initial conditions, States B, C or D could transition to their denser counterparts. State F would be the starting point for stand initiation if the site soils, weather conditions and a high cone production year all coincide after a disturbance. In that case, the successional pathway would be through States G and H to reach State I.

A natural disturbance would interrupt the successional pathway. A non-lethal surface fire would maintain States A through D in small patches, sending up to 9 percent back to State A, but maintaining State E at the 200-acre scale. A mixed severity fire would maintain the existing state, opening the canopy closure over 45 percent of the area and send up to 55 percent to State A. A stand replacement fire would start stand initiation, sending the entire patch to States A or J. Fire in the closed states (F – I) would have similar results, although less of the area would remain in the existing state because of the increased fire intensity associated with a closed canopy. Insect outbreaks would affect the successional pathway. A low intensity outbreak would maintain the current state by killing isolated trees. A moderate intensity outbreak would result in a proportion of a closed stand moving to an open state and an open stand moving to a younger state. A high intensity outbreak would result in the stand moving to state A.

Human disturbance occurs in the form of actions designed to move a patch or stand towards the desired condition (State E). These management actions would mostly be thinning smaller trees that are under older trees. In some cases logging of larger trees is desirable if there is a lack of States A – C.

There is some debate about how quickly an area regenerates after a large stand-replacing fire. Three options were modeled using VDDT. In the first option 9 percent of a fire area naturally regenerated each year. This means that a 1,000 acre fire would be totally restocked after 45 years (see Table 14). The second option, based upon TNC's model, assumes that no natural regeneration occurs (see Table 15). The TNC assessment for ponderosa pine used peer-reviewed, published information for this scenario. The third option tries to strike a middle ground. It is assumed that large stand replacement fires will regenerate, but slowly and only within planted areas or those that are within seed-fall zones and shaded

during the summer months. This seems to be occurring on the Kaibab and lands on the edge of the Willis, Summit, Oak Point and other fires. Oak Point is the smallest of these fires at 216 acres but on a dry hot site. A field examination of four fires dating from the 1960s through the 1990s on or near the Forest was recently completed. (Kaibab National Forest 2008) Based upon these results, natural regeneration is quite slow – on a track of several centuries to regenerate areas of 1000 acres without live ponderosa pine tree cover. With planting, these seem to be on track to recover at least ten percent tree cover in a decade or two. The results of the third option are in Table 16 and will be used to determine projected trends of the PNVT.

Table 14 - Reference, current and projected conditions of the Ponderosa Pine Bunchgrass PNVT given the current management and disturbance frequencies and assuming 9%/year regeneration after large stand replacement wildland fires.

Kaibab NF Ecosystem Diversity Analysis																						
Ponderosa Pine Forest PNVT			Regeneration after a fire																			
	Vegetation State																					
Vegetation State	A	B	C	D	E	F	G	H	I	J												
Reference Condition	0	0	0.1	0.8	99.1	0	0	0	0	0	**Departure**	**FRCC**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Current Condition																						
North Kaibab RD 155,208.64	7.13	3.69	20.56	8.23	2.15	0.48	3.75	35.39	15.94	2.68	96.95	3	0	0	0.1	0.8	2.15	0	0	0	0	0
Tusayan RD 104,881.34 acres	4.89	7.66	21.65	6.77	1.29	0.22	7.68	43.75	6.09		97.81	3	0	0	0.1	0.8	1.29	0	0	0	0	0
Williams RD 293,219.35 acres	3.1	2.23	8.44	1.72	0.5	2.99	11.79	63.16	6.06		98.6	3	0	0	0.1	0.8	0.5	0	0	0	0	0
Forest 553,309 acres	4.65	3.74	14.65	4.65	1.15	1.69	8.59	51.08	9	0.8	97.95	3	0	0	0.1	0.8	1.15	0	0	0	0	0
Projected Trends -- Forest																						
20 Years	6.01	14.23	5.89	2.97	2.21	1.03	2.96	31.29	33.31	0.1	96.89	3	0	0	0.1	0.8	2.21	0	0	0	0	0
40 Years	6.53	22.14	3.56	1.52	2.61	0.89	0.78	16.28	45.67	0.02	96.49	3	0	0	0.1	0.8	2.61	0	0	0	0	0
50 Years	6.27	21.23	2.72	1.23	1.77	0.95	0.48	17.72	47.62	0.01	97.33	3	0	0	0.1	0.8	1.77	0	0	0	0	0
100 Years	5.93	21.62	3.56	1.39	2.35	1.22	0.42	19.11	44.38	0.02	96.75	3	0	0	0.1	0.8	2.35	0	0	0	0	0
250 Years	6.62	20.7	3.18	1.43	2.06	1.15	0.56	19.76	44.54	0	97.04	3	0	0	0.1	0.8	2.06	0	0	0	0	0
500 Years	6.65	20.9	3.24	1.38	1.98	0.95	0.53	19.51	44.86	0	97.12	3	0	0	0.1	0.8	1.98	0	0	0	0	0
1000 Years	6.05	21.63	3.25	1.45	1.89	1.21	0.55	18.5	45.46	0.01	97.21	3	0	0	0.1	0.8	1.89	0	0	0	0	0

Table 15-Reference, current and projected conditions of the Ponderosa Pine Bunchgrass PNVT given the current management and disturbance frequencies and assuming0%/year regeneration after large stand replacement wildland fires.

Kaqibab NF Ecosystem Diversity Analysis																						
Ponderosa Pine Bunchgrass - No regeneration in State J																						
	Vegetation State																					
Vegetation State	A	B	C	D	E	F	G	H	I	J												
Reference Condition	0	0	0.1	0.8	99.1	0	0	0	0	0												
Current Condition																						
North Kaibab RD 155,208.64	7.13	3.69	20.56	8.23	2.15	0.48	3.75	35.39	15.94	2.68												
Tusayan RD 104,881.34 acres	4.89	7.66	21.65	6.77	1.29	0.22	7.68	43.75	6.09													
Williams RD 293,219.35 acres	3.1	2.23	8.44	1.72	0.5	2.99	11.8	63.16	6.06		**Departure**	**FRCC**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Forest 553,309 acres	4.65	3.74	14.65	4.65	1.15	1.69	8.59	51.08	9	0.8	97.95	3	0	0	0.1	0.8	1.15	0	0	0	0	0
Projected Trends -- Forest																						
20 Years	4.86	2.53	3.1	3.11	0.71	6.71	6.67	32.2	36.23	3.86	98.39	3	0	0	0.1	0.8	0.71	0	0	0	0	0
40 Years	3.89	1.31	0.92	1.51	0	11.38	5.93	12.59	54.49	7.98	99.1	3	0	0	0.1	0.8	0	0	0	0	0	0
50 Years	3.23	0.69	0.34	1.02	0	13.65	6.95	10.1	54.57	9.45	99.1	3	0	0	0.1	0.8	0	0	0	0	0	0
100 Years	2.91	1.03	0.14	0.95	0	13.43	12.4	5.74	45.58	17.81	99.1	3	0	0	0.1	0.8	0	0	0	0	0	0
250 Years	2.71	1.09	0.11	0.58	0	11.68	11.6	8.35	28.85	35.04	99.32	3	0	0	0.1	0.58	0	0	0	0	0	0
500 Years	2.58	0.98	0.15	0.37	0	10.92	9.11	7.63	21.05	47.21	99.53	3	0	0	0.1	0.37	0	0	0	0	0	0
1000 Years	1.75	0.93	0.1	0.34	0	9.95	8.78	6.81	18.02	53.32	99.56	3	0	0	0.1	0.34	0	0	0	0	0	0

Table 16-Reference, current and projected conditions of the Ponderosa Pine Bunchgrass PNVT given the current management and disturbance frequencies and assuming 3%/year regeneration after large stand replacement wildland fires.

Kaqibab NF Ecosystem Diversity Analysis																						
Ponderosa Pine Bunchgrass - Forest Assumption on Natural Regen in State J																						
Natural Regen 0.0327	Vegetation State																					
Vegetation State	A	B	C	D	E	F	G	H	I	J												
Reference Condition	0	0	0.1	0.8	99.1	0	0	0	0	0												
Current Condition																						
North Kaibab RD 155,2	7.13	3.69	20.56	8.23	2.15	0.48	3.75	35.39	15.94	2.68												
Tusayan RD 104,881.34	4.89	7.66	21.65	6.77	1.29	0.22	7.68	43.75	6.09													
Williams RD 293,219.35	3.1	2.23	8.44	1.72	0.5	2.99	11.79	63.16	6.06		**Departure**	**FRCC**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Forest 553,30	4.65	3.74	14.65	4.65	1.15	1.69	8.59	51.08	9	0.8	97.95	3	0	0	0.1	0.8	1.15	0	0	0	0	0
Projected Trends -- Forest																						
20 Years	3.92	3.61	2.53	3.22	0.5	6.1	7.9	32.38	36.57	3.27	98.6	3	0	0	0.1	0.8	0.5	0	0	0	0	0
40 Years	3.37	2.44	0.81	1.34	0	12.12	7.2	13.09	54.62	5.01	99.1	3	0	0	0.1	0.8	0	0	0	0	0	0
50 Years	2.87	1.52	0.44	1.14	0	14.69	8.38	11.46	53.88	5.62	99.1	3	0	0	0.1	0.8	0	0	0	0	0	0
100 Years	3.26	2.12	0.22	0.91	0	17.24	14.68	8	45.55	8.02	99.1	3	0	0	0.1	0.8	0	0	0	0	0	0
250 Years	2.87	2.6	0.38	0.54	0	15.82	15.79	12.58	35.46	13.94	99.36	3	0	0	0.1	0.5	0	0	0	0	0	0
500 Years	2.51	2.54	0.26	0.35	0	15.22	15.54	11.62	32.69	19.27	99.55	3	0	0	0.1	0.4	0	0	0	0	0	0
1000 Years	2.69	2.08	0.23	0.63	0	14.14	15.06	11.2	29.92	24.05	99.27	3	0	0	0.1	0.6	0	0	0	0	0	0

Reference Conditions - There is no evidence of stand replacement fire occurring at a scale greater than 100 acres during the reference period (Lang & Stewart 1910, Fulé 2003b). Large (> 500 acres) stand replacement fires started occurring on the forest in the 1960s. State E, uneven aged stands at the scale of approximately 100 acres is the reference condition. The state consists of clumps and groups of different ages with interspaces between them. Fire was predominately a non-lethal surface fire with group torching occasionally occurring where other natural disturbance processes had occurred between fires. Fire frequency was short, less than 25 years.

Current Conditions - Mountain pine beetle outbreaks occur about once every 20 years. These outbreaks last about five years. Lately, Ips beetle outbreaks are becoming more frequent and extensive. Western tent caterpillar and frost events combine to cause mortality in aspen. Extensive defoliation has occurred every decade since the 1940's. Defoliation for three or more consecutive years can cause mortality. The Jacob Lake area has been impacted by defoliation.

Wildland fires were fully suppressed until 2003. Since 1995 approximately 10,771 acres of stand replacement fire have occurred within this PNVT (2 percent of the PNVT). In areas of ponderosa pine with stand replacement fire patches greater than 1,000 acres, seedlings have yet to re-establish, even in the older fires (Willis, 1987; Hockderffer-Coconino N.F., 1996) and regeneration by planting has been only partially successful at elevations less than 8,700 feet.

Since 2003 some wildland fires caused by lightning have been managed for resource benefits. These fires have ranged in size from a spot to several thousand acres. Fuels reduction treatments including prescribed fire and thinning occur on about 20,000 acres per year. Timber harvest does occur, usually in the form of thinning from below, sanitation cuts in diseased areas, or harvests designed to replicate the natural clumping of trees and age classes outlined in the Goshawk Guidelines.

Managed and un-managed grazing does occur in this PNVT. Managed livestock grazing is under permit. Grazing numbers, season, and duration are managed. Un-managed grazing occurs by deer, elk, and bison.

Developed and dispersed recreation does occur. Developed recreation includes the use of trails, roads, campgrounds, overlooks, and special use permits. Dispersed recreation is popular and includes camping, bird watching, and some cross country travel (both on foot and on ATV). Rock quarries and utility corridors exist in this PNVT. The road system is well developed.

Cheatgrass and bull thistle occupy up to 1 percent of this PNVT, mostly along roads. Areas with large wildland fires can have extensive populations of invasive weeds.

The current forest has a greater proportion of the forest in a closed state, 79 percent versus 0 percent in the reference condition. The inter-space between clumps of trees is smaller or non existent, resulting in a more continuous canopy closure. The forest is also younger than pre-settlement time, 19 percent versus small patches within State E. Larger patches of stand replacement fire are occurring. There are more areas with tree species that are not adapted to frequent fire (white fir, corkbark fir, and spruce) encroaching into the pine PNVT. The amount of aspen is declining. On the south half of the forest aspen reproduction is not growing to an intermediate or mature state because of un-managed grazing. Aspen on the north half of the forest is in decline from frequent tent caterpillar defoliation.

Projected Trends - The VDDT model can be used to project current disturbance frequency and display trends into the future. The results show that the proportion of the forest in each state moves further away from reference conditions and then stabilizes after 100 years. At the current rate of natural and human disturbance the ponderosa pine forest will be younger and denser than today as shown by the amounts of the forest in States A, B, F, H, and I. Diversity between patches larger than 100 acres will likely rise, while small-scale diversity will decline. This is the result of continued stand replacement fire, encroachment of fire intolerant tree species, and further build up of live and dead fuels.

Threats/Risk Assessment Results – The primary threat to this PNVT is the lack of fire disturbance. Because of that, canopy cover is denser and more continuous across States. When fires occur now, they carry a significant risk of a negative outcome, further departing states. For this reason, the secondary threats of wildfire and drought are also carried forward for this PNVT. The insect/disease threat (with Moderate ratings) is also a function of canopy cover (density and continuity).

Tree density and states are the primary characteristics that are departed. They are denser and younger than in reference conditions.

Although not a threat to the PNVT in general because of its limited extent on the Forest where elk are present, elk browsing represents a high severity, moderate duration threat to aspen on the Williams RD and across the White Mountains – San Francisco Peaks – Mogollon Rim Section. Aspen are declining in the long term from elk pressure and perhaps climate change, along with short-term effects of droughts and diseases. Continued pressure from elk are expected to prevent recovery of aspen from short-term disturbances and substantially reduce aspen presence on Williams RD in a relatively short period.

Mixed Conifer Forests

Introduction - *Dry Mixed Conifer* and Mixed Conifer with Aspen PNVTs exist on approximately 128,000 acres on the Williams and North Kaibab Districts of the Forest and can not be separated with spatial data used in this assessment. However, a check of FIA data reveals that about 83% of the plots are in the Dry Mixed Conifer PNVT. This PNVT is used for the analysis.

These stands are generally on the north slopes of cinder cones on the Williams District and at higher elevations on the North Kaibab District. Aspen occurs in patches on the Williams District and as a near co-dominant species on the North Kaibab District. Logging has occurred mostly on the North Kaibab, although some logging did occur on Bill Williams Mountain. Logging was selective, but shelterwood and sanitation cuts have occurred.

Table 17-States and transition model for the Dry Mixed Conifer PNVT. VSS relationships are from the current forest plan.

State	Estimated Age (yrs)	Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	0 to 39	< 10%	Grass, seedling, or sapling state; or pine fir savannah (Stand Initiation)	1
B	40 to 79	10 to 30%	Young forest	2
C	80 to 119	10 to 30%	Mid-Age forest	3 – 4
D	120 to 159	10 to 30%	Mature to old forest	5 – 6
E	160 plus All ages	<32%	Mature to old forest with regeneration (Uneven aged forest)	6
F	0 to 39	> 10%	Grass, seedling, or sapling state	1
G	40 to 79	30 to 60%	Young forest	2
H	80 to 119	30 to 60%	Mid-Age forest	3 – 4
I	120 to 159	30 to 60%	Mature to old forest	5 – 6
J		30 to 60%	Uncharacteristic – presence of re-sprouting species that shortens the FRI and prevent the re-establishment of pine or fir	None

The model shown in Table 17 is the Ponderosa Pine Bunchgrass model developed by TNC. States F through J represent conditions that are found on the contemporary landscape. This model is being used because the Fire Regime for the two PNVTs is a short return interval with non-lethal fire effects (see Table 9). Fire history studies (Fulé 2003c) on the Kaibab Plateau found the same FRI in the two PNVTs and no evidence of stand replacement fire greater than 100 acres in either. Vankat found no evidence of stand replacement fire in patches larger than 240 acres, with the mean patch size of 15 acres. (Vankat 2004) Wolf and Mast (1998) reported fire return intervals of 4.9 to 10.3 years in mixed conifer prior to 1870.

State E would be the reference conditions as well as the desired condition in the current Plan under the Goshawk Guidelines. A forest in this state would consist of States A through D in patches that make up

about 100 acre stands. The canopy closure in State A would be less than 10 percent and between 10 and 30 percent in States B through D. State E is an un-even aged stand with a canopy closure of 32 percent or less. States F through J represent conditions that exist in the contemporary forest.

Without disturbance a patch would start in State A and move through States B, C, D and E until it reached a mature or old closed forest condition in State I. State F would be the starting point for stand initiation if the site soils, weather conditions and a high cone production year all coincide after a disturbance. In that case, the successional pathway would be through States G and H to reach State I.

A natural disturbance would interrupt the successional pathway. A non-lethal surface fire would maintain States A through E, sending up to 9 percent back to State A. A mixed severity fire would maintain the existing state, opening the canopy closure over 45 percent of the area and send up to 55 percent to State A. A stand replacement fire would start stand initiation, sending the entire patch to State A. Fire in the closed states (F – I) would have similar results, although less of the area would remain in the existing state because of the increased fire intensity associated with a closed canopy. Insect outbreaks would affect the successional pathway. A low intensity outbreak would maintain the current state by killing isolated trees. A moderate intensity outbreak would result in a proportion of a closed stand moving to an open state and an open stand moving to a younger state. A high intensity outbreak would result in the stand moving to state A.

Three models were considered for Dry Mixed Conifer in a manner identical to Ponderosa Pine. System responses that would be expected to differ and are not modeled would occur after a stand-replacing fire. They are the development of an aspen state across a larger portion than in Ponderosa Pine rather quickly and the development of a white fir component thereafter without a historic FRI in place. The results of the third option are in Table 16 and will be used to determine projected trends of the PNVT.

Table 18-Reference, current and projected conditions of the Dry Mixed Conifer PNVT given the current management and disturbance frequencies and assuming 9% annual natural regeneration after large stand replacement wildland fires

Kaibab NF Ecosystem Diversity Analysis																						
Dry Mixed Conifer PNVT					(State J in initial settings (Regeneration occurs after fires)																	
	Vegetation State (see description b																					
Vegetation State	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**												
Reference Condition	**0.27**	**11.23**	**20.28**	**68.23**	**0**	**0**	**0**	**0**	**0**	**0**	**Departure**	**FRCC**	**A**	**B**	**D**	**B**	**E**	**F**	**G**	**H**	**I**	**J**
Current Condition																						
North Kaibab RD 113,619.88 acres	13.48	3.08	7.03	1.79	5.51	0	7.7	46.22	10.44	4.75	87.83	3	0.3	3.1	7	1.8	0	0	0	0	0	0
Tusayan RD																						
Williams RD 14,117.84 acres	7.21	0	3.33	0.32	0	2.1	10.02	69.55	7.47	0	96.08	3	0.3	0	3.3	0.3	0	0	0	0	0	0
Forest 127,738 acres	12.85	2.76	6.66	1.64	4.95	0.21	7.94	48.59	10.14	4.26	88.67	3	0.3	2.8	6.7	1.6	0	0	0	0	0	0
Projected Trends -- Forest																						
20 Years	16.18	33.15	3.76	2.26	0.7	0.17	1.6	19.83	21.68	0.67	82.48	3	0.3	11	3.8	2.3	0	0	0	0	0	0
40 Years	13.19	52.59	3.11	1.53	0.2	0.32	0.05	8.53	20.42	0.06	83.86	3	0.3	11	3.1	1.5	0	0	0	0	0	0
50 Years	12.67	48.92	3.14	0.96	0.12	0.3	0.02	16.31	17.54	0.02	84.4	3	0.3	11	3.1	1	0	0	0	0	0	0
100 Years	13.73	43.84	5.29	0.41	0.14	0.35	0.06	24.24	11.94	0	82.8	3	0.3	11	5.3	0.4	0	0	0	0	0	0
250 Years	13.92	43.95	5.28	0.61	0.11	0.37	0.05	23.63	12.08	0	82.61	3	0.3	11	5.3	0.6	0	0	0	0	0	0
500 Years	13.51	43.79	5.31	0.53	0.09	0.35	0.08	24.78	11.56	0	82.66	3	0.3	11	5.3	0.5	0	0	0	0	0	0
1000 Years	13.3	43.41	5.08	0.68	0.08	0.23	0.05	25.04	12.13	0	82.74	3	0.3	11	5.1	0.7	0	0	0	0	0	0

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Table 19-Reference, current and projected conditions of the Dry Mixed Conifer PNVT given the current management and disturbance frequencies and assuming no natural regeneration after large stand replacement wildland fires

Kaibab NF Ecosystem Diversity Analysis																						
Dry Mixed Conifer PNVT			With State J in Initial Settings (No regeneration after fire)																			
	Vegetation State																					
Vegetation State	A	B	C	D	E	F	G	H	I	J												
Reference Condition	0.27	11.23	20.28	68.23	0	0	0	0	0	0	Departure	FRCC	A	B	C	D	E	F	G	H	I	J
Current Condition																						
North Kaibab RD 113,619.88 acres	13.48	3.08	7.03	1.79	5.51	0	7.7	46.22	10.44	4.75	87.83	3	0.27	3.08	7.03	1.79	0	0	0	0	0	0
Tusayan RD																						
Williams RD 14,117.84 acres	7.21	0	3.33	0.32	0	2.1	10.02	69.55	7.47	0	96.08	3	0.27	0	3.33	0.32	0	0	0	0	0	0
Forest 127,738 acres	12.85	2.76	6.66	1.64	4.95	0.21	7.94	48.59	10.14	4.26	88.67	3	0.27	2.76	6.66	1.64	0	0	0	0	0	0
Projected Trends -- Forest																						
20 Years	15.53	4.59	2.73	2.37	0.58	15.47	6.59	19.71	22.55	9.88	90.04	3	0.27	4.59	2.73	2.37	0	0	0	0	0	0
40 Years	18.25	2.8	1.04	1.43	0	23.43	7.49	7.57	22.67	15.32	94.46	3	0.27	2.8	1.04	1.43	0	0	0	0	0	0
50 Years	13.73	1.32	0.68	1.22	0	28.84	9.57	6.36	19.9	18.38	96.51	3	0.27	1.32	0.68	1.22	0	0	0	0	0	0
100 Years	13.54	2.11	0.19	0.46	0	25.57	14.24	3.93	7.89	32.07	96.97	3	0.27	2.11	0.19	0.46	0	0	0	0	0	0
250 Years	9.23	1.52	0.35	0.13	0	15.26	8.86	4.04	2.47	58.14	97.73	3	0.27	1.52	0.35	0.13	0	0	0	0	0	0
500 Years	5.02	0.71	0.15	0.06	0	7.2	4.93	1.86	1	79.07	98.81	3	0.27	0.71	0.15	0.06	0	0	0	0	0	0
1000 Years	1.76	0.32	0.11	0.02	0	3.37	2.1	0.69	0.4	91.23	99.28	3	0.27	0.32	0.11	0.02	0	0	0	0	0	0

Table 20-Reference, current and projected conditions of the Dry Mixed Conifer PNVT given the current management and disturbance frequencies and assuming 3.27% annual natural regeneration after large stand replacement wildland fires

Kaibab NF Ecosystem Diversity Analysis																						
Dry Mixed Conifer PNVT			forest option on regen after fire - probability 0.0327																			
	Vegetation State																					
Vegetation State	A	B	C	D	E	F	G	H	I	J												
Reference Condition	0.27	11.23	20.28	68.23	0	0	0	0	0	0	Departure	FRCC	A	B	C	D	E	F	G	H	I	J
Current Condition																						
North Kaibab RD 113,619.88 acres	13.48	3.08	7.03	1.79	5.51	0	7.7	46.22	10.44	4.75	87.83	3	0.3	3.1	7	1.8	0	0	0	0	0	0
Tusayan RD																						
Williams RD 14,117.84 acres	7.21	0	3.33	0.32	0	2.1	10.02	69.55	7.47	0	96.08	3	0.3	0	3.3	0.3	0	0	0	0	0	0
Forest 127,738 acres	12.85	2.76	6.66	1.64	4.95	0.21	7.94	48.59	10.14	4.26	88.67	3	0.3	2.8	6.7	1.6	0	0	0	0	0	0
Projected Trends -- Forest																						
20 Years	11.9	9.33	2.88	2.36	0.63	13.8	8.91	20.09	21.97	8.13	85.16	3	0.3	9.3	2.9	2.4	0	0	0	0	0	0
40 Years	14.52	8.72	0.99	1.42	0	22.75	11.81	7.31	21.76	10.72	88.6	3	0.3	8.7	1	1.4	0	0	0	0	0	0
50 Years	12.69	6.25	0.77	1.21	0	25.84	15.68	7.55	18.58	11.43	91.5	3	0.3	6.3	0.8	1.2	0	0	0	0	0	0
100 Years	13.11	7.71	0.89	0.5	0	26.16	20.51	7.78	8.11	15.23	90.63	3	0.3	7.7	0.9	0.5	0	0	0	0	0	0
250 Years	12.02	7.68	0.7	0.27	0	22.6	18.15	8.74	4.85	24.99	91.08	3	0.3	7.7	0.7	0.3	0	0	0	0	0	0
500 Years	10.05	6.57	0.7	0.11	0	18.99	15.4	7.68	3.79	36.71	92.35	3	0.3	6.6	0.7	0.1	0	0	0	0	0	0
1000 Years	7.98	4.79	0.46	0.18	0	14.23	11.08	5.48	2.84	52.96	94.3	3	0.3	4.8	0.5	0.2	0	0	0	0	0	0

Reference Conditions - Fire history studies (Fulé 2003c) on the Kaibab Plateau found the same FRI in the two mixed conifer PNVTs and no evidence of stand replacement fire greater than 5 acres in either. Vankat found no evidence of stand replacement fire in patches larger than 240 acres, with the mean patch size of 15 acres. (Vankat 2004) Wolf and Mast reported in 1998 fire return intervals of 4.9 to 10.3 years in mixed conifer prior to 1870. Clumps and groups consisting of states A through D at a scale of 100 acre stands to make up State E.

Current Conditions - This PNVT is outside HRV. Today's forest is younger and denser than during the reference condition. Today's forest has about 5 percent in a mature uneven aged state and only 23% of the area is comprised of states that make up State E. The other 72 percent of the PNVT is occupied by stands with a canopy closure greater than 30 percent. Human disturbance occurs in the form of actions designed to move a patch or stand towards the desired condition (State E). These management actions would mostly be thinning smaller trees that are under older trees. In some cases logging of larger trees is desirable if there is a lack of States A – C.

Wildland fires within the Dry Mixed Conifer PNVT have been suppressed. There is no evidence of stand replacement fire occurring at a scale greater than 100 acres during the reference period even though the mixed conifer has a large aspen component (Lang & Stewart 1910, Fulé 2003b). Large (> 500 acres) stand replacement fires started occurring on the forest in the 1960s (Saddle Mountain, Point, Demotte). Since 1995 approximately 11,420 acres of stand replacement fire have occurred within the PNVT (9 percent of the PNVT) (Pumpkin, Warm, Outlet, others).

Outbreaks of western spruce budworm, Douglas fir beetle, or fir engraver occur on about a 15 year interval, a shorter interval than prior to 1950. Outbreaks of insects consist of spruce budworm attacks that stress trees after periods of increased moisture and fir beetle or fir engraver that seek out weakened trees during droughts. The two events seem to be related (Lynch 2007).

Stand improvement treatments, like thinning, occur on about 1,000 acres per year. Timber harvest does occur, usually in the form of thinning from below, sanitation cuts in diseased areas, or harvests designed to replicate the natural clumping of trees and age classes outlined in the Goshawk Guidelines.

Managed and unmanaged grazing does occur in this PNVT. Managed livestock grazing occurs in the PNVT under permit. The numbers, timing, and amount of grass/shrub utilization are managed. Un-managed grazing occurs by elk, deer, and bison. The numbers, timing, and amount of grass/shrub utilization are beyond the control of the Forest. Both motorized and non-motorized recreation occurs. Organized and dispersed camping occurs. There are rock quarries and utility corridors within this PNVT.

Cheatgrass and bull thistle occupy up to 1 percent of this PNVT, mostly along roads. Areas with large wildland fires can have extensive populations of invasive weeds.

Projected Trends - Model results show that reference conditions will not be achieved at any future time period. Because of the current frequency of stand replacement fire, more than 10 percent of the forest will be in State A during the next 250 years, while 45 to 55 percent of the forest will be in states with dense forest (States G, H, & I). The rest of the forest would be in an uncharacteristic state that does not easily regenerate after fires due to increases in soil temperatures and decreases in soil moisture. This condition would perpetuate the modern frequency of stand replacement fire instead of the historic pattern of lower intensity surface fires.

Threats/Risk Assessment Results - The primary threat to this PNVT is the lack of fire disturbance. Because of that, canopy cover is denser and more continuous across States. When fires occur now, they carry a significant risk of a negative outcome, further departing states and species composition. For this reason, the secondary threats of wildfire and drought are also carried forward for this PNVT. The insect/disease threat (with Moderate ratings) is also a function of canopy cover and species composition shifts.

Tree density and species relative abundance are the primary characteristics that are departed. Older tree states are also missing in some cases, but in others they are present but masked by the overabundance of younger trees.

Although not a threat to the PNVT in general because of its limited extent on the Forest where elk are present, elk browsing represents a high severity, moderate duration threat to aspen on the Williams RD and across the White Mountains – San Francisco Peaks – Mogollon Rim Section. Aspen are declining in

the long term from elk pressure and perhaps climate change, along with short-term effects of droughts and diseases. Continued pressures from elk are expected to prevent recovery of aspen from short-term disturbances and substantially reduce aspen presence on Williams RD in a relatively short period.

Sagebrush Shrublands

Introduction - The sagebrush Shrublands PNVT covers about 88,715 acres on The North Kaibab and Tusayan RD's. One would also expect to see this PNVT on the Williams RD, but none is mapped. It occurs mostly in drainage bottoms, but occurs on a broad flat plain above Marble Canyon and on slopes near the Upper Basin and Little Mountain. The area is within GA's 1, 3, 8, 11, 12, 16, and 19 in the current Forest Plan. General Desired Conditions in the plan call for created openings to be less than four acres in size, unless the opening is being created for wildlife habitat. Other Desired Conditions are to provide at least 40 percent cover for wildlife, provide both thermal and hiding cover, and maintain a cover forage ratio of at least 40:60.

Table 21-States and transition model for the Sagebrush PNVT from the LANDFIRE Model 251064

State	Estimated Age (yrs)	Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	0 to 24	< 5%	Scattered sagebrush and grasses recovering from fire. Little litter	N/A
B	25 to 120	6 to 20%	Mature grass with mid-seral shrubs	N/A
C	120 plus	> 20 %	Late seral mixture of herbaceous and shrub vegetation	N/A
D	All ages	All	Uncharacteristic state due to the presence of invasive grasses or shrubs that shorten the FRI or out competes native grasses	N/A
E	All ages	All	Type conversion to crested wheat grass.	N/A

Table 22-Reference conditions are from LANDFIRE Model 251064. There are no desired conditions for this PNVT in the current plan. Current Conditions from Mid-scale Vegetation Data.

	Ecosystem Characteristic -- Vegetation State				
Vegetation State	A	B	C	D	E
Reference Condition	10	70	20	0	0
Current Plan Desired Conditions					
Current Condition	1.37	15.56	43.69	20.01*	13.35

* estimated from Invasive Plants Report – Mid-scale proportions of State B, C and D are reduced by 4.5% each.

A stand replacement wildland fire would transition a stand to State A. Without disturbance it would transition to State B. Mixed severity fire (every 120 years) would maintain a stand in this state. Stand replacement wildland fire occurs in State C with a FRI of 200 years.

Reference Conditions - Young sage with a shrub cover of less than 20 percent. Grass and forbs are abundant. Historic FRI of 120 years with mixed severity fire effects.

Current Conditions - Wildland fires do occur in this PNVT. Bridger Knoll is the largest, but fires less than 10 acres have occurred. These fires have all been suppressed. Historically, mixed severity fire burned at a frequency of 75 to 140 years. Stand replacement fires accounted for 33 percent of all fires and burned every 100 to 240 years. A total of 99 acres of this PNVT have burned as parts of large wildland fires since 1950. About 640 acres of this PNVT are mowed every decade.

Some areas of sagebrush have been type converted to grasses on both districts. Sage is re-establishing itself in these plantings. Some mowing of sage is occurring on the Tusayan District to convert areas to grasslands.

Invasive plants occur on more than 7,000 acres of this PNVT (20 percent). Cheatgrass is the most common invasive. Thistles and Dalmatian toadflax are also present. Roads exist in this PNVT, both in valley bottoms and on flats. There are earthen tanks in valley bottoms to provide water for wildlife and livestock.

State E does exist in the sagebrush shrubland across the Forest. It is estimated that about 13 percent of the area in State A may have been converted to crested wheat grass. Today's shrubland is more mature and closed than during the reference period. Invasive plants are more pervasive. Cheatgrass readily expands in recently burned areas if not mitigated (Bridger Knoll 1996, Pumpkin 1996). PJ encroaches into the PNVT; approximately 7 percent of the area in State C has a PJ canopy cover of 10 percent or greater.

Projected Trends - These trends can be expected to continue under the current natural and management disturbance frequencies. At the current occurrence of mixed severity fire frequency the entire PNVT will burn only every 2,500 years. Under the current occurrence of stand replacement fire frequency the entire PNVT will burn only every 1,425 years.

Threats/Risk Assessment Results - The primary threats to this PNVT are the combination of lack of fire disturbance, limiting nutrient cycling (and perhaps seed germination), and closed shrub states becoming more common with juniper encroaching – creating larger areas susceptible to single stand-replacing events. A continued departure is forecast. Severe elk pressure on native shrubs, including sensitive species has been demonstrated but is beyond FS authority to address. Also contributing to this is a secondary threat from bison (an exotic wildlife species) herbivory. Fire disturbance at this point may lead to some negative outcomes for species composition, including reduced presence of Wyoming sagebrush. An increase in invasive plant presence after wildfire is a moderate risk.

Montane Grasslands

Introduction - There are approximately 41,000 acres of this PNVT on the Forest located on all three districts. Areas of montane grasslands vary from small patches (<10 acres) surrounded by conifer forest or large landscape size areas (Demotte Park, Garland Prairie, Government Prairie, and Pleasant Valley are several 1000 acres each). Smaller patches can be circular in shape and coincide with small sinkhole features or long and narrow and coincide with valley bottoms. The PNVT exists on all three RDs, but is limited in extent on the Tusayan District.

Montane grasslands exist with EMAs 2, 10, 13, and 7. Desired Conditions in the current Plan are to maintain existing openings, create additional openings with a high forb composition and to provide one permanent water source per 640 acres. Garland Prairie is a proposed Research Natural Area. Desired conditions for Garland Prairie are to protect the area from activities that directly or indirectly modify ecological processes.

Table 23-SW Region state and transition model for Montane Grassland PNVT

State	Age (yrs)	Herbaceous Cover/Canopy Cover	Description	Vegetative Structural Stage (VSS)
A	0 to 2	< 30%	Young grass recovering from fire. Little litter	N/A
B	3 to 43	30 to 60%	Mid Development	N/A
C	44 to 84	>70%	Late Development	N/A
D	All Ages	30 to 60%	Invaded species dominate	N/A
E	>43	>10% CC	Tree Encroachment	N/A

Table 24-Reference conditions from LANDFIRE BPS 1511460 Model. No desired conditions are given in the current Plan. Current conditions from Mid-Scale vegetation data.

Ecosystem Characteristic -- Vegetation State						
Vegetation State	A	B	C	D	E	**Departure**
Reference Condition	20	30	50	0	0	
Plan Desired Condition						
Current Condition	1.5	2.8	84.9	2.8	8.1	45.7

Using the Mid-scale data it is difficult to place grasses into states. Data that showed the existence of conifers or shrubs was placed in State E. Most other data that showed the composition to be herbaceous was placed into State C because of the lack of fire occurrence.

Reference Conditions - Wildland fire would occur in the form of a surface fire. Grass vegetation is considered to be fire regime II because the historic FRI was less than 35 years and the fire burned the overstory, in this case grasses. It has been documented that post fire cover is less than pre-fire conditions, but that cover returns close to pre-fire conditions within a few years (Johnson 1998). Encroachment by conifers would move a meadow to State E. Fires that burn in that state may burn hotter and damage soils and slow the return to near pre-fire cover conditions. Downed logs that burn during a wildfire tend to create areas of damaged soils under and near the logs. Meadows that become infested by annual grasses tend to burn more frequently than historically.

Current Conditions - Wildland fires do occur in this PNVT. They start both within the PNVT and in other PNVTs and spread into the grasslands (Demotte, Point, and Pumpkin fires). Most fires within this PNVT have been suppressed. Since 2003 several fires have been managed for resource benefits on the Tusayan District that have spread through or around the montane grasslands. The 2006 Warm fire on the North Kaibab District mostly burned around the montane grasslands and did not burn invading conifers.

Invasive plants have infested approximately one percent of the PNVT. Species include Dalmatian toadflax and cheatgrass.

There are no known events where insects have affected montane grasslands. Mormon crickets have been seen in Pleasant Valley and Demotte Park.

Roads and trails exist within this PNVT, although efforts have been made to close unnecessary roads in the past. Off road vehicle travel is prohibited in this PNVT but does occur. Flowers and seeds are collected from meadows. Managed and unmanaged grazing does occur throughout this PNVT. Livestock graze under permit during the summer. They generally do not enter the meadows until after the spring cool season growing period. Deer, elk, and sometimes bison graze in the meadows. In both cases use is more extensive in the narrower meadows.

Meadows are being invaded by conifer species. It has been estimated that encroachment is occurring an average rate of 12 to 16 feet per decade. Encroachment rates are faster during wet periods and slower during dry periods (Moore and Huffman 2004). Many narrower meadows surrounded by ponderosa pine have a high numbers of pine seedlings within them (estimated 20 to 50 seedlings per acre in the Mile-and-a-Half area). Garland Prairie has young conifer encroachment that extends 0.25 miles into the PNVT.

Projected Trends - Conifer encroachment is expected to continue given the current disturbance frequencies. The PNVT will continue to move away from reference conditions.

Threats/Risk Assessment Results – The primary threat to this PNVT is the lack of fire disturbance, limiting nutrient cycling and perhaps seed germination. Past ungulate pressure and perhaps current ungulate pressure may also play a substantial role, especially unmanaged grazing. Closed shrub states are becoming more common; pine and juniper also are encroaching. A continued departure is forecast. Fire disturbance at this point may lead to some negative outcomes for species composition toward invasive plants but is not deemed a high risk at present.

Great Basin Grasslands

Introduction - There are approximately 44,000 acres of this PNVT on the Forest located on the Tusayan and Williams Districts. Grasslands are located in drainage bottoms and are surrounded by sagebrush or pinyon-juniper PNVTs. In some cases ponderosa pine will border the PNVT if it is on a north facing aspect. The area provides valuable winter habitat for deer, elk, antelope, and turkey.

This PNVT is in EMAs 1, 3, 8, and 9. The Double A Wild Burro Territory includes some of this PNVT on the NW corner of the Williams District. Desired conditions from the current Forest Plan are to provide forage to cover ratios of 40:60 to 60:40. There is neither a TNC Assessment nor VDDT Model for this PNVT. Table 25-Possible states and transitions for Great Basin Grassland PNVT

State	Estimated Age (yrs)	Herbaceous Cover/Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	0 to 2	< 20%	Young grass recovering from fire. Little litter	N/A
B	3 to 43	20 to 50%	Mid aged grasses and forbs	N/A
C	44 to 84	>50 %	Mature grasses	N/A
D	All ages		Uncharacteristic state due to the presence of invasive grasses or shrubs that shortens the FRI or out competes native vegetation	N/A
E	>43	>10% CC	Tree encroachment	N/A

Using the Mid-scale data it is difficult to place grasslands into states. Very few wildland fires have occurred within this PNVT to merit assigning any acres to State A. Data that showed the existence of conifers or shrubs was placed in State E. All other data that showed the composition to be herbaceous was placed into State C because of the lack of fire occurrence.

Table 26-Reference conditions from LANDFIRE BPS 2411350 Model. No desired conditions are given in the current Plan. Current conditions from Mid-scale Vegetation Data.

Ecosystem Characteristic -- Vegetation State					
Vegetation State	A	B	C	D	E
Reference Condition	5	73	20	2	
Plan Desired Condition					
Current Condition		7.09	38.2	2.4	52.3

Reference Conditions - During the reference period wildland fire would occur in the form of a surface fire. Grass vegetation is considered to be fire regime II because the historic FRI was less than 35 years and the fire burned the overstory, in this case grasses. It has been documented that post fire cover is less than pre-fire conditions, but that cover returns close to pre-fire conditions within a few years (Johnson 1998). Encroachment by trees or shrubs would move a meadow to State E. Fires that burn in that state may burn hotter and damage soils and slow the return to near pre-fire cover conditions.

Current Conditions - Wildland fires do occur in this PNVT. They are generally small at less than 10 acres. Managed and unmanaged grazing occurs. Balancing managed livestock grazing and wildlife needs so that damage does not occur is difficult. Roads exist in this PNVT. Little recreation use occurs. Some encroachment into the grasslands by shrubs and PJ occurs.

Invasive plants exist on a limited basis. Cheatgrass occurs within less than 1% of the PNVT. No known insect epidemics are known to have occurred.

Projected Trends - Grasslands will continue to move away from reference conditions. Shrub cover will become greater. Tree encroachment will accelerate.

Threats/Risk Assessment Results -The primary threat to this PNVT is the lack of fire disturbance, limiting nutrient cycling and perhaps seed germination. Closed shrub states are becoming more common and juniper also is encroaching. Past ungulate pressure and perhaps current ungulate pressure may also play a substantial role. A continued departure is forecast. Fire disturbance at this point may lead to some negative outcomes for species composition toward invasive plants but is not deemed a high risk at present.

Spruce-Fir Forest

Introduction - There are approximately 29,000 acres of this PNVT on the Forest, mostly on the North Kaibab Ranger District. This PNVT occurs in patches that are generally surrounded by Mixed Conifer Forest, Ponderosa Pine or Montane Grassland PNVTs. In the current Plan desired conditions are the Goshawk Guidelines as outlined in the Regional Amendment to the Plan in 1996. Under the Plan the proportion of states would be: State A – 10 %, State B – 10 percent, State C – 40 percent, and State D 40 percent. The maximum opening size in the current Plan is 2 acres.

Reference Conditions – Fulé (2003b) reported a historic FRI of 8.2 years in spruce-fir forests on the Kaibab Plateau. Stands were initiated both by fire and by other means. Stand-replacing fires appear to have been at small scales in Spruce-Fir Forest on the Kaibab Plateau (Fulé et al. 2003a; Lang and Stewart 1910; Vankat 2004). A study found that fire dates in spruce-fir often coincided with fire dates for other forest types on the Plateau. This suggests that fire may have started in ponderosa pine or mixed conifer and spread into the spruce-fir stands. Sub-stand patches were initiated both by fire and by other means. The PNVT appears to have had a structure that was quite variable of over small spatial scales and over time. (Fulé et al. 2003b)

Because of the close intermix of PNVTs (Ponderosa Pine, Mixed Conifer Forests) where Spruce-Fir Forest occurs, the frequency of fire disturbance, its historic species demographics, and its relatively low elevation; it is being modeled using the mixed conifer with aspen model developed by TNC. The historic FRI would be between those of dry mixed conifer and spruce-fir developed by TNC. (Fulé 2003a)

Without disturbance a patch would start in State A and move through States B and C until it reached a mature or old closed forest condition in State D. State E would be the starting point for stand initiation if the site soils and weather conditions do not allow for the establishment of aspen seedlings after a disturbance. In that case, the successional pathway would be through State F to reach State G.

A natural disturbance would interrupt the successional pathway. A non-lethal surface fire would maintain States A through D, sending up to 9 percent back to State A. A mixed severity fire would maintain the existing state, opening the canopy closure over 45 percent of the area and send up to 55 percent to State

A. A stand replacement fire would start stand initiation, sending the entire patch to States A or E. Fire in the closed states (E – G) would have similar results, although less of the area would remain in the existing state because of the increased fire intensity associated with a closed canopy. Insect outbreaks would affect the successional pathway. A low intensity outbreak would maintain the current state by killing isolated trees. A moderate intensity outbreak would result in a proportion of a closed stand moving to an open state and an open stand moving to a younger state. A high intensity outbreak would result in the stand moving to state A.

Table 27-States for the Spruce-Fir PNVT

State	Estimated Age (yrs)	Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	0 to 3	10 to 40%	Grass & forbs with aspen ramets, and seedlings	1
B	4 to 99	> 40%	Aspen and young forest understory	2
C	100 to 199	20 to 60%	Mid aged forest w/regeneration	3 – 4
D	200 plus	20 to 60%	Old forest w/regeneration	5 – 6
E	4 to 99	10 to 40%	Young forest with no aspen, shade intolerant conifers	2
F	100 to 199	>40%	Mid aged forest w/ regeneration	3 – 4
G	200 plus	>40%	Old forest w/ regeneration	5 – 6

Current Conditions - Human disturbance occurs in the form of actions designed to move a patch or stand towards the desired condition. These management actions are mostly thinning smaller trees that are under older trees. In some cases logging of larger trees is desirable if there is a lack of States A – C.

Wildland fires infrequently occur in this PNVT. About 215 acres of stand replacement fire has occurred since 1996 (Point and Warm fires). Most fires are suppressed at less than one/tenth acre in size.

Invasive plants are less likely to be found in this PNVT because the closed canopy restricts their establishment. Dalmatian toadflax and bull thistle are found on less than 0.10 percent of the area.

Insects and diseases affect the PNVT. When populations are at endemic levels, spruce beetle is found in individual diseased or damaged spruce. When outbreaks do occur the impacts can convert spruce-fir stands to fir dominated stands. It is difficult to identify specific outbreaks during contemporary times due to the survey methods that have been used. Field observations show that activity has occurred in areas of spruce-fir during the summer of 2003 and may be occurring again. Areas on the Dixie NF in south central Utah have been impacted heavily by spruce budworm outbreaks. There are stands where the entire population of spruce has died. Western tent caterpillar outbreaks and frost events are causing mortality in the aspen.

Managed and unmanaged grazing occurs at low levels. Some fuel wood gathering occurs. Developed and dispersed recreation does occur, mostly in the form of hunting, dispersed camping, and mountain biking on existing roads and trails. Management activities include thinning of understory and overstory trees.

Projected Trends – Modeling indicates a rapid shift from mid-aged closed (F) to an older closed state (G). This seems to be an artifact of the model, so the two states are evaluated together. In 50 years, there is little difference from the current states, with 75 percent of the area in a mature closed canopy state (F & G) versus the reference condition of 34 percent. At no point in the future would the amount of old open forest (State D) that existed under reference conditions be achieved.

Table 28 - Reference conditions from TNC Assessment for mixed conifer with 15 year FRI. Projected Trends from VDDT results using mixed conifer w/aspen model. Current Conditions from Mid-scale data.

	Ecosystem Characteristic -- Vegetation State						
Vegetation State	A	B	C	D	E	F	G
Reference Condition	0.10	3.54	12.70	27.05	21.95	15.79	18.18
Desired Conditions from current Plan	10	10	40	40			
Current Condition	1.32	5.8	6.45	1.82	9.92	69.79	4.91
Projected Trends							
20 Years	0.54	8.37	10.64	3.15	8.51	52.14	16.65
40 Years	0.51	9.66	8.99	3.1	6.83	43.6	27.31
50 Years	0.05	9.55	6.93	2.75	6.38	41.48	32.92
100 Years	0.045	9.5	4.55	3.09	6.36	28.67	47.78
250 Years	0.47	9.89	2.02	4.41	6.3	19.81	57.1
500 Years	0.53	10.08	1.63	4.16	6.69	19.19	57.72
1000 Years	0.4	9.43	1.78	4.37	7.03	18.21	58.78

Threats/Risk Assessment Results – The primary threat to this PNVT is the lack of fire disturbance. While generally counter-intuitive for this PNVT, local, peer-reviewed research (Fulé, et al. 2003) shows this type has been significantly influenced by fires in adjacent PNVTs in close proximity historically. Much of the PNVT as mapped may in fact be Ponderosa Pine or one of the Mixed Conifer Forest PNVTs. A species shift toward Engelmann spruce and corkbark fir – away from aspen, ponderosa pine and Douglas-fir – has been demonstrated. Because of that, canopy cover is denser and more continuous across States. When fires occur now, they carry a significant risk of a negative outcome, further departing states and species composition. For this reason, the secondary threats of wildfire and drought are also carried forward for this PNVT. The insect/disease threat (with Low/Moderate ratings) is also a function of canopy cover and species composition shifts.

Tree density and species relative abundance are the primary characteristics that are departed. Older tree states may also missing in some cases, but in others they are present but masked by the overabundance of younger trees.

Semi-Desert Grasslands

Introduction - The Semi-desert grassland PNVT covers about 25,000 acres on the North Kaibab District. It is located along the east slopes of Buckskin Mountain and East Little Mountain, and borders House Rock Valley. The PNVT extends south into the tributaries of South Canyon and Buck Farm Creeks. A portion of the PNVT in the flat slopes near the Buffalo Ranch may actually be a Black Sagebrush PNVT. TNC has classified this specific area as being altered, and not restorable to grassland in their Ecological and Biological Diversity of National Forests in R-3, 2006. The area is within GA 16 in the current Plan. The area provides important winter range for mule deer, and year-long habitat to antelope and bison. Desired conditions in the current plan would be improved habitat components and diversity.

Table 29-TNC States for the Semi-desert Grasslands PNVT

State	Estimated Age (yrs)	Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	0 to 2	< 10%	Young grass recovering from fire. Little litter	N/A
B	3 to 43	6 to 9%	Mature grass with some shrubs	N/A
C	44 to 84	10 to 29 %	Grass with a closed shrub overstory	N/A
D	85 plus	30 to 60%	Closed Shrub overstory with grass in the interspaces	N/A
E	All ages	All	Uncharacteristic state due to the	N/A

			presence of invasive grasses or shrubs that shortens the FRI or out competes native grasses	

Disturbance would move portions of the PNVT from one successional state to another. A wildland fire would result in the affected area moving from its current state to a younger state, usually State A, because fire would have lethal effects on all shrubs and trees. Without disturbance an area in a similar condition would move to an older state over time, until it reaches a mature condition. Grazing could interrupt the successional pathway by creating or maintaining open ground or reduction of seed source. Insects could interrupt the successional pathway. There is no documented evidence that this has happened.

Table 30-Reference condition uses the TNC 10 year FRI. Desired Conditions from the current plan & modeling results. Current conditions are derived from the Mid-scale Vegetation Data.

	Ecosystem Characteristic -- Vegetation State				
Vegetation State	A	B	C	D	E
Reference Condition	19.2	80.4	0.04	0.002	
Current Plan Desired Conditions (estimated)	20	40	30	10	
Current Condition	0	69.67	10.51	17.95	1.87
Projected Trends					
20 Years	0.09	36.56	38.81	22.73	1.81
40 Years	0.05	3.72	67.57	26.85	1.81
50 Years	0.02	2.24	57.26	38.66	1.82
100 Years	0.03	0.68	5.81	91.67	1.81
250 Years	0.04	0.66	1.71	95/75	1.84
500 Years	0.01	0.68	1.49	95.94	1.88
1000 Years	0.01	0.68	1.49	95.94	1.88

Reference Conditions - The PNVT would consist of grasses with sparse shrub density, less than 10 percent. Fire would maintain this open structure with a FRI of 2.5 to 10 years.

Current Conditions - Few wildland fires are known to have occurred within this PNVT since 1950. Only one was larger than 10 acres.

Managed livestock grazing occurs within the northern portion of this PNVT during the winter months. Unmanaged grazing occurs in the southern portion of the PNVT by bison and mule deer. Motorized and non-motorized recreation occurs. Some dispersed camping occurs. Trail maintenance and water development are the primary management activities.

Noxious weeds surveys have not been completed, but invasives are thought to occupy less than one-tenth of the area and consist of mostly of cheatgrass. The amount of Semi-desert grassland currently in State B is grossly overstated because of the contemporary lack of fire. The majority of the PNVT is currently in States C & D. Establishment of pinyon juniper and sage within these grasslands is occurring.

The PNVT is more mature and less diverse than during the reference period as seen by the proportions of the PNVT that are in States D and E.

Projected Trends - The PNVT will continue to move away from reference conditions under the current disturbance frequencies. Within 100 years the majority of the PNVT will consist of a closed shrub structure with few grasses. Invasive grasses will spread and shorten the FRI.

Threats/Risk Assessment Results - The primary threat to this PNVT is the lack of fire disturbance, limiting nutrient cycling and perhaps seed germination. Closed shrub states are becoming more common and juniper also is encroaching. A rapid departure is forecast. Contributing to this is a secondary threat

from bison (an exotic wildlife species) herbivory. Fire disturbance at this point may lead to some negative outcomes for species composition toward invasive plants but is not deemed a high risk at present.

Desert Communities

Introduction - This PNVT consists of about 13,800 acres on the North Kaibab Ranger District in Kanab and Jumpup Creeks. It is within the Kanab Creek Wilderness Area. The area has been grazed only intermittently (with unauthorized use) by livestock since 1998. This PNVT surrounds the Cottonwood/Willow Riparian PNVT.

The desired conditions, standards and guidelines for GA 13 in the current Plan apply to the area, however there are no specific components that apply to this PNVT. Portions of the PNVT area provide critical winter habitat for mule deer. Desert mountain sheep habitat is also provided.

Table 31-State and transition model for the Desert Communities PNVT from LANDFIRE Model 1511090

State	Estimated Age (yrs)	Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	0 to 2	< 10%	Young grass recovering from fire. Little litter.	N/A
B	3 to 43	6 to 9%	Mature grass with some shrubs.	N/A
C	44 to 84	10 to 29 %	Grass with a closed shrub overstory.	N/A
D	85 plus	30 to 60%	Closed Shrub overstory with grass in the interspaces.	N/A
E	All ages	All	Uncharacteristic state due to the presence of invasive grasses or shrubs that shortens the FRI or out competes native grasses.	N/A

There is no TNC Assessment or VDDT Model developed for the desert communities PNVT. Inferences about reference conditions can be drawn from the semi-desert grasslands, interior chaparral and Madrean encinal assessments.

Table 32-Reference conditions from LANDFIRE Model 1511090. Desired conditions from current plan. Current conditions are from the Mid-Scale Vegetation Data.

Ecosystem Characteristic -- Vegetation State					
Vegetation State	A	B	C	D	E
Reference Condition	5	20	75		
Plan Desired Condition	2	8	90		
Current Condition			41.96	58.04	

Mid-scale vegetation data does not delineate invasive species or an uncharacteristic state. Assuming that invasive species infestation is similar to sagebrush shrublands, approximately 15% of this PNVT is in an uncharacteristic, State E. That 15 percent would reduce the current proportions in states C, and D equally.

Reference Conditions - Widespread grasses with a shrub cover less than 30 percent.

Current Conditions - Only 10 wildland fires have occurred since the 1950s, and none of them have exceeded 10 acres. The Jump Fire started on the edge of the PNVT in 1996 and burned several thousand acres north of the PNVT. The PNVT has not been inventoried for invasive species (Phillips 2007). It is assumed that cheatgrass occupies the PNVT at a similar rate as semi-desert grasslands or the sagebrush shrublands for about 15 perecnt of the area. There is potential for tamarisk to spread outside of the riparian areas into the more mesic areas in this PNVT.

Trail maintenance occurs on an annual basis. Managed livestock grazing is allowed outside of Kanab Creek, but has not occurred since 1998.

In addition to the presence of the invasive species this PNVT is departed from the historical range of variation. This is due to the amount of the vegetation that has a closed shrub overstory and the lack of young to mature open grasses.

Projected Trends - Infill of shrubs will continue. Encroachment by pinyon juniper will occur. The cover percentage of grasses will be reduced. The amounts of State D will continue to increase. The trend away from reference conditions is expected to continue given the lack of disturbance or management activity.

Threats/Risk Assessment Results – The primary threats to this PNVT are the combination of lack of fire disturbance, leading to an increase in closed tree-shrub states and conifers encroaching – creating larger areas susceptible to single stand-replacing events. Drought plays a role in raising the risk this will occur. A continued departure is forecast. Fire disturbance at this point may lead to some negative outcomes for soils and increased invasive plants.

Gambel Oak Shrublands

Introduction - This PNVT occurs in patches totaling approximately 5,360 acres of the North Kaibab and Williams Districts.

Table 33-State and transition model for Gamble Oak Shrubland PNVT using the Madrean Pine Oak Woodland model developed by TNC.

State	Herbaceous Cover/Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	< 20%	Grasses dominate. Sprouting shrubs recover quickly.	N/A
B	20 to 70%	Mid Development Closed Grass and forbs declining	N/A
C	>50 %	Late Development - Open	N/A
D	> 70%	Late Development - Closed	N/A
E	>10% CC	Uncharacteristic state due to the presence of invasive grasses or shrubs that shortens the FRI or out competes native vegetation	N/A

Table 34-Possible reference conditions. desired conditions from current plan, and current conditions for Gambel Oak Shrubland

Ecosystem Characteristic -- Vegetation State					
Vegetation State	**A**	**B**	**C**	**D**	**E**
Reference Condition	**5**	**50**	**15**	**30**	
Plan Desired Condition					
Current Condition	**0**	**0**	**91.18**	**8.82**	**0**

Reference Conditions - The majority of the PNVT would be open enough to support an understory of grass and forbs. Younger shrubs would have little dead woody material and a historic FRI of less than 25 years.

Current Conditions - All of the PNVT consists of older plants with a high dead woody component. Fire spreads easily. In the areas with thick shrubs there is little grass cover. The PNVT is departed from reference conditions.

Projected Trends - The PNVT will continue to move away from reference conditions.

Threats/Risk Assessment Results - The primary threats to this PNVT are the combination of lack of fire disturbance, leading to an increase in closed tree-shrub states and conifers encroaching – creating larger areas susceptible to single stand-replacing events. Drought plays a role in raising the risk this will occur. A continued departure is forecast. Fire disturbance at this point may lead to some negative outcomes for soils and increased invasive plants.

Wetland/Cienega

Introduction - There are approximately 1,480 acres of Wetland/Cienega on the forest, split between the North Kaibab and Williams Districts. Most of the PNVT on the North Kaibab (Demotte Park) is likely Montane Grassland because most mapped areas lack the water sources described in the PNVT. Half of the PNVT is associated with small lakes, (Crane, Round, Grassy, Holden, Fay, Coleman, Scholz, Moritz, Raymond) that are less than an acre or two in size.

Table 35-SW Region state and transition model for Wetland/Cienega PNVT

State	Age (yrs)	Herbaceous Cover/Canopy Cover	Description	Vegetative Structural Stage (VSS)
A	0 to 2	< 30%	Young grass recovering from fire. Little litter	N/A
B	3 to 43	30 to 60%	Mid Development	N/A
C	44 to 84	>70%	Late Development	N/A
D	All Ages	30 to 60%	Invaded species dominate	N/A
E	>43	>10% CC	Tree Encroachment	N/A

Table 36-Reference conditions from LANDFIRE BPS 1511460 Model. No desired conditions listed in the current Plan. Current conditions from Mid-scale vegetation data.

Ecosystem Characteristic -- Vegetation State					
Vegetation State	A	B	C	D	E
Reference Condition	5	80	13	2	
Plan Desired Condition					
Current Condition	0	89.07	3.04	0.57	7.33

Using the Mid-scale data it is difficult to place grasses into states. Data that showed the existence of conifers or shrubs was placed in State E. All other data that showed the composition to be herbaceous was placed into State B or C because of the lack of fire occurrence.

Encroachment by conifers would move a meadow to State E. Fires that burn in that state may burn hotter and damage soils and slow the return to near pre-fire cover conditions. Downed logs that burn during a wildfire tend to create areas of damaged soils under and near the logs. Meadows that become infested by annual grasses tend to burn more frequently than historically.

Reference Conditions - Wildland fire would occur in the form of a surface fire. Grass vegetation is considered to be fire regime II because the historic FRI was less than 35 years and the fire burned the overstory, in this case grasses. It has been documented that post fire cover is less than pre-fire conditions, but that cover returns close to pre-fire conditions within a few years (Johnson 1998).

Current Conditions - Wildland fires of limited extent occur in this PNVT, starting in others and spreading into this one. Most fires within this PNVT have been suppressed. Since 2003 several fires have been managed for resource benefits on the Tusayan District that have spread through or around wetland/cienegas. The 2006 Warm fire on the North Kaibab District mostly burned around Crane Lake and did not burn invading conifers.

Invasive plants have infested at approximately the same rate as in the montane grasslands - less than 1% or about 15 acres.

There are no known events where insects have changed wetland/cienega states. Mormon crickets have been seen in Pleasant Valley and Demotte Park.

Roads and trails exist within this PNVT, although efforts have been made to close unnecessary roads in the past. Off road vehicle travel is prohibited in this PNVT but does occur. Flowers and seeds are collected from meadows. Managed and unmanaged grazing does occur throughout this PNVT. Livestock graze under permit during the summer. They generally do not enter the meadows until after the spring cool season growing period. Deer, elk, and sometimes bison graze in the meadows. In both cases use is more extensive in the narrower meadows.

Meadows are being invaded by conifer species. It has been estimated that encroachment is occurring at an average rate of 12 to 16 feet per decade. Encroachment rates are faster during wet periods and slower during dry periods (Moore and Huffman 2004). Many narrower meadows surrounded by forests have a high numbers of seedlings within them. As conifers move into adjacent grasslands, wetland/cienegas may become dewatered, allowing conifers to encroach into this PNVT, as well.

Periods of dry winters and dry summers do occur.

Projected Trends - The PNVT is near reference conditions, but trending away. There are no young grasses and about 7 percent of the PNVT has encroaching conifer trees. Under the current management and disturbance frequency this trend away from reference conditions is expected to continue, albeit at a slow pace.

Threats/Risk Assessment Results - The primary threat to this PNVT is the lack of fire disturbance, limiting nutrient cycling and perhaps seed germination. Adjacent forest/woodland species are encroaching. Contributing to this is a secondary threat from drought. Tree encroachment and tree density of adjacent PNVTs serve to lower water input and flow in this system. A slow departure is forecast. Fire disturbance at this point may lead to some negative outcomes for species composition toward invasive plants and is deemed a moderate risk at present.

Cottonwood Willow Riparian Forest

Introduction - This PNVT consists of about 1,200 acres on the North Kaibab District in Kanab Creek. It extends is from the confluence of Kanab Creek and Slide Creek on the north to the Grand Canyon National Park on the south. Side canyons to the east that have intermittent water flow contribute about 25 percent of the PNVT area.

The area is within Geographic Area (GA) 13 in the current Plan. Desired conditions in the current Plan call for maintaining three or more age classes of woody riparian species with 10 percent of the area in early seral states. Other desired conditions are to maintain not less than 90 percent of the potential shrub cover in riparian areas and to maintain 90 percent of the stream bank in stable condition.

Table 37 - State and transition model for Cottonwood Willow Riparian Forest PNVT from LANDFIRE Model 1511550

State	Estimated Age (yrs)	Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	0 to 4	< 10%	Young grass and shrubs. Some tree sprouts. Little litter.	N/A
B	5 to 29	10 to 30%	Grasses, shrubs, and saplings.	N/A
C	30 to 49	10 to 30%	Young cottonwood and willow.	N/A
D	50 plus	30 to 60%	Mature cottonwood and willow.	N/A
E	All ages	All	Uncharacteristic state due to the presence of invasive grasses, shrubs or trees whose presence shortens the FRI or displaces native tree species.	N/A

There is neither a TNC Assessment nor VDDT Model for this PNVT, so a surrogate was developed and displayed below. This is intended to provide conditions that would be likely to sustain native populations of plants, and animals with the exception of those that require perennial water. The perennial water flow, if present historically, has been lost due to upstream water impoundments outside of the Forest.

Table 38 - Reference conditions from LANDFIRE Model 1511550 for the desert riparian biophysical setting. Desired conditions from the current Plan. Current conditions from the Mid-Scale Vegetation Data.

Ecosystem Characteristic -- Vegetation State					
Vegetation State	A	B	C	D	E
Reference Condition	20	25	35	20	0
Plan Desired Condition	10	10	10	70	0
Current Condition	0	0	6.87	1.03	92.10

Reference Conditions - The reference condition of this PNVT includes 55 percent of the type in mid-aged to mature cottonwood and willow trees and 20 percent in grass, shrubs and tree sprouts. This implies a historic disturbance interval of about 60 years for stand-replacement floods or fires and about 30 years for mixed severity floods or fires. The natural role of fire in the system is not readily apparent and is probably highly variable. The adjacent Desert Communities PNVT would have experienced little or no fire. This PNVT was intensively used by native peoples, but the relative impact of their activities on this system are unknown.

Floods or wildland fire would result in the affected area moving from its current state to a more open or a younger state. Spring floods, timed with seedfall of cottonwood, temporarily raise the water table and are critical for regeneration of this species. Without disturbance older states develop until a mature condition (State D) is reached. .

Current Conditions - Although Kanab Creek is listed as a perennial stream, water flow has been limited to after significant winter snowmelt and rain events since the early 1900s due to water impoundments upstream. Field observations in 2008 indicate recent flooding sufficient to uproot trees or change streambank morphology, but appears to be of small scale (< 1 acre) and relatively infrequent. No large fires have occurred in this PNVT since the 1950's. The area was grazed by livestock during the winter

months until 1998. The Decision Notice for the Kane Ranch Grazing Allotment excluded Kanab Creek from grazing in 2000. Unpermitted livestock and evidence of them from the previous year was noted in 2008. This is an occasional recurring event. No management activities occur other than some trail maintenance.

The majority of the PNVT is in an uncharacteristic state, with willows nearly absent, very few large old cottonwoods, and an abundance of tamarisk and Russian olive (Phillips 2007). Within Kanab Creek there are only 5 to 10 large cottonwood trees per mile of stream. Seep willow (*Baccharis salicifolia*) is abundant where riparian vegetation is present. Herbaceous cover is uncommon.

Projected Trends - This PNVT is at high risk due to the invasion of tamarisk, and, to some degree, Russian olive. Kanab Creek extends to the south through the Park until it joins the Colorado River. The portion of this PNVT that is in the Park has the same threat.

The PNVT is also at high risk due to the lack of year round water flow and flooding disturbance. This is the result of water impoundments that occur more than 20 miles upstream, and the increased presence of juniper and tamarisk in or near Kanab Creek and its tributaries.

While cottonwood and willow species reestablish following spring floods, tamarisk may be better adapted to post-disturbance (both floods and fires) environments than native species. It appears to be more tolerant of both droughts and floods than native willows. The ability of tamarisk to tolerate high levels of soil salinity may also favor it in the post-fire environment, as soil salinity tends to increase after fire. Tamarisk may increase fire frequency and is likely to persist following fire and expand its dominance with repeated burning of low-elevation riparian plant communities. It also raises the salinity of the soil surface to a range that is toxic to native cottonwoods.

Many sites along southwestern river systems are characterized by tamarisk communities with halophytic, fire-tolerant shrubs (e.g. big saltbrush and arrowweed) as co-dominants, with only senescent individuals of the historically dominant cottonwood and willow remaining. It has been suggested that cottonwood is nearing localized extinction on many riverine systems of the desert Southwest

[44, 45,81,212,231]. (Fire Effects Information System, http://www.fs.fed.us/database/feis/plants/tree/tamspp/all.html#FIRE%20ECOLOGY) (http://www.coopext.colostate.edu/TRA/PLANTS/index.html#http://www.coopext.colostate.edu/TRA/tamarisk.html)

Threats/Risk Assessment Results - The primary threat within FS control in this PNVT is posed by the nearly continuous cover of tamarisk, and, to some degree, Russian-olive. It is possible, if logistically difficult to reduce the presence of these species and keep them reduced through various management efforts. Biological controls are being developed which may be more effective in time.

CURRENT PLAN DESIRED CONDITIONS

The desired conditions for the current Plan are shown in the table below by cover type. There is a relationship but not a complete crosswalk between cover type and PNVT.

Table 39 - Comparison of existing condition, trends and desired conditions from the current plan

Habitat Component	Existing Condition & Trends (From TNC Report, personal observation, Fulé' Studies)	Desired Conditions from Current Forest Plan
PJ Woodland	More homogenous than HRV. Invasive species present. Some PJ Grasslands and PJ Shrublands have converted to Persistent woodlands.	Uneven aged. Forage for wildlife and livestock present.
Ponderosa Pine	Relative to historic conditions: Forest structure includes multiple canopy layers that act as ladder fuels, leading to intense crown fires. Surface fuel loading resembles a timber litter or slash fuel model instead of a shaded grass fuel model. Fuel loading of needle litter exceeds that of grasses. Herbaceous understory is not as diverse and continuous. Forest is more susceptible to insect outbreaks Dwarf-mistletoe is more prevalent.. PNVT has been encroached by PJ and oak at the lower elevations and shade-tolerant conifers at the higher elevations. Current t/a 293 – 317 Historic t/a 25 – 136 Current ba 150 – 153 Historic ba 33 – 58 Mesic PIPO sites have more ABCO, ABLA, & PIEN and less PIPO & PSME. Dry PIPO sites have more PSME and less PIFL.	Forest has a structure of grouped trees and is uneven-aged, (openings and even-aged groups < 4 acres). Each site, landscape, GA has the following distribution of vegetation structural stages: VSS Size Description % Area 1 Opening/Seedling 7% to 13% 2 Seedling/Sapling (<5" dbh) 7% to 13% 3 Poles (5 - 12" dbh) 17% to 23% 4 Immature (12 to 18" dbh) 17% to 23% 5 Mature (18 to 24" dbh 17% to 23% 6 Old (> 24") 17% to 23% Site density varies according habitat use: Goshawk PFA, FA, Nest Site. The minimum average densities for VSS 4 - 6 are: Habitat VSS Canopy Density PP-FA 4-6 40+% PP-PFA 4 60+% (1/3) 50+% (2/3) PP-FA 5-6 50+% PP-NA 5-6 60 - 70% Also, 2 snags and downed logs per acre. Total fuel loading of 5 - 7 tons per acre. Old growth function exists on at least 20% of the naturally forested area by forest type in any landscape. A sustained level of owl nest/roost habitat well distributed across the landscape in restricted areas (minimum of 15% of the pine/oak restricted habitat) is present.
Mixed Conifer	Relative to historic conditions: Continuous forest with little change in stand structure or age over space. Larger proportion of white fir and Douglas fir. More canopy layers with a continuous even aged overstory. Fire extent is larger and more intense .	A sustained level of owl nest/roost habitat well distributed across the landscape in restricted areas (minimum of 25% of the restricted habitat) is present. Natural disturbance patterns are mimicked in tree spacing and patch sizes. All species of native trees on the landscape including early seral species are present. Natural canopy gap processes produce horizontal

Habitat Component	Existing Condition & Trends (From TNC Report, personal observation, Fulé' Studies)	Desired Conditions from Current Forest Plan
	Current t/a 332 – 354 Historic t/a 65 – 98 Current ba 169 – 197 Historic ba 76 – 78 More ABCO and PIEN and less PIPO, PIFL & PSME in both mesic and dry sites.	variation in stand structure. Forest has a structure of grouped trees and is uneven-aged, (openings and even-aged groups < 4 acres). Each site, landscape, GA has the distribution of vegetation structural stages shown in Ponderosa Pine. Site density varies according habitat use: Goshawk PFA, FA, Nest Site. The minimum average densities for VSS 4 - 6 are: Habitat / VSS / Canopy Density MC-FA / 4 / 60+% (1/3); 40+% (2/3) MC-PFA / 4-6 / 60+% MC-FA / 5 / 50+% MC-FA / 6 / 60+% MC-NA / 5-6 / 60+% Goshawk Nest Areas are all mature to old forest stands, making up at least 180 acres per territory. Non-uniform spacing of trees and clumpiness exists. Also, 3 snags, 5 downed logs, and 10-15 tons of woody debris per acre. Maximum opening size is up to 4 acres.
Sagebrush Shrubland	Encroachment by Juniper. Established invasive annuals.	Forage for wildlife and livestock is present.
Spruce-fir	Relative to historic conditions: Canopy closure is higher and patch size is larger than in the past, so wildfires may replace larger patches. Aspen dominance in patches is reduced. Fuel loading, surface fuels and ladder fuels, is higher. Stands are more susceptible to root disease infection and insect outbreaks.	Forest has a structure of grouped trees and is uneven-aged, (openings and even-aged groups < 4 acres). Each site, landscape, GA has the distribution of vegetation structural stages shown in Ponerosa Pine. Site density varies according habitat use: Goshawk PFA, FA, Nest Site. The minimum average densities for VSS 4 - 6 are: Habitat / VSS / Canopy Density SF-FA / 4 / 60+% (1/3); 40+% (2/3) SF-PFA / 4 / 60+% SF-FA / 5-6 / 60+% SF-PFA / 5-6 / 70+% SF-NA / 5-6 / 70+% Goshawk Nest Areas are all mature to old forest stands, making up at least 180 acres per territory. Non-uniform spacing of trees and clumpiness exists. Also, 3 snags, 5 downed logs, and 10-15 tons of woody debris per acre. Maximum opening size is up to 4 acres.
Grasslands	Invasive species (cheatgrass, thistles, toadflax), pine, juniper & shrubs present/encroaching and increasing. What forage is there is high quality.	Various GA's - Garland Prairie: A natural grassland condition exists. Other GA's - High quality forage present with high forb composition (25%)
Desert	Eroded streams	No desired conditions.

Habitat Component	Existing Condition & Trends (From TNC Report, personal observation, Fulé' Studies)	Desired Conditions from Current Forest Plan
Communities	Invasive species present and increasing.	
Riparian		Woody riparian communities and riparian communities dominated by shrub and herbaceous species are in satisfactory or better condition. Vegetation is characterized by at least three age classes of woody riparian species with 10% of the woody plant cover in sprouts, suckers, seedlings and saplings. In riparian areas, at least 90% of the potential shrub cover in riparian areas is present. At least 90% of the total linear miles of streambank is in stable condition.
Aspen Forest & Woodlands	Aspen occurs in small discontinuous patches ranging from one to one hundred acres in size. Clones are particularly small and scattered within the pine type on the Williams RD. Regeneration is nearly absent on the unless protected from ungulate browsing with 8 ft. fencing. Stand dominance has decreased due to conifer succession where fire return intervals have been altered. Over the past 10 years, aspen is in an accelerated state of decline from abiotic events that caused widespread overstory mortality.	Included within other PNVTs. MSO: Natural disturbance patterns are mimiced. Goshawk: Nest areas have at least 60% canopy cover. Old growth function is on at least 20 percent of the forested area.

PROJECTED TRENDS

Temporal Departure Summary

Table 40 presents a summary of the assessment of PNVT existing conditions and trends. It describes the level of departure from reference conditions of each PNVT on the Forest and the expected trend. The trend is evaluated at 50 years.

Table 40 - Temporal Departure of PNVTs on the Forest.

PNVT	Departure Percentage	Departure from Reference Condition	Projected Future Trend Under Current Plan
Pinyon Juniper Woodland	> 33%	Moderate	Static / Slowly Away
Ponderosa Pine	98%	High	Static
Mixed Conifer Forests*	88%	High	Away
Sagebrush Shrubland	59%	Moderate	Away
Montane / Subalpine Grassland	74%	High	Away
Colorado Plateau / Great Basin Grassland	55%	Moderate	Away
Spruce Fir Forest**	85%	High	Static
Semi-Desert Grassland	30%	Low	Away
Desert Communities	58%	Moderate	Away
Gambel Oak Shrubland	76%	Low	Away
Wetland/Cienega	16%	Low	Slowly Away
Cottonwood Willow Riparian Forest	92%	High	Away

* - Mixed Conifer Forest are Dry Mixed Conifer (>80%) and Mixed Conifer w/ Aspen (<20%)

** - Much (most?) of this PNVT is actually Mixed Conifer Forest, based upon recent work by Fule. For this reason, the mixed conifer with aspen VDDT model was used.

On way to evaluate ecological need for change in management is presented in Table 41. Forestwide, all PNVTs show some risk. Those with the greatestrisk have dark shading in Table 40. Those with more intermediate needs are shown in lighter shades. If the PNVT is deviated and stable, primary threats are within agency control and reversable, a trellised shading is applied.

	Liklihood:		
Severity	**Stable (no trend)**	**Trend Towards Reference Condition**	**Trend Away from Reference Condition**
Significant Deviation from Reference Conditions	**Legacy of Past Management OR Stabel deviation from ongoing activities. Evaluate system reversibility, threats.**	Risk addressed. Continue current management and identify restoration opportunities.	**Potential for high risk. Evaluate threats and reversibility.**
No Significant Deviation from Reference Conditions	No risk. Continue current management.	N/A	**Potential risk. Evaluate magnitude of future deviations, threats and reversibility.**

It is important to also consider the rate of departure for PNVTs. Those with the highest rate are:

Since most PNVTs are departed and are moving further away - or are so departed with the metrics used that they cannot depart further – there is little ability to prioritize need for change between PNVTs. Much of that process will occur when soil, water, species and spatial niche are considered in integration.

Significant Departure Characteristics, Contributing Activities and Responsive Management

PNVT	Significant Departure Characteristics	Significant Contributing Activities	Responsive Management
Pinyon Juniper Woodland	Canopy densities higher. More continuity of canopy. Invasives.	Past fire suppression and past managed grazing.	Fire suppression when crown fire risk is moderate or high across large areas. Density reduction in characteristic patterns. Weed control.
Ponderosa Pine	Canopy densities higher. More younger states.	Past fire suppression grazing and tree cutting practices. Current wildfires and drought.	Fire suppression when crown fire risk is moderate or high. Canopy density and fuels reduction in characteristic patterns. Regeneration in characteristic patterns. Retain most older trees.
Dry Mixed Conifer	Canopy densities higher. Species abundance shifts. More younger states.	Past fire suppression, grazing and tree cutting practices.	Fire suppression when crown fire risk is moderate or high. Canopy density and fuels reduction in characteristic patterns and species composition. Regeneration in characteristic patterns and species composition. Retain most older trees.
Sagebrush Shrubland	Increasing shrub density/continuity and juniper encroachment. Loss of understory species abundance and species abundance shifts.	Past fire suppression, past and current unmanaged grazing.	Reintroduce fire to reduce shrub density, recycle nutrients and control juniper encroachment. Other practices to control shrub density may be required first. Modified wildlife management (bison) and managed grazing practices may also be necessary first.
Montane / Subalpine Grassland	Increasing shrub density; pine and juniper encroachment.	Past fire suppression and past managed grazing. Current unmanaged grazing may also be a threat.	Reintroduce fire to reduce shrub density, recycle nutrients and control juniper encroachment. Other practices to control shrub density may be required first. Modified grazing practices may be necessary first, but may prove ineffective with continued pressure from elk.
Colorado Plateau / Great Basin Grassland	Increasing shrub density and juniper encroachment.	Past fire suppression and past/current ungulate grazing (managed & unmanaged).	Reintroduce fire to reduce shrub density, recycle nutrients and control juniper encroachment. Other practices to control shrub density may be required first. Modified grazing practices may be necessary first, but may prove ineffective with continued pressure from elk.

PNVT	Significant Departure Characteristics	Significant Contributing Activities	Responsive Management
Spruce Fir Forest	Canopy densities higher. More continuous dense canopy. Species abundance shifts. More younger states.	Past fire suppression, grazing and tree cutting practices.	Fire suppression when crown fire risk is high until canopy density and fuels reduction in characteristic patterns and species composition. Regeneration in characteristic patterns and species composition. Retain most older trees.
Semi-Desert Grassland	Increasing shrub density and juniper encroachment.	Past fire suppression, past and current managed/unmanaged grazing.	Reintroduce fire to reduce shrub density, recycle nutrients and control juniper encroachment. Other practices to control shrub density may be required first. Modified wildlife management (bison) and managed grazing practices may also be necessary first.
Desert Communities	Increased invasive plants. Decreased FRI. Increased shrub/juniper canopy cover.	Past managed/unmanaged herbivory. Introduction of invasive plants.	Reduce density of junipers and shrubs. Control invasive plants.
Gambel Oak Shrubland	Canopy densities higher. More continuity of canopy. Invasives.	Past fire suppression. Introduction of invasive plants.	Reintroduce fire to reduce canopy density and break up continuity, recycle nutrients and control conifer encroachment. Other practices to control density may be required first.
Wetland/Cienega	Increased tree structure/cover. Invasive plants. Decreased FRI. Decreased water flow (surface/sub-surface.)	Past fire suppression and past managed grazing. Current unmanaged grazing may also be a threat, as is motorized recreation.	Reintroduce fire to reduce tree density/encroachment. Other practices to control tree density may be required first. Reduce tree density of adjacent PNVTs. Enforce closures to motorized vehicles and repair damage.
Cottonwood Willow Riparian Forest	Loss of flooding disturbance and perennial stream. Loss of tree structure and native species diversity, especially cottonwood and willow, replaced by tamarisk and Russian-olive.	Upstream impoundments-diversions. Introduction of non-native trees/shrubs.	Control of invasive species.

While the Forest set up objectives in 1994 to manage most forested vegetation and disturbances to attain the reference conditions, the attainment of these objectives has been generally unsuccessful. A combination of existing conditions, compliance with regulations (NEPA, Clean Air Act and ESA, at least), appeals and litigation over project proposals, a lack of appropriate mill capacity, declining budgets and resultant declines in organizational capacity have all contributed to this lack of progress.

The cottonwood willow riparian forest is at high risk because of invasive shrubs.

Montane grasslands are at a high risk due to encroachment of conifer invasive and non-native vegetation.

The forested PNVTs will be continuous dense young forests. Patches will increase in size and become even-aged. Larger patches will allow natural disturbance agents to affect larger areas.

The woodland PNVTs will be homogeneous PJ woodlands that resemble the persistent type.

NEED FOR CHANGE

For ponderosa pine and mixed conifer PNVTs, the desired conditions are closer to HRV than current conditions. This is addressed in the current plan, and is probably not in need of substantial change. Desired conditions that identify opening sizes that allow for Wildland Fire Use need to be designed.

Change to include some even-aged conditions for pinyon-juniper and spruce-fir PNVTs may be needed. These systems appear to have supported stand-replacing events of several acres up to perhaps a several hundred acres. Desired condition need to reflect that the Forest has all three types of PJ, with different historic disturbance frequencies. There are likely species that benefit from these disturbances and conditions created.

More robust desired conditions for grasslands, sagebrush, oak, aspen, and riparian areas could be developed. Current Plan descriptions are sparse.

There are substantial amounts of existing vegetation that have converted from their historic vegetation type (e.g.: montane grasslands to ponderosa pine, Great Basin grasslands to sage, sage to PJ, pine to mixed conifer). A decision could to be made concerning whether these conditions are desirable and sustainable.

The desired conditions for all PNVTs need to be clarified so that the reader can envision what an area would look like after a project is completed.

Goals and Objectives should probably be developed in concert with desired conditions to maintain some realism about what may be attainable in the next 15 to 50 years.

For the forest and woodland PNVTs on the Forest, the primary major threat comes from uncharacteristic wildfire, where fuel loadings from live and dead vegetation are above historic levels. This may also pose some erosional threat to soils under grasslands invaded with trees. The following chart displays an assessment by sub-section of threat level for PNVTs subject to uncharacteristic wildfire disturbance. Threats by sub-section must be viewed with substantial caution because of apparent mistakes made in mapping them. (See Appendix 1) However two subsections group such that it may be understood the greatest area of moderate and high threats are on the Williams Ranger District (in the White Mountains - San Francisco Peaks – Mogollon Rim Section) and the next group of two sub-sections is on the North Kaibab Ranger District (in the Grand Canyon Section). The majority of the remainder is in four sub-sections on Tusayan and North Kaibab Ranger Districts.

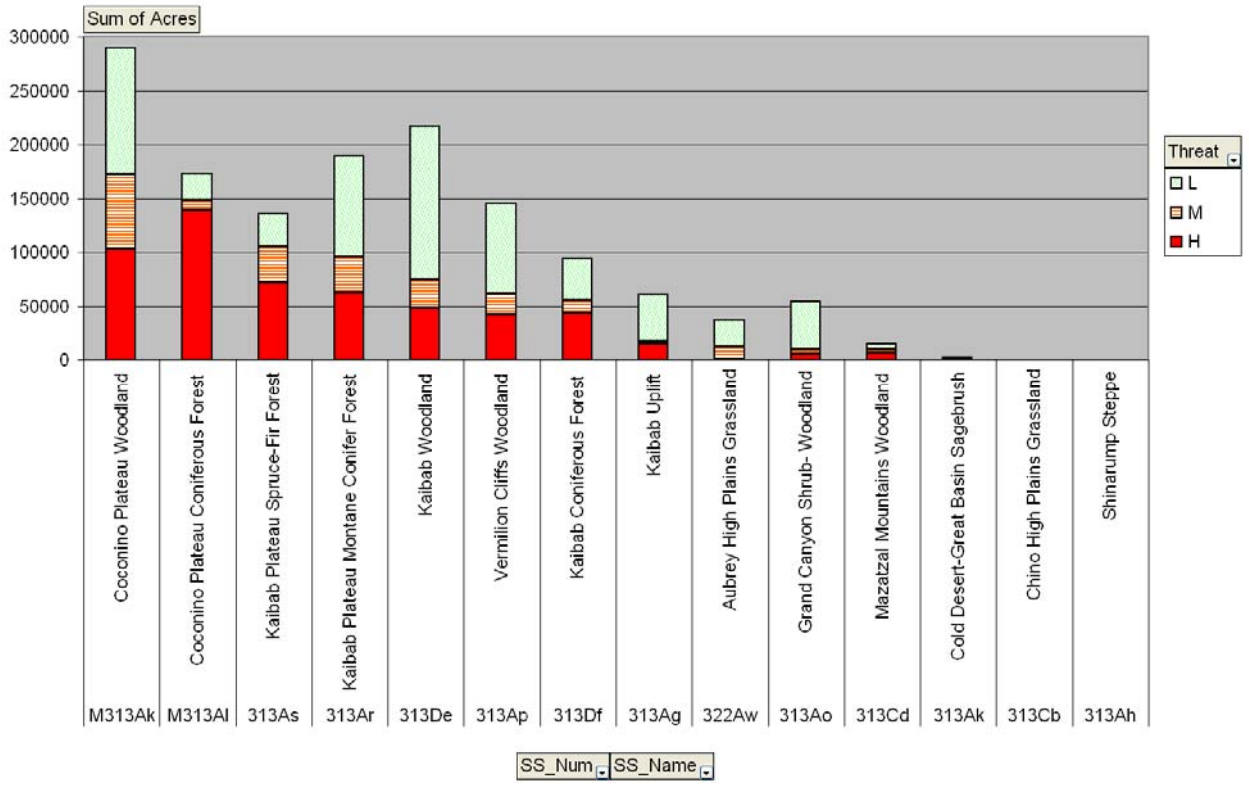

Figure 6. Acres of threat (H – High, M – Moderate, L – Low) of uncharacteristic fire by Sub-section.

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Appendix 1 – Spatial Resolution Problems with Subsections

The ecological sustainability working group product developed in the Southwestern Region to evaluate contributions to ecological sustainability in forest plans suggests a forest's contribution be evaluated at the sub-section scale. This is the next ecological scale up from the ECOMAP landtype association scale and is on par with the general ecosystem survey. It is intended to respond to physiographic and elevational characteristics of the land. However, many sub-sections are smaller than the Forest and at least the Forest spatial niche is better handled at the Section scale. Sub-sectional analysis may be useful in identifying a focus on the Forest of need for change. On the Kaibab NF, analysis of the climate classes generalized from the Terrestrial Ecosystem Survey and existing vegetation cover both indicate an issue of mapping accuracy for sub-sections crossing the Forest exists.

It appears the sub-section map is displaced approximately 7,000 meters to the east from where it was probably intended to be placed. This is consistent across all three Ranger Districts. See Figure XX+2 for the Forest and Figure XX+3 for a close-up of the North Kaibab RD. Maps developed at the sub-section scale are much less precise than those developed at smaller scales, so it would not necessarily be of concern if boundaries were generally correct. However, in this case, there is a systematic bias in the locations of many subsections. This bias is distinguishable from other mapping off the Forest – such as the Shinarump Steppe subsection where the boundary follows a physiographic-elevational break relatively closely.

This error makes significant differences for several sub-sections – raising or lowering PNVT contributions by over 40 percent. (See Figures XX and XX+1.) For example, the Kaibab Plateau Montane Conifer Forest sub-section[1] appears to have been drawn to encompass the warm, dry montane coniferous forest (LSC 5) on this Plateau between about 7000' and 8000'. Instead, only half of it is captured here, with most of the rest in the Vermillion Cliffs Woodland (west) and the Kaibab Plateau Spruce-Fir Forest, crossing the Plateau, its east side and the valley beow, with significant areas in elevations from 5400' to 8500'.

It is impracticable to fix the sub-sectional map in a timely manner for this process. However, it doesn't appear that the sub-sectional scale of analysis is necessary to adequately describe the Kaibab NF's ecological niche, nor even where on the Forest needs for change are greatest. Each Ranger District on the Forest is geographically separate and are essentially in distinct Sections, as well. An analysis combining sub-sections within a section on-Forest, while not as precise as the sub-sectional evaluation, it is substantially more accurate and can narrow the focus of need for change to the District level.

[1] Subsections, smaller areas within Sections with similar surficial geology, lithology, geomorphic process, soil groups, subregional climate, and potential natural communities. Subsection boundaries usually correspond with discrete changes in geomorphology. Names of Subsections are usually derived from geologic features, such as Plainfield sand dune, Tipton till plain, and granite hills. (Cleland, et al. 1997)

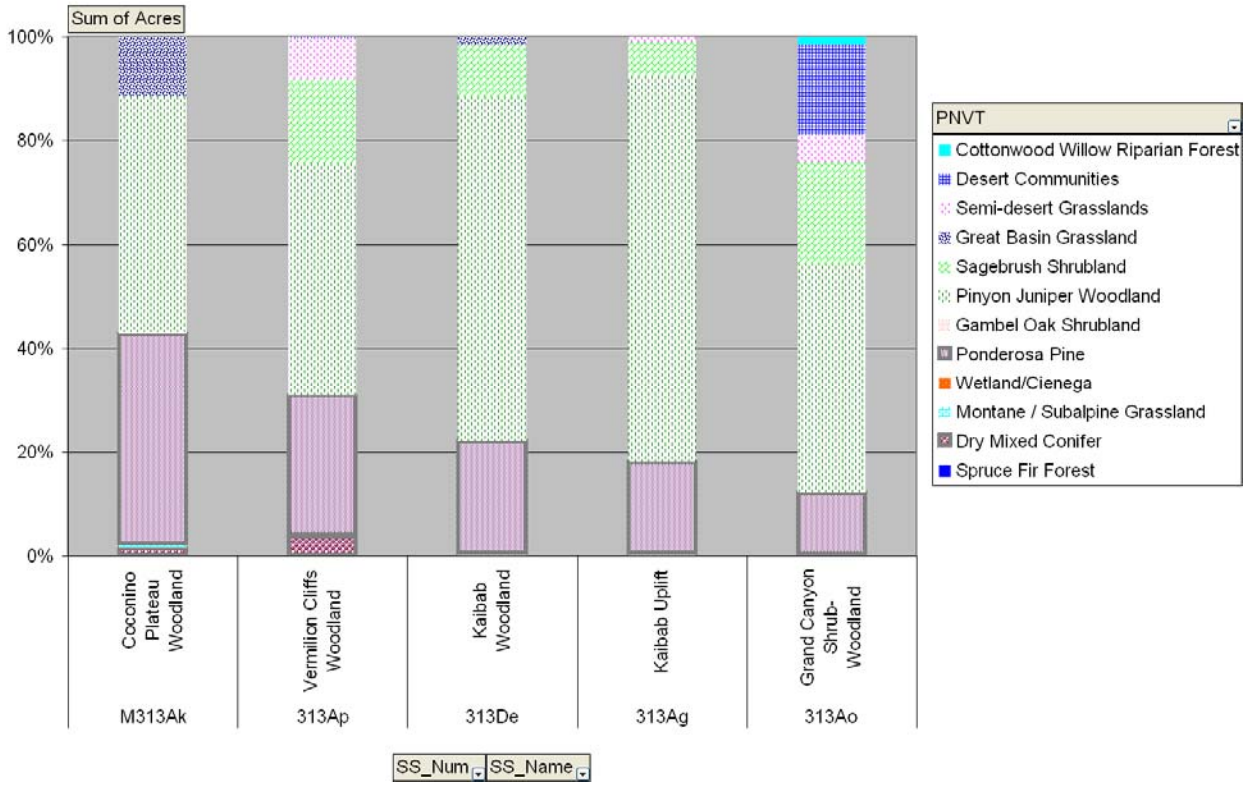

Figure XX. PNVT by "Woodland" Subsections.

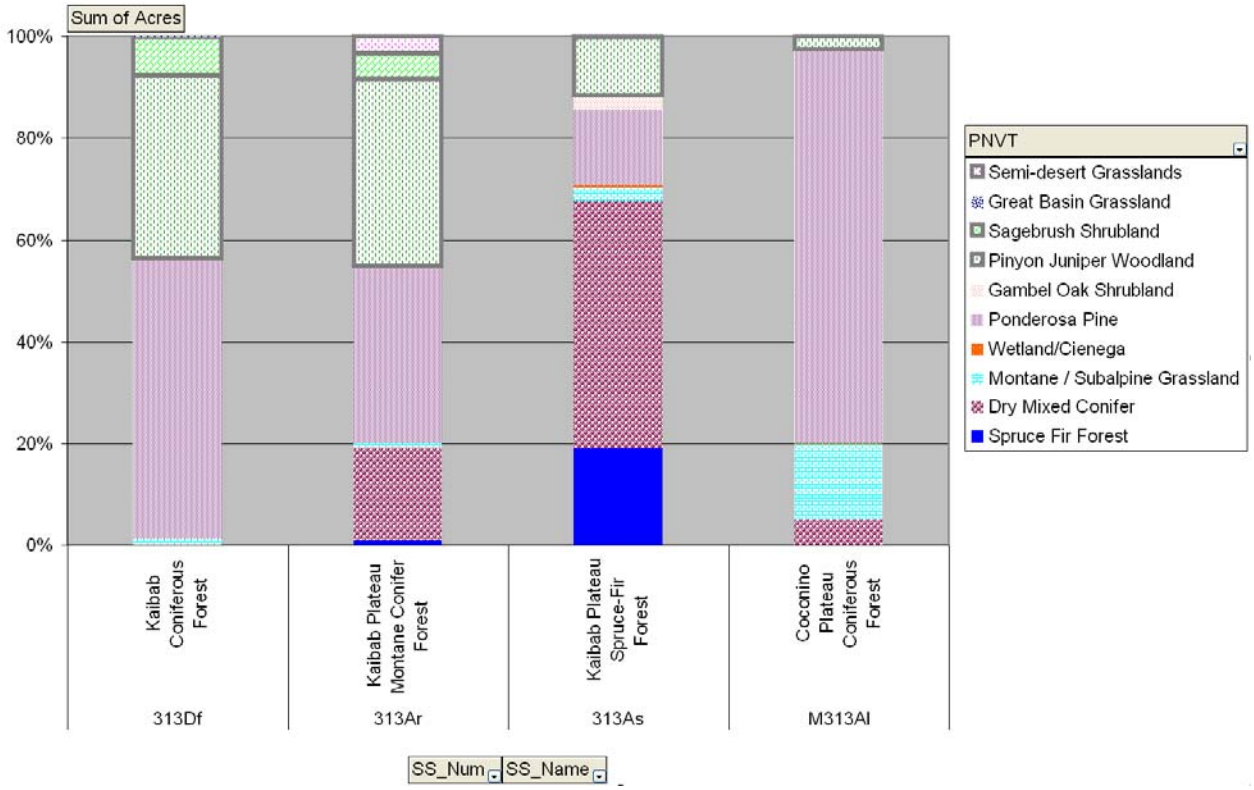

Figure XX+1. PNVT by "Forest" Subsections.

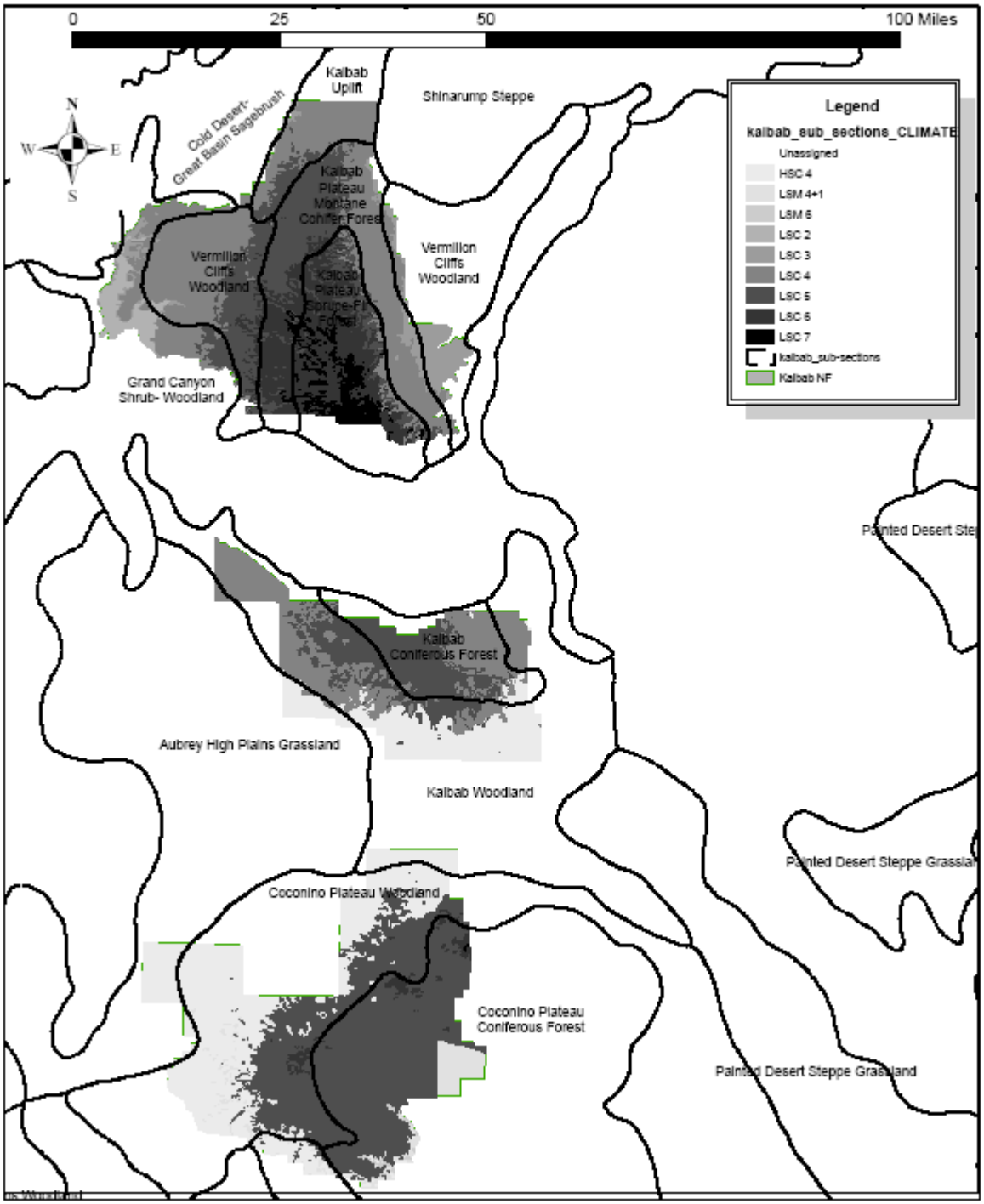

Figure XX+2. Kaibab NF, TES General Climate Classes and ECOMAP Sub-sections. Note systematic eastward (and perhaps northward) displacement of the sub-boundaries relative to climate classes.

Affected Sub-Sections, Climate Classes for North Kaibab RD

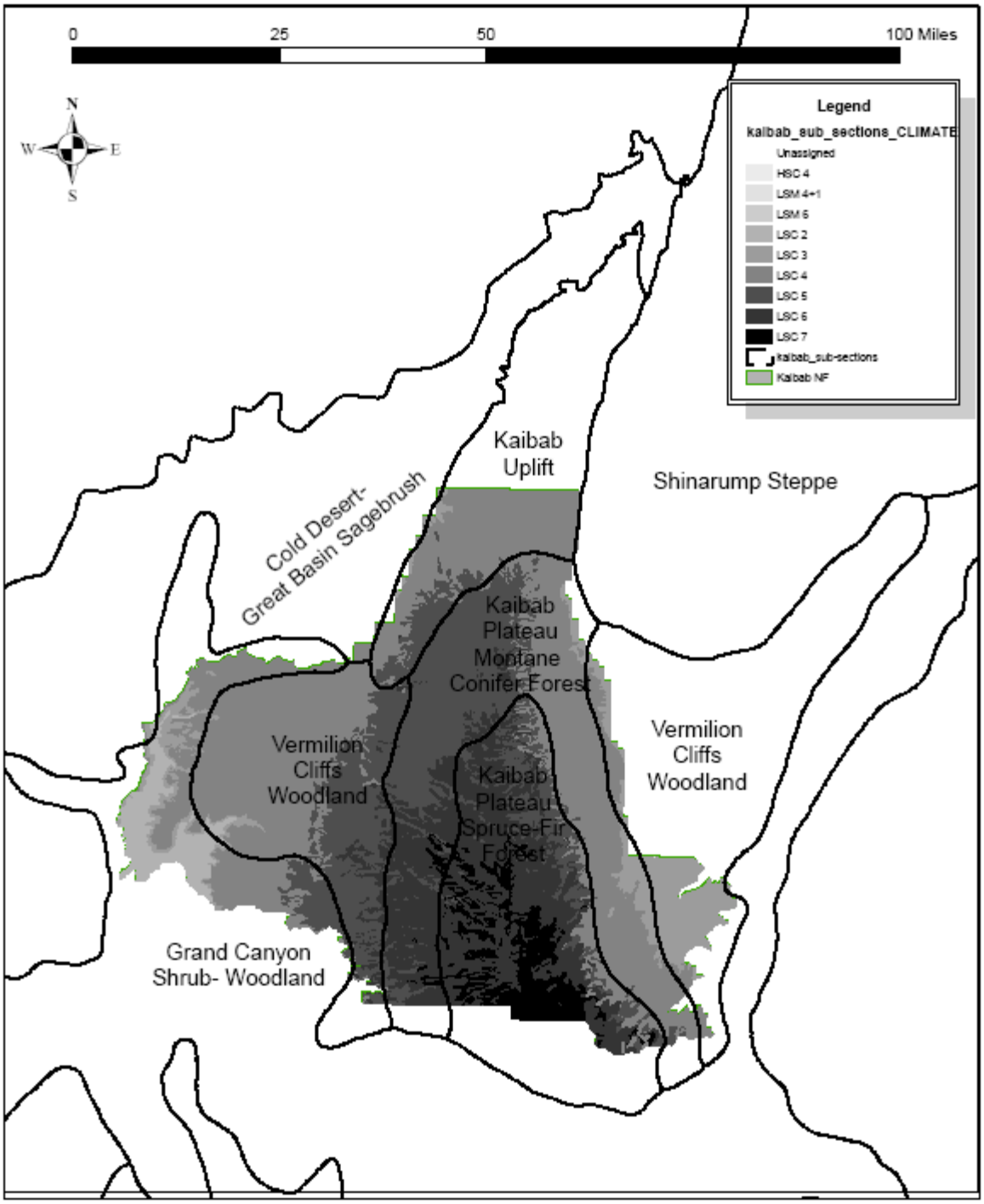

Figure XX+3. Close-up of North Kaibab RD, TES General Climate Classes and ECOMAP Sub-sections. The systematic eastward (and perhaps northward) displacement of the sub-section boundaries relative to climate classes would lead to a dilution of many PNVTs importance in at least two sub-sections.

Appendix 2 – Assigning Risk to Vegetation Structures in PNVTs.

A crosswalk of ReGAP data (off Arizona National Forests) and midscale data (on Arizona National Forests), provided by Jack Treipke was used to conduct an assessment of negative outcomes from disturbances due to the departures of PNVTs within Sections. PNVT and structure were assigned departures, as Shown in Table 41. Risk of negative outcome values used are: 0 – unevaluated; L - low - structure likely to be fairly typical of reference period and/or negative outcomes from disturbance not expected; M - medium - structure somewhat atypical - at least across 1/3 - 2/3 of the affected area and some negative outcomes expected from disturbances; and, H - high - most structure highly atypical with highly negative outcomes expected from disturbances. The ratings consider the likelihood and consequences of uncharacteristic disturbances. This often assumes that a high risk (highly departed from reference) will result in a highly negative outcome, but not always. For example, a highly uncharacteristic departure (such as tree invasion in a grassland PNVT) received an “M” or even an “L” in some cases, because the consequence of a disturbance may be likely to restore at least some natural structure and function, barring non-native species invasion.

Risk of negative outcome values (H, M and L) were summarized by PNVT and Section by area and then percent. Then, the following logic was used to present an overall rating for the PNVT within a Section:

```
=IF( % H >0.5 , "H",
        IF(% H + % M >0.67, "H",
                IF(% H >0.25, "M",
                        IF(% H + % M >0.5, "M",
                                "L")))).
```

An adjustment was made for Cottonwood Willow Riparian Forest – all of which was rated “L” based upon structure, because it is thought that most of the structure in this PNVT, both on and off the Forest is composed of invasive tree species and that the primary disturbance regime (flooding) is greatly departed. The rating was changed to H for this PNVT in all three Sections

The results of the classification are summarized in Table 42.

Table 41 – Assignment of Risk of Negative Outcome Values to Vegetation Structure Within PNVTs.

Analysis PNVT	Struct	Departure
Alpine and Tundra	Herbaceous	0
	Other	0
	Seed/Sap	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0
Barren	Herbaceous	0
	Other	0
	Seed/Sap	0
	Shrub-Closed	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0
	Water	0

Analysis PNVT	Struct	Departure
Cottonwood Willow Riparian Forest	Herbaceous	L
	Other	0
	Seed/Sap	L
	Shrub-Closed	L
	Shrub-Open	L
	Small/Med-Closed	L
	Small/Med-Open	L
	Sparsely Vegetated	L
	Very Large-Closed	L
	Very Large-Open	L
	Water	0
Desert Communities	Herbaceous	L
	Other	0
	Seed/Sap	M
	Shrub-Closed	M
	Shrub-Open	L
	Small/Med-Closed	H
	Small/Med-Open	L
	Sparsely Vegetated	L

Analysis PNVT	Struct	Departure
	Very Large-Closed	H
	Very Large-Open	L
	Water	0
Disturbed/Altered	Herbaceous	0
	Other	0
	Seed/Sap	0
	Shrub-Closed	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0
	Water	0
Gambel Oak Shrubland	Herbaceous	L
	Seed/Sap	L
	Small/Med-Closed	L
	Small/Med-Open	L
	Very Large-Closed	M
	Very Large-Open	L
Great Basin Grassland	Herbaceous	L
	Other	0
	Recently Burned	M
	Seed/Sap	M
	Shrub-Closed	M
	Shrub-Open	L
	Small/Med-Closed	M
	Small/Med-Open	M
	Sparsely Vegetated	L
	Very Large-Closed	M
	Very Large-Open	L
	Water	0
Great Plains Grassland	Herbaceous	L
	Seed/Sap	M
	Small/Med-Closed	M
	Small/Med-Open	M
	Very Large-Closed	M
	Very Large-Open	L
		M
Interior Chaparral	Herbaceous	0
	Other	0
	Seed/Sap	0
	Shrub-Closed	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0
	Water	0
Madrean Encinal Woodland	Herbaceous	0
	Other	0
	Seed/Sap	0
	Shrub-Closed	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0

Analysis PNVT	Struct	Departure
	Water	0
Madrean Pine Oak Woodland	Herbaceous	0
	Other	0
	Seed/Sap	0
	Shrub-Closed	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0
	Water	0
Mixed Broad Leaf Deciduous Riparian Forest	Herbaceous	0
	Other	0
	Seed/Sap	0
	Shrub-Closed	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0
	Water	0
Mixed Conifer Forests	Herbaceous	L
	Other	0
	Recently Burned	M
	Seed/Sap	L
	Shrub-Closed	H
	Shrub-Open	M
	Small/Med-Closed	H
	Small/Med-Open	L
	Sparsely Vegetated	L
	Very Large-Closed	H
	Very Large-Open	L
	Water	0
Montane / Subalpine Grassland	Herbaceous	L
	Other	0
	Seed/Sap	M
	Shrub-Closed	M
	Shrub-Open	L
	Small/Med-Closed	M
	Small/Med-Open	L
	Sparsely Vegetated	L
	Very Large-Closed	M
	Very Large-Open	L
	Water	0
Montane Willow Riparian Forest	Herbaceous	0
	Seed/Sap	0
	Shrub-Closed	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0
	Water	0

Analysis PNVT	Struct	Departure
Pinyon Juniper Woodland	Herbaceous	L
	Other	0
	Recently Burned	M
	Seed/Sap	L
	Shrub-Closed	M
	Shrub-Open	L
	Small/Med-Closed	H
	Small/Med-Open	L
	Sparsely Vegetated	L
	Very Large-Closed	H
	Very Large-Open	L
	Water	0
PNVT Not Available	Herbaceous	0
	Other	0
	Seed/Sap	0
	Shrub-Closed	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0
	Water	0
Ponderosa Pine	Herbaceous	L
	Other	0
	Recently Burned	M
	Seed/Sap	L
	Shrub-Closed	H
	Shrub-Open	L
	Small/Med-Closed	H
	Small/Med-Open	L
	Sparsely Vegetated	L
	Very Large-Closed	H
	Very Large-Open	L
	Water	0
Quarry	Small/Med-Open	0
	Very Large-Open	0
Sagebrush Shrubland	Herbaceous	L
	Other	0
	Seed/Sap	L
	Shrub-Closed	L
	Shrub-Open	L
	Small/Med-Closed	M
	Small/Med-Open	L
	Sparsely Vegetated	L
	Very Large-Closed	M
	Very Large-Open	L
	Water	0
Semi-desert Grasslands	Herbaceous	L
	Other	0
	Seed/Sap	M
	Shrub-Closed	M
	Shrub-Open	L
	Small/Med-Closed	M
	Small/Med-Open	L
	Sparsely Vegetated	L
	Very Large-Closed	M
	Very Large-Open	L
	Water	0
Spruce Fir Forest	Herbaceous	L

Analysis PNVT	Struct	Departure
	Other	0
	Seed/Sap	L
	Shrub-Open	L
	Small/Med-Closed	L
	Small/Med-Open	L
	Sparsely Vegetated	L
	Very Large-Closed	L
	Very Large-Open	L
	Water	0
Urban or Agricultural	Herbaceous	0
	Other	0
	Recently Burned	0
	Seed/Sap	0
	Shrub-Closed	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0
	Water	0
Water	Herbaceous	0
	Other	0
	Seed/Sap	0
	Shrub-Closed	0
	Shrub-Open	0
	Small/Med-Closed	0
	Small/Med-Open	0
	Sparsely Vegetated	0
	Very Large-Closed	0
	Very Large-Open	0
	Water	0
Wetland/Cienega	Herbaceous	L
	Other	0
	Seed/Sap	M
	Shrub-Closed	L
	Shrub-Open	L
	Small/Med-Closed	H
	Small/Med-Open	H
	Sparsely Vegetated	L
	Very Large-Closed	H
	Very Large-Open	L
	Water	0
(blank)	(blank)	(blank)

Table 42 – Summary of PNVT Departures by Section.

Departure Summary				
PNVT	**313A**	**313D**	**M313A**	**Notes**
Pinyon Juniper Woodland	H	H	H	Assumes most of this PNVT is PJ/Grass - as is 2/3 of the KNF.
Ponderosa Pine	H	M	H	
Mixed Conifer Forests	H	H	H	Assumes most of this PNVT is Dry MC - as is > 80% of KNF.
Sagebrush Shrubland	L	M	H	
Montane / Subalpine Grassland	L	L	L	
Great Basin Grassland	M	H	M	
Spruce Fir Forest	L	L	L	
Semi-desert Grasslands	L	M	M	
Desert Communities	M	H	L	
Gambel Oak Shrubland	L	-	L	
Wetland/Cienega	H	H	L	
Cottonwood Willow Riparian Forest	H	H	H	Departure Summary adjusted to "H" form "L" based upon assumption that most vegetation in this PNVT is dominated by invasive species and that the disturbance regime is greatly altered by impoundments.

Appendix 3 - PNVT Model Results and Risk Assessments for the Kaibab NF

1. Pinyon Juniper Woodlands Sage

Table 1.1: Comparison of pinyon juniper woodlands sage PNVT successional states reference, current, and projected conditions

A	B	C	D	E	Closed = >30% canopy cover	
Grass/shrub/seedling	**Young Closed Canopy**	**Young Open Canopy**	**Late Open Canopy**	**Late Closed Canopy**		
10	20	25	35	10	**Reference Condition**	
15		15	20-40	40-60	**Current Plan Desired Condition**	***Departure***
2.86	25.05	11.9	58.91	1.28	**Current Condition**	**29**
					Projected Trends	
10.23	18.71	10.84	51.61	8.61	20 Years	*17*
17.04	17.08	8.64	45.79	11.45	40 Years	*19*
18.89	16.24	8.04	43.75	13.08	50 Years	*21*
21.37	19.17	12.81	33.77	12.88	100 Years	*14*
22.43	27.93	19.88	20.18	9.58	250 Years	*20*
22.59	31.86	21.43	15.4	8.72	500 Years	*24*
22.66	32.2	22.18	14.97	7.99	1000 Years	*25*

Assumptions: Reference conditions for this model were identified from Landfire BpS for LFNat_west:

Landfire BpS for LFNat_west (incl. most of KNF)

BpS_Model	BpS_Name	A	B	C	D	E	U	FRG	LandscapeLevel
1510160	Colorado Plateau Pinyon-Juniper Woodland	10	20	25	35	10	0	III	2

Information developed subsequent to the risk assessment assigns various PJ habitat types to different fire regimes. A query of FIA plots for habitat types shows about 1/3 of the type may be fire regime III, while about 2/3 may be fire regime I. The proportions are shown in the table below. The departure in Table 1 is summarized as “Low” and “Toward” (at 50 years) for this type. For the PJ grass type, the current condition of 40 to 60 percent closed canopy represents a moderate departure from reference condition. Without frequent fire, this will likely trend away. The overall evaluation for P-J is also moderate departure, with static to away trend.

Habitat class	# Plots	% of Plots
PJ or Ju Grass	65	67
PJ Oak	22	23
PJ Sage	10	10

Table 1.2. Trends for structure, composition and process pinyon juniper woodlands

Structure	Composition	Process
Woodland has changed from a mosaic of different ages to a homogeneous landscape.	PJ has spread uphill into the PIPO PNVT.	Longer fire return interval results in homogeneous woodlands of thousands of acres.
Uncharacteristic grass/forb/brush state exists in which Pinyon Juniper does not grow back in any known time after fire.	Gambel oak is declining. Large old oak decreasing in abundance.	Higher fire severity on the watershed. Higher fire intensity.
Lack of micro-openings allows for larger stand replacement fires.	Change in composition of understory species such as decreased density and compositional shifts from perennial grasses to perennial forbs and woodlands litter.	Reduced nutrient cycling due to the longer fire return interval.
	Higher needle litter loading across more of the PNVT reduces the herbaceous component.	Increase evapo-transpiration and less runoff which results in less base flow to springs, seeps and streams.
Increase in ladder fuels due to multiple canopy layers.	Higher loading of downed woody debris.	Increased loss of pinyon pine from *Ips* outbreaks of larger extent.
Increased stand density	PJ has spread downhill into semi-desert, sage, and grassland communities.	
Increased density of logs and snags.	Lower herbaceous understory composition	
	Overstory shifts in composition to more pinyon pine.	

Table 1.3: Description of threats, Forest Service control/authority and associated effects to the pinyon juniper woodland PNVT

Threat	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing the understory grasses, forbs, shrubs and reproduction by wildlife.	No.	Affects the composition and structure of understory of herbaceous and shrubs vegetation and lengthens the fire return interval. Reduces productivity and alters composition of herbaceous community by decreasing cool season grasses.
Managed Grazing	Grazing under permit	Yes	Affects the composition and structure of understory of herbaceous and shrubs vegetation and lengthens the fire return interval.

Threat	Description of threat	Under FS control/authority	Effects
Invasive plants		Yes	Reduces herbaceous diversity and shortens the fire return interval.
Vegetative treatments	Thinning treatments that move the composition or structure of stands towards desired conditions.	Yes	Changes in composition & structure to move stands towards the desired condition. Minor short term accelerated erosion, and sediment delivery to streams and soil compaction without use of Best Management Practices. Use of machinery sometimes.
Fuelwood cutting	Harvest of snags and logs for personal use as fire wood.	Yes	Reduction of snags, downed woody material, oak, alligator and Utah? Juniper
Lack of Fire	The response to an unwanted wildland fire.	Yes	Increases canopy closure, tree density duff, snags, downed woody material, ladder fuels, fuel loading, decreases composition, diversity, productivity of herbaceous and shrub understory, reduces carbon nitrogen ratio, decreases age and species diversity. Increase in potential fire severity to watershed.
Fire Suppression	Actions taken to control unwanted wildland fires	Yes	Dozer lines can increase sediment runoff and compact the soils. Damage can occur to TE & S plants. Invasive plants can be carried into the area by vehicles.
Fire Use	Prescribed fires and the use of lightning fires for resource benefits	Yes	WFU and prescribed fire: reduces fuel hazards, tree densities, creates openings in canopy. Increases abundance and nutrition of herbaceous understory. Improves Gambel oak and alligator juniper regeneration. Potential loss of snags, downed logs, large oak, especially when first entry. High fuel loadings can contribute to soil mineralization, hydrophobicity, and loss of productivity. These effects tend to be greater under wildland fire use because of drier fuel conditions.
Insect/disease	Increased risk of *Ips* beetles. Increase in mistletoe infections.	No – FS can control stand densities and resiliency.	Increased risk of epidemic bark beetle infestations which could cause loss of older age classes in small to large patches. Increases number of snags and eventually downed logs. Increases fire hazard and fuel loading. Increase herbaceous understory where patches of mortality have occurred.

Threat	Description of threat	Under FS control/authority	Effects
Uncharacteristic Wildfire Effects	Fires that burn with a higher fire intensity or extent than reference conditions	Yes – Decision to suppress is under authority and control	Can create large patches of homogeneous vegetation and create conditions were natural regeneration of shrubs and trees does not occur because of increased soil temperatures. Can cause soils mineralization, potential for increased sediment movement. Creates growing space for invasive plants that more easily regenerate after fire.
Drought	When a region receives below average precipitation over an extended period, usually ranging from several months to several years.	No. Not under FS authority. FS can control stand densities.	Increases tree susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, can reduce cover of litter causes increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and storage in seeps and springs. Reduces tree growth.
Climate Change	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level.	No	Increases tree mortality, susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduce cover of litter causes increased susceptibility to soil erosion, and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and storage in seeps and springs. Reduces tree growth. See Regional letter on how to address global warming in revision. Longer and more severe droughts. As temperatures rise, the effects of these are more severe. Fire season can start earlier and last longer.
Minerals (uranium, quarries)	Exploration and extraction	Yes but limited due to Mining Act. Quarries are permit based.	Areas of type conversion from vegetation to bare ground.
Off highway vehicles	Motorized vehicles off of designated roads or routes	Yes through TMR and through Forest Orders?	Limited removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, and reduced soil productivity. Localized areas of increased soil compaction across the PNVT. Increased fire risk. Increased opportunities for fuelwood theft e.g. loss of large snags, oaks, etc.

Threat	Description of threat	Under FS control/authority	Effects
Water withdrawal (wells)	Withdrawal of water for domestic or commercial use.	Yes	Possible drop in local water table resulting in less water quantity and connected seeps and springs and subsequent decrease in riparian habitat.
Dams/impoundments	Structures that allow for the collection of surface water	Yes.	Concentrate water and alters downstream water regime. Water can concentrate wildlife and livestock resulting in soil compaction, decreased productivity, altered composition and structure of herbaceous species. This is most likely within 1/8 mile around the impoundment. An altered downstream water regime can reduce overall riparian habitat. Riparian habitat could become established adjacent to impoundments. Impoundments allow large herbivores to access more habitat, increasing impacts to soils and understory species across the PNVT.
Roads	Poorly designed and maintained Levels 1-3 and user-created roads	Yes. Can be limited by enforcement and mitigation	Provide pathway for sediments into connected waters. Exposed cutbanks contribute to erosion. Use of road network increased fire risk. Road use can fragment wildlife habitat and create disturbance. Roads can be barriers to some forms of wildlife.
Forest product gathering	Collection of any forest product not covered under timber, firewood, or mineral permits.	Yes	User created roads cause minor rutting and loss of soil productivity. Minor and localized activities.
Non-motorized recreation	Any use of the forest that is not tied to a motorized vehicle.	Yes	Includes hunting, bicycles, hiking, rock climbing, camping, etc. Localized vegetation removal, erosion down trails, disturbance.
Motorized recreation	Any use of the forest that is tied to a motorized vehicle.	Yes	User created roads and includes dispersed camping. Limited removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, and reduced soil productivity. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk. Increased wildlife disturbance from activities and noise.

*Shaded rows in Table 3 are threats screened out because the FS has neither control nor authority to change them.

Table 1.4. Threat matrix: evaluation of risk severity for the pinyon juniper woodland PNVT

Low means: <25% PNVT, 0-4 months, Moderate means: 4-8 months, 25-75% PNVT High means: >75% PNVT, > 8 months				**Screened out in Table 3. Carried forward past Table 4 evaluation.**		**Risk**	
THREAT	**Extent**	**Duration**	**Severity**	Consequences	**Reversibility**	**Threat Severity overall**	**Likelihood**
Unmanaged Grazing	**M**	**M**	**25%**	Possible changes in composition or structure of understory. Elk are heavily browsing shrubs where monitored.	**R**	**L**	**H**
Managed Grazing	**H**	**L**	**10%**	Removal of animals before utilization impacts composition	**R**	**L**	**H**
Invasive plants	**M**	**H**	**25%**	Cheat grass spread from sites along roads to more wide spread areas after disturbance. Increases FRI, changing % in states.	**R**	**M**	**M**
Vegetative treatments (commercial & non commercial)	**L**	**L**	**<10%**	Reduction of tree density towards historic levels. Increase Understory. Decrease canopy cover.	**R**	**L**	**L**
Fuelwood cutting (dead, standing and down)	**L**	**M**	**<10%**	Reduction of snags & downed logs	**R**	**L**	**L**
Lack of fire	**H**	**M**	**100**	Continued fire suppression will increase density and continuity, resulting in increased threat of larger/more intense stand replacement fire within the PNVT.	**R**	**H**	**H**
Fire Suppression	**L**	**L**	**25**	Spread of invasive plants.	**R**	**M**	**H**
Insect/disease	**M**	**L**	**100**	Decrease canopy cover, tree density. Shift species toward juniper. Increase fuel loadings. Shift to younger trees. Increase snags, logs.	**R**	**M**	**M**

Low means: <25% PNVT, 0-4 months, Moderate means: 4-8 months, 25-75% PNVT High means: >75% PNVT, > 8 months				**Screened out in Table 3.** **Carried forward past Table 4 evaluation.**	**Risk**		
THREAT	**Extent**	**Duration**	**Severity**	Consequences	**Reversibility**	**Threat Severity overall**	**Likelihood**
Fire Use	**L**	**L**	**20%**	Continued fire management will reduce patch size and promote younger open age classes within the PNVT.	**R**	**L**	**L**
Uncharacteristic Wildfire Effects	**L**	**L**	**20%**	No one fire should burn through entire PNVT at one time because the PNVT is distributed is wide spread.	**R***	**M**	**H**
Drought	**H**	**M-H**	**100%**	PNVT at risk due to additional pinyon *Ips* beetle outbreaks, increased fire hazard during droughts.	**R**	**H**	**H and cyclic**
Climate Change	**H**	**H**	**100%**	PNVT at risk due to additional pinyon *Ips* beetle outbreaks, increased fire hazard during droughts.	**I**	**H**	**M - H**
Minerals (quarries)	**L**	**L**	**1%**	PNVT not at risk because extent of quarries is limited and under permit system. Uranium exploration is underway on the Tusayan and NK RD's.	**R**	**L**	**M**
Off highway vehicles	**L**	**L**	**45%**	Use could impact TE&S plant species and spread invasive plants.	**R**	**L**	**H**
Water Withdrawal	**L**	**L**	**1%**	Slight decrease in riparian habitat	**R**	**L**	**L**
Dams impoundments	**L**	**M**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT	**R**	**L**	**M**
Roads	**L**	**M**	**20%**	PNVT not at risk.	**R**	**L**	**M**
Forest Product Gathering	**L**	**L**	**5%**	PNVT not at risk.	**R**	**L**	**M**
Non-motorized Recreation	**L**	**L**	**5%**	PNVT not at risk.	**R**	**L**	**M**

Low means: <25% PNVT, 0-4 months, Moderate means: 4-8 months, 25-75% PNVT High means: >75% PNVT, > 8 months				Screened out in Table 3. Carried forward past Table 4 evaluation.		Risk	
THREAT	**Extent**	**Duration**	**Severity**	Consequences	**Reversibility**	**Threat Severity overall**	**Likelihood**
Motorized Recreation	**M**	**M**	**10%**	Use could impact TE&S plant species and spread invasive plants.	**R**	**M**	**M**

The primary threat to this PNVT is the lack of fire disturbance, with secondary associated threats of drought and Ips outbreaks, although much of the recent Ips damage (1996, 2004) occurred on sites that are quite marginal and may not even have been PJ historically. Departure from lack of fire seems especially true in the PJ-grassland portion that makes up about 2/3 of the PNVT, but also seems to apply to PJ-shrubland portions to some degree as well. Fire disturbance at this point often leads to negative outcomes for structure and species composition often shifts to invasive plants that increase the FRI. For the 1/3 of the type in PJ-shrubland, this would represent a further departure from reference conditions. Therefore, Uncharacteristic Wildfire Effects represents a significant threat. Also for this reason, the secondary threat of invasive species is also carried forward for this PNVT.

Tree density and associated loss of understory plant cover and diversity within the type is the primary characteristic that is departed, especially in the PJ-grasslands. In the PJ-shrublands, the continuity of high tree density represents a departure. Lowering tree densities in characteristic patterns would reverse or mitigate the threats. This is more difficult to do on steep slopes and in wilderness, but is still technically feasible; most of this PNVT is easily accessible.

2. Ponderosa Pine

Table 2.1: Comparison of the ponderosa pine PNVT successional states to reference, current and projected conditions

Vegetation State	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**												
Reference Condition	0	0	0.1	0.8	99.1	0	0	0	0	0	**Departure**	**FRCC**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Current Condition																						
North Kaibab RD 155,208.64	7.13	3.69	20.56	8.23	2.15	0.48	3.75	35.39	15.94	2.68	96.95	3	0	0	0.1	0.8	2.15	0	0	0	0	0
Tusayan RD 104,881.34 acres	4.89	7.66	21.65	6.77	1.29	0.22	7.68	43.75	6.09		97.81	3	0	0	0.1	0.8	1.29	0	0	0	0	0

Williams RD 293,219.35 acres	3.1	2.23	8.44	1.72	0.5	2.99	11.79	63.16	6.06		98.6	3	0	0	0.1	0.8	0.5	0	0	0	0	0
Forest 553,309 acres	4.65	3.74	14.65	4.65	1.15	1.69	8.59	51.08	9	0.8	97.95	3	0	0	0.1	0.8	1.15	0	0	0	0	0
Projected Trends -- Forest																						
20 Years	14.31	6.28	5.86	2.68	2.15	1.15	2.72	32.28	32.45	0.12	96.95	3	0	0	0.1	0.8	2.15	0	0	0	0	0
40 Years	21.95	7.07	3.03	1.46	2.01	1.39	0.75	16.25	46.08	0.01	97.09	3	0	0	0.1	0.8	2.01	0	0	0	0	0
50 Years	21.32	10.32	1.87	1.24	1.95	1.48	0.78	13.93	47.08	0.03	97.15	3	0	0	0.1	0.8	1.95	0	0	0	0	0
100 Years	20.18	19.34	1.94	1.42	1.74	2.39	0.85	11.42	40.7	0.02	97.36	3	0	0	0.1	0.8	1.74	0	0	0	0	0
250 Years	19.71	19.21	2.89	0.9	1.56	2.31	1.05	15.73	36.63	0.01	97.54	3	0	0	0.1	0.8	1.56	0	0	0	0	0
500 Years	20.04	18.48	2.79	1.15	1.81	2.17	1.17	15.52	36.86	0.01	97.29	3	0	0	0.1	0.8	1.81	0	0	0	0	0
1000 Years	19.99	17.74	2.91	1.01	1.38	2.36	1.13	15.87	37.57	0.04	97.72	3	0	0	0.1	0.8	1.38	0	0	0	0	0

Table 2.2. Trends for structure, composition and process for ponderosa pine PNVT.

Structure	Composition	Process
Openings between groups of ponderosa pine are lacking.		Longer Fire Return Interval allows seedlings/saplings to escape and openings are occupied.
Closed canopy forests exist where we had open canopy forests. Multiple canopy layers within even-aged groups are more common than during the reference period.	Increase in shade tolerant tree species that are not adapted to frequent surface fires (Douglas fir, white fir, spruce). Ponderosa pines have established within aspen clones (D1) and are now over topping aspen where it was a cohort (D3).	Shade tolerant tree species out compete fire adapted species for moisture, sunlight, and nutrients. Longer Fire Return Interval allows for seedling/sapling escape, leading to composition shift in overstory. Regeneration of aspen follows fire and other disturbance, successful recruitment lacking under ungulate overgrazing by elk.
Canopy based height is lower due to the absence of frequent fire.	Shade tolerant tree species promote stand replacement wildland fires because of the multiple canopy layers and reduced canopy base heights. With a closed canopy, even light burns seem to take a disproportionate toll on Gambel oak, perhaps due to heat trapped by the overstory of pine.	Pine reproduction after large stand replacement fires is not occurring within expected timelines. Could be due to increased soil temperature, uncharacteristic vegetation that shortens the FRI, or to seedling competition with grasses.
Large oak trees that were in the interspaces and openings are declining in numbers and more shrub type oak exists throughout a stand.	The spread of pine and other species into clumps of Oak cause increased mortality from wildland fire, even non-lethal surface fires.	Stand replacement fires burn with higher fire intensity. Higher fire intensity leads to soil damage, soil loss, and soil movement. Affects to soils effect establishment of seedlings.
The lack of interspace between clumps has reduced the amount of space available for root systems	Gambel oak is declining. Large old oak decreasing in abundance.	Reduced nutrient cycling

Structure	Composition	Process
Lack of micro-openings allow fires to transition from non-lethal surface fires to mixed severity and crown fires more easily.	Higher needle litter loading across more of the PNVT. Reduced grass forage, production, composition, and diversity. Ponderosa pine has filled into what were previously openings. Natural clumps/groups of trees hard to distinguish	Increase evapo-transpiration and less runoff which results in less base flow to springs, seeps and streams. Less snowfall has reduced the amount of base flow to springs, seeps, and streams.
Increase in ladder fuels	Higher loading of duff, needle litter and downed woody debris.	Increased loss of trees tied to increase in insect and disease outbreaks.
Increased stand density (trees/acre)	Lower production of grasses, forbs, and shrubs.	Increased vulnerability of forest to fire, drought, insects, and disease. Increase in mixed severity and stand replacement wildland fires because of surface fires burning hotter, increased flame lengths, and increased pathways to carry fire into the canopy.
Increased density of logs and snags.	Lower herbaceous understory diversity.	Grazing by elk of seedlings and saplings is reducing reproduction success (aspen, shrubs, and trees) and growth to mature states
Closed canopy forests now exist where we had open canopy forests. Multiple canopy layers now dominate between groups instead of existing in their own group.	More canopy cover results in makes more litter. Closed canopy results in decrease in diversity and change in understory species composition and productivity. Higher canopy results in increases in shade tolerant tree species on moist locations that are not adapted to frequent surface fires (Douglas-fir, white fir). Decrease in oak with increased ponderosa pine canopy.	Shade tolerant tree species out compete fire adapted species for moisture, sunlight, and nutrients. Increased canopy, increased evapo-transpiration, decreased water runoff and yield. Increased susceptibility to crown fires. Increase evapo-transpiration and less runoff which results in less base flow to springs, seeps, and streams.
Reduction of seedlings and saplings on D1 and D4 because of browsing by elk. Estimates browsed: aspen seedlings, 90 to 100% browsed: other species are affected but the extent is not known.	Understory vegetation is less vigorous, diverse and productive.	Higher risk of accelerated erosion following wildfires. Higher risk of loss of soil productivity following wildfires. Acres are not receiving recurring surface fires at historic frequency. Flush of mineral/nutrients resulting from low intensity fire not occurring.
	Soil condition: Static, 99% historic, 98% current, Soil Productivity: Static to downward for untreated acres. Upward for treated.	Lack of frequent surface fires has allowed potential for more lethal fires.

Table 2.3: Description of threats, Forest Service control/authority and associated effects to the ponderosa pine PNVT

Specific Threats	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing the understory grasses, forbs, shrubs and reproduction by deer, elk and other wildlife.	No – control. Yes – Can mitigate in very limited areas. Can build exclosures.	Affects the composition, structure, and productivity of understory vegetation (herbaceous, shrubs, young trees (aspen and pine), including decreases in cool season grasses and other palatable species of grasses, forbs and aspen while increasing less palatable species.
Managed Grazing	Grazing managed under permits.	Yes	Animal are removed before grasses or forbs are fully utilized.
Invasive plants	Cheatgrass, toadflax and non-native thistles exist on < 1% of the PNVT.	Yes	Current threats are to the understory composition of grasses and forbs and possibly at the lower elevations of the PNVT.
Herbicides	Use of herbicides to reduce unwanted plants.	Yes	Has localized affects reducing invasive plants. Affects are short term. Affects can be more wide-spread if used improperly.
Thinning	Thinning treatments of trees that move the composition or structure of forest stands towards desired conditions in the LMP	Yes	Changes in composition & structure. (Potential decreases in tree density, decrease in canopy closure, increase in understory and variation). Loss of natural clumping and grouping (canopy interlock) of forest structure. Minor short term accelerated erosion, and sediment delivery to streams and soil compaction without implementation of Best Management Practices. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.

Specific Threats	Description of threat	Under FS control/authority	Effects
Regeneration Cutting	Regeneration treatments to move the structure of forest stands towards desired conditions in the LMP	Yes	Changes in composition & structure. (decreases in tree density, decrease in canopy closure, increase in understory and variation). Loss of old and large trees there natural arrangement (legacy trees may not be left in cuts less than 1 acre). Loss of green trees with benefits for wildlife (spike tops, lightning struck, etc). Minor short term accelerated erosion, and sediment delivery to streams and soil compaction without implementation of Best Management Practices. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity. Potential for non-native thistles at landings.
Uncharacteristic Wildland Fire Effects	Mixed and Stand replacement fire that occurs outside of the HRV.	Yes	Increases canopy closure, tree density duff, snags, downed woody material, ladder fuels, fuel loading, decreases composition, diversity, productivity of herbaceous and shrub understory, reduces carbon nitrogen ratio, decreases age and species diversity. Increase fire severity to watershed from sterilized soils and reduction in mychorrizae.

Specific Threats	Description of threat	Under FS control/authority	Effects
Insect/disease	Increased risk of bark beetles. Increase in mistletoe infections.	No (control). Yes, FS can manage stand density/resiliency.	Increased risk of epidemic bark beetle infestations which could cause loss of older age classes in small to large patches. Increases number of snags and eventually downed logs. Increases fire hazard of needle litter, downed woody material, and live understory fuels. Aspen defoliation is occurring at a higher frequency and extent. Increase herbaceous understory where patches of mortality have occurred. Increase in mistletoe infections could affect the sustainability of individual uneven-aged stands. Even-aged treatments designed to control mistletoe can reduce the structural diversity of stands. Leaving a regularly spaced stand may promote further spread of mistletoe. Mistletoe treatments can decrease available nesting, roosting, and feeding sites for birds and mammals. Treatments can reduce the numbers of mistletoe-created snags that tend to have greater longevity than snags created by fire or beetles.
Fire Use	Prescribed fire use and the use of natural ignitions for resource benefits	Yes	WFU and prescribed fire: reduces fuel hazards, tree densities, creates openings in canopy. Increases abundance and nutrition of herbaceous understory. Improves Gambel oak and alligator juniper regeneration. Potential loss of snags, downed logs, large trees, oak especially when first entry. Potential soil disturbance where fuel loadings are high that contributes to mineralization, hydrophobicity, and loss of soil productivity. These effects tend to be greater under wildland fire use because wider burning window.

Specific Threats	Description of threat	Under FS control/authority	Effects
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Wildfire may reduce short term fuel hazards, reduce tree densities, and creates openings in canopy and can kill a lot of stuff in a big area in a big hurry. Wildfires can create large treeless areas that take a long time to regenerate back to trees. May improve Gambel oak, aspen, New Mexico locust and alligator juniper regeneration. Loss of persistent snags, downed logs, large trees, oak depending on intensity while at the same time, more ephemeral snags and downed logs can be created. Low to medium severity burns increase abundance and nutritional quality (for wildlife) of herbaceous understory, and can alter composition. Wildfire may create areas of moderate to high burn severity that can accelerate erosion resulting in sediment delivery to connected streams, decreased water quality and soil productivity. Where fuel loadings are high, soil mineralization, hydrophobicity, and loss of soil productivity may occur. Invasive species respond positively to disturbance.
Drought	When a region receives below average precipitation over an extended period, usually ranging from several months to several years.	No - control. Yes - FS can manage stand densities.	Increases tree mortality, susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduce cover of litter causes increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and storage in seeps, springs. Reduces tree growth.

Specific Threats	Description of threat	Under FS control/authority	Effects
Climate Change	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease precipitation, and may increase annual variability of precipitation amounts. Increased transpiration may more than offset any increases in precipitation even if precipitation increases do occur. A scenario: http://geochange.er.usgs.gov/sw/impacts/biology/veg_chg_model/ Regional model concordance for temp and precipitation: http://ipcc-wg1.ucar.edu/wg1/Report/suppl/docs/AR4WG1_Pub_Ch11-SM.pdf	No.	Increases tree mortality, susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduce cover of litter causes increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and storage in seeps and springs. Reduces tree growth. See Regional letter on how to address global warming in revision. Longer and more severe droughts. As temperatures rise, the effects of these are more severe. Fire season can start earlier and last longer.
Minerals (uranium, quarries)	Exploration and extraction	Yes but limited due to Mining Act. Quarries are permit based.	Areas of type conversion from vegetation to bare ground.
Water withdrawal (wells)	Withdrawal of water for domestic purposes.	Yes on NF No on Private	Possible drop in local water table resulting in less water quantity and connected seeps and springs and subsequent decrease in riparian habitat.
Dams/impoundments	Structures that allow for the collection of surface water	Yes	Concentrate water and alters downstream water regime. Water can concentrate wildlife and livestock resulting in soil compaction, decreased herbaceous productivity, altered composition and structure and protective vegetative ground cover. This is most likely within 1/8 mile around the impoundment. An altered downstream water regime can reduce overall riparian habitat. Riparian habitat could become established adjacent to impoundments.
Firewood cutting (illegal)	Harvest of snags and logs for personal use as fire wood.	Yes	Reduction of snags, downed woody material, oak, alligator and Utah? juniper

Specific Threats	Description of threat	Under FS control/authority	Effects
Roads	Poorly designed and maintained Levels 1-3 and user-created roads	Yes. Creation of user-created roads not in our control however mitigation or closure is.	Provide pathway for sediments into connected waters. Provide pathway for invasive species into forest matrix. Exposed cutbanks contribute to erosion. Use of road network increased fire risk. Road use can fragment wildlife habitat and create disturbance. Roads can be barriers to some forms of wildife.
Motorized recreation and Off highway vehicles	Any use of the forest that is tied to a motorized vehicle.	Yes through TMR and Forest Orders	User created roads and includes dispersed camping. Limited removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, reduced soil productivity, impacts to wildlife, and vectors for invasive species dispersal. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk. Increased wildlife disturbance from activities and noise.
Developed Recreation	Developed Campgrounds, trails, and special use permit areas	Yes	All localized, except accelerated invasives [covered elsewhere.]
Non-motorized dispersed recreation	Excessive or inappropriate use. Increased fire risk. Ground disturbance, vegetation damage. Poorly located, designed, or maintained trails.	Yes	Localized vegetation removal and disturbance, accelerated erosion down trails and soil compaction, and reduced effectiveness of wildlife habitat due to disturbance. Increased introduction of invasive plants. Increased fire risk as a result of increased potential ignition sources. Greater impacts around developed communities, impact levels tend to correspond with human population size. Provide pathway for sediments into connected waters. Exposed cutbanks contribute to erosion.
Solid waste dumping	Household trash, batteries, landscape waste, meth labs waste, motor oil, appliances, and vehicles.	No/Yes	Contamination of soils and water from industrial waste. Introduction of invasive plants through landscape materials, see effects for Invasive Plants. Potential injury or mortality on wildlife. Greater impacts around communities, impact levels tend to correspond with human population size. Greater impacts also occur adjacent to roads.

Table 2.4. Threat matrix: evaluation of risk severity for the ponderosa pine PNVT

Note: Threats in Table 3 not under agency authority or control were not carried forward

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months*				**Screened out in Table 3.**		***Risk***	
				Carried forward past Table 4 evaluation.			
THREAT	***Extent***	***Duration***	***Severity***	***Consequences***	***Reversibility***	***Threat Severity overall***	***Likelihood***
Unmanaged Grazing	**H**	**M**	**25%**	Aspen – represented by small clones scattered through the PNVT - are not regenerating on the Williams RD. Shrub reproduction is also limited. Loosing native species diversity on Williams RD. Not a problem for most of PNVT where aspen is present.	**R**	**L**	**H**
Managed Grazing	**H**	**L**	**25%**	The forest has met the AMU/forage production objectives outlined in the 1982 plan, although some allotments continue in an unsatisfactory condition.	**R**	**L**	**H**
Invasive plants	**M**	**H**	**<0.1%**	Composition/structure trends: Loss of native plants, diversity reduction trending toward monoculture of annual and short-lived perennials (homogeneity) of non-native species, from what was previously complex structure (heterogeneous native population) and composition. Process trend-changes the way fire moves across the landscape. Allelopathic processes affect native plant's ability to germinate and establish. The effects of invasive plants on vegetative composition, structure, and processes affect all trophic levels (insects, grazers, animals, birds, etc.).	**R**	**M**	**M**
Herbicides	**L**	**L**	**<0.001%**	Trend is to move vegetation towards reference conditions over the long-term. Effects may last 5-10 years due to repeated applications: killing non-native species, opening up growing space to be occupied by native vegetation, potentially short-term accelerated erosion. Effects to water are negligible because they are mitigated through state regulation. There can be some native plants killed.	**R**	**M**	**M**
Fuelwood cutting (dead, standing and down)	**M**	**M**	**<10%**	In areas closest to roads, medium to large oaks are removed, and large pine snags are removed- affecting structure and composition. Reduction of snags and oak. Greater impacts around communities, impact levels tend to correspond with human population size.	**R**	**M**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Thinning treatments	**M**	**L**	**25%**	Shift in composition, structure, and process towards desired condition. Trends starting toward reference condition. Best Management Practices mitigate short term negative effects to soil and connected waters, lack of direction for slash pile treatments. There are BMPs for mitigation for invasive plants. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.	**R**	**L**	**H**
Fire suppression	**L**	**L**	**100**	Line construction (dozer/handline) results in removal of herbaceous vegetation, litter and exposing mineral soil along line, and increase in invasive weeds. Reduction in snags along firelines. Burnouts may create stand replacement fire effects. Retardant-minor onsite increase in nitrogen which can affect native/non-native plant competitive abilities.	**R**	**L**	**H**
Lack of fire (Fire Regime 1: Historic Fire Return Interval of < 35 Yrs. Severity would historically replace less than 75% of the overstory)	**M-H**	**H**		Structural change is increased tree density, changing from open to closed canopy. Composition change reduction in other species such as oak or aspen, with a reduction in herbaceous understory replaced by increases in amount of pine duff and litter. Increases live and dead fuels, increasing burn severity. Process is lost fires on the landscape. In some areas the ability to reintroduce fire is limited until mechanical treatments move the stands towards HRV. Continued lack of fire will result in continued movement away from HRV.	**Y**	**H**	**H**
Insect/disease	**M**	**M**	**100**	Decrease canopy cover, tree density. Increase fuel loadings. Shift to younger trees. Increase snags, logs. Outbreaks are more frequent than prior to the 1950's. This increased frequency has remained consistent in the past 10 years. Change in structure- primarily loss of older trees, reduced tree growth, tree vigor, increases number of snags and eventually downed logs.	**R**	**M**	**M**
Fire Use	**M**	**M**	**20%**	Continued fire use can reduce the threat of mixed severity and stand replacement fire to the PNVT. Can loose control of these fires with serious adverse ouitcomes. Potential increase of invasive weeds. Increase in smoke emission.	**R**	**L**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Wildfire	**M**	**L**	**20%**	Structure, composition, and function of this PNVT are at an increasing risk of loss due to changing fuel conditions. Adverse effects to soil, including accelerated erosion, loss of productivity, and degraded water quality. Fire can increase invasive plants. The small scale heterogeneity of structure could be lost.	**R***	**H**	**H**
Drought	**H**	**M-H**	**100%**	Reduced plant growth, reduced litter (increased erosion), increased invasive plant infestations, increased plant mortality, increased severity of fire effects, and reduced water recharge.	**R****	**H**	**H and cyclic**
Climate Change	**H**	**H**	**100%**	Permanent changes in climate will likely reduce the extent of this PNVT to higher elevations and north facing slopes. The effects could make the affects of wildland fire and insects permanent.	**R****	**H**	**H**
Minerals (quarries)	**L**	**L**	**1%**	PNVT not at risk because extent of quarries is limited and under permit system.	**R**	**L**	**L**
Motorized Recreation	**M**	**M**	**5%**	User created roads increase the risk of fire starts and the spread of invasive plants.	**R**	**M**	**M**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT	**R**	**L**	**L**
Roads	**H**	**M**	**20%**	PNVT not at risk because most system roads have been re-located from drainage bottoms to ridge tops.	**R**	**L**	**M**

The primary threat to this PNVT is the lack of fire disturbance. Because of that, canopy cover is denser and more continuous across States. When fires occur now, they carry a significant risk of a negative outcome, further departing states. For this reason, the secondary threats of wildfire and drought are also carried forward for this PNVT. The insect/disease threat (with Moderate ratings) is also a function of canopy cover (density and continuity).

Tree density and states are the primary characteristics that are departed. They are denser and younger than reference,

Although not a threat to the PNVT in general because of its limited extent on the Forest where elk are present, elk browsing represents a high severity, moderate duration threat to aspen on the Williams RD and across the White Mountains – San Francisco Peaks – Mogollon Rim Section. Aspen are declining in the long term from elk pressure and perhaps climate change, along with short-term

effects of droughts and diseases. Continued pressure from elk are expected to prevent recovery of aspen from short-term disturbances and substantially reduce aspen presence on Williams RD in a relatively short period.

3. Dry Mixed Conifer PNVT

Table 3.1: Comparison of the dry mixed conifer PNVT successional states reference, current, and projected conditions

Kaibab NF Ecosystem Diversity Analysis																							
Dry Mixed Conifer PNVT									(No State J in initial settings (Regeneration occurs after fires)														
	Vegetation State (see description below)																						
Vegetation State	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**													
Reference Condition	**0**	**0**	**0.1**	**0.8**	**99.2**	**0**	**0**	**0**	**0**	**0**	100	**Departure**	**FR CC**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Current Condition																							
North Kaibab RD 113,619.88 acres	13.48	3.08	7.03	1.79	5.51	0	7.7	46.22	10.44	4.75	100	93.59	3	0.3	3.1	7	1.79	0	0	0	0	0	0
Tusayan RD																							
Williams RD 14,117.84 acres	7.21	0	3.33	0.32	0	2.1	10.02	69.55	7.47	0	100	99.58	3	0.3	0	3.3	0.32	0	0	0	0	0	0
Forest 127,738 acres	17.11	2.76	6.66	1.64	4.95	0.21	7.94	48.59	10.14	0	100	94.15	3	0.3	2.8	6.7	1.64	0	0	0	0	0	0
Projected Trends -- Forest																							
20 Years	13.59	4.88	3.5	2.4	0.97	18.94	8.67	22.01	24.44	0.6	100	98.03	3	0.3	4.9	3.5	2.4	0	0	0	0	0	0
40 Years	11.58	2.32	1.58	1.81	0.17	31.36	13.48	9.82	26.01	1.87	100	98.87	3	0.3	2.3	1.6	1.81	0	0	0	0	0	0
50 Years	9.42	1.15	0.72	1.48	0.09	33.37	19.48	8.85	24.14	1.3	100	98.83	3	0.3	1.2	0.7	1.48	0	0	0	0	0	0
100 Years	10	1.95	0.57	0.78	0.11	34.02	29.12	9.05	13	1.4	100	98.96	3	0.3	2	0.6	0.78	0	0	0	0	0	0
250 Years	10.2	2.03	0.74	0.46	0.07	32.7	30.39	13.05	8.91	1.45	100	99.38	3	0.3	2	0.7	0.46	0	0	0	0	0	0
500 Years	10.39	2.16	0.82	0.38	0.08	32.47	30.63	12.92	8.45	1.7	100	99.59	3	0.3	2.2	0.8	0.38	0	0	0	0	0	0
1000 Years	10.01	2.11	0.71	0.42	0.06	33.44	30.46	12.99	8.35	1.45	100	99.75	3	0.3	2.1	0.7	0.42	0	0	0	0	0	0

A	B	C/F	D/G	E	Closed = >40% canopy cover
Grass/forb Aspen/oak ramets	Young aspen, MC regen, closed canopy	Mid Mixed conifer forest with regeneration	Late Mixed conifer forest with regeneration	Young forest. shade intolerant conifers 10-40% cover no aspen	E: is uncharacteristic state with elk present. It is similar to B however there is less canopy cover due to less aspen.

		open/closed	open/closed		
			Assume most of this is open state in reference		

Assumptions: This is PNVT will be modeled using the ponderosa pine/bunch grass model because research shows that the reference condition fire return interval was similar to that of ponderosa pine (Fulé, et al., 2003). PP reference state percentages are also used.

A comparison of 1940 photos to current shows that aspen is not as dominant because it has been overtopped. Some of current B should be C and F, size classes and composition.

Table 3.2. Trends for structure, composition and process for the dry mixed conifer PNVT

Structure	Composition	Process
Closed canopy forests exist where we had open canopy forests.	Dry mixed conifer now exists where it didn't in the past – it has invaded areas previously occupied by aspen, grasslands, ponderosa pine and wetlands within the PNVT.	Longer Fire Return Interval allows seedlings/saplings to escape and openings are occupied.
Uncharacteristic grass/forb/brush state exists in which dry mixed conifer does not grow past the stand initiation phase in any known time.	Aspen is declining due to competition with conifers for water and sunlight.	Shade tolerant tree species out compete fire adapted species for moisture, sunlight, and nutrients. Longer Fire Return Interval allows for seedling/sapling escape, leading to composition shift in overstory. Regeneration of aspen follows fire and other disturbance, successful recruitment lacking under ungulate overgrazing by elk.
Lack of micro-openings allow fires to transition from non-lethal surface fires to mixed severity and stand replacement fires more easily.	Change in composition of understory species such as decreased density and compositional shifts from perennial grasses to perennial forbs.	Stand replacement fires burn with higher fire intensity. Higher fire intensity leads to soil damage, soil loss, and soil movement. Affects to soils effect establishment of seedlings.
Multiple canopy layers predominate within groups instead of existing in their own group.	Higher needle litter loading across more of the PNVT. Reduces the forb component.	Reduced nutrient cycling
Increase in ladder fuels	Higher loading of downed woody debris.	Increased loss of trees tied to increase in insect and disease outbreaks.
Increased stand density	Lower forage production and density	Ungulates feed on aspen when other

Structure	Composition	Process
		vegetation is limited.
Increased density of logs and snags.	Lower herbaceous understory diversity	Increased vulnerability of forest to fire, drought, insects, and disease. Increase in stand replacement wildland fires because of surface fires burning hotter, increased flame lengths, and increased pathways to carry fire into the canopy.
	More canopy cover results in makes more litter. Closed canopy results in decrease in diversity and change in understory species composition and productivity. Higher canopy results in increases in shade tolerant tree species on moist locations that are not adapted to frequent surface fires (Douglas-fir, white fir). Decrease in oak with increased ponderosa pine canopy.	Grazing by elk of seedlings and saplings is reducing reproduction success (aspen, shrubs, and trees) and growth to mature states
	Understory vegetation is less vigorous, diverse and productive.	
	Soil condition: Static, 99% historic, 98% current, Soil Productivity: Static to downward for untreated acres. Upward for treated.	Lack of frequent surface fires has allowed potential for more lethal fires.

Table 3.3: Description of threats, Forest Service control/authority and associated effects to dry mixed conifer PNVT

Specific Threats	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing the understory grasses, forbs, shrubs and reproduction by deer, elk and other wildlife.	No – control. Yes – Can mitigate in very limited areas..	Affects the composition and structure of understory vegetation (herbaceous, shrubs, young trees (aspen and pine), including decreases in cool season grasses and other palatable species of grasses, forbs and aspen while increasing less palatable species. Reduces or eliminates reproduction of aspen. Retards growth of young conifers.
Managed Grazing	Grazing managed under permits.	Yes	Animals are removed before grasses or forbs are fully utilized.
Invasive plants	Cheatgrass, toadflax and non-native thistles exist on < 1% of the PNVT.	Yes	Current threats to the understory composition of grasses and forbs. More likely to occur at the lower elevations of the PNVT.
Herbicides	Use of herbicides to reduce unwanted plants.	Yes	Has localized affects reducing invasive plants. Affects are short term. Affects can be more wide-spread if used improperly.

Specific Threats	Description of threat	Under FS control/authority	Effects
Thinning	Thinning treatments of trees that move the composition or structure of forest stands towards desired conditions in the LMP	Yes	Changes in composition & structure. (Potential decreases in tree density, decrease in canopy closure, increase in understory and variation). Loss of natural clumping and grouping (canopy interlock) of forest structure. Minor short term accelerated erosion, and sediment delivery to streams and soil compaction without implementation of Best Management Practices. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.
Regeneration Cutting	Regeneration treatments to move the structure of forest stands towards desired conditions in the LMP	Yes	Changes in composition & structure. (decreases in tree densities and canopy closure, increase in understory amount and variation). Loss of old and large trees there natural arrangement (legacy trees may not be left in cuts less than 1 acre). Loss of green trees with benefits for wildlife (spike tops, lightning struck, etc). Minor short term accelerated erosion, and sediment delivery to streams and soil compaction without implementation of Best Management Practices. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity. Potential for non-native thistles at landings.
Uncharacteristic Wildland Fire Effects	Mixed and Stand replacement fire that occurs outside of the HRV.	Yes	Increases canopy closure, tree density duff, snags, downed woody material, ladder fuels, fuel loading, decreases composition, diversity, productivity of herbaceous and shrub understory, reduces carbon nitrogen ratio, decreases age and species diversity. Increase fire severity to watershed from sterilized soils and reduction in mychorrizae.
Insect/disease	Increased risk of bark beetles. Increase in mistletoe infections.	No (control). Yes - FS can manage stand	Increased risk of epidemic bark beetle infestations which could cause loss of older age classes in

Specific Threats	Description of threat	Under FS control/authority	Effects
		density/resiliency.	small to large patches. Increases number of snags and eventually downed logs. Increases fire hazard of needle litter, downed woody material, and live understory fuels. Aspen defoliation is occurring at a higher frequency and extent. Increase herbaceous understory where patches of mortality have occurred. Increase in mistletoe infections could affect the sustainability of individual uneven-aged stands. Even-aged treatments designed to control mistletoe can reduce the structural diversity of stands. Leaving a regularly spaced stand may promote further spread of mistletoe. Mistletoe treatments can decrease available nesting, roosting, and feeding sites for birds and mammals. Treatments can reduce the numbers of mistletoe-created snags that tend to have greater longevity than snags created by fire or beetles.
Fire Use	Prescribed fire use and the use of natural ignitions for resource benefits (Used very little in this PNVT – WFU not allowed in MSO Habitat on the NKRD)	Yes	WFU and prescribed fire: reduces fuel hazards, tree densities, creates openings in canopy. Increases abundance and nutrition of herbaceous understory. Improves aspen regeneration. Potential loss of snags, downed logs, large trees, oak especially when first entry. Potential soil disturbance where fuel loadings are high that contributes to mineralization, hydrophobicity, and loss of soil productivity. These effects tend to be greater under wildland fire use because wider burning window.
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Wildfire may reduce short term fuel hazards, reduce tree densities, and creates openings in canopy and can kill a lot of stuff in a big area in a big hurry. Wildfires can create large treeless areas that take a long time to regenerate back to trees. May improve Gambel oak and aspen regeneration. Loss of persistent snags, downed logs, large trees, oak depending on intensity while

Specific Threats	Description of threat	Under FS control/authority	Effects
			at the same time, more ephemeral snags and downed logs can be created. Low to medium severity burns increase abundance and nutritional quality (for wildlife) of herbaceous understory, and can alter composition. Wildfire may create areas of moderate to high burn severity that can accelerate erosion resulting in sediment delivery to connected streams, decreased water quality and soil productivity. Where fuel loadings are high, soil mineralization, hydrophobicity, and loss of soil productivity may occur. Invasive species respond positively to disturbance.
Drought	When a region receives below average precipitation over an extended period, usually ranging from several months to several years.	No – control. Yes - FS can manage stand densities.	Increases tree mortality, susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduce cover of litter causes increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and storage in seeps, springs. Reduces tree growth.
Climate Change	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease precipitation, and may increase annual variability of precipitation amounts. Increased transpiration may more than offset any increases in precipitation even if precipitation increases do occur. A scenario: http://geochange.er.usgs.gov/sw/impacts/biology/veg_chg_model/ Regional model concordance for temp and precipitation:	No.	Increases tree mortality, susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduce cover of litter causes increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and storage in seeps and springs. Reduces tree growth. See Regional letter on how to address global warming in revision. Longer and more severe droughts. As temperatures rise, the effects of these are more severe. Fire season can start earlier and last longer.

Specific Threats	Description of threat	Under FS control/authority	Effects
	http://ipcc-wg1.ucar.edu/wg1/Report/suppl/docs/AR4WG1_Pub_Ch11-SM.pdf		
Minerals (uranium, quarries)	Exploration and extraction	Yes but limited due to Mining Act. Quarries are permit based.	Areas of type conversion from vegetation to bare ground.
Water withdrawal (wells)	Withdrawal of water for domestic purposes.	Yes on NF No on Private	Possible drop in local water table resulting in less water quantity and connected seeps and springs and subsequent decrease in riparian habitat.
Dams/impoundments	Structures that allow for the collection of surface water	Yes	Concentrate water and alters downstream water regime. Water can concentrate wildlife and livestock resulting in soil compaction, decreased herbaceous productivity, altered composition and structure and protective vegetative ground cover. This is most likely within 1/8 mile around the impoundment. An altered downstream water regime can reduce overall riparian habitat. Riparian habitat could become established adjacent to impoundments.
Firewood cutting (illegal)	Harvest of snags and logs for personal use as fire wood.	Yes	Reduction of snags, downed woody material, and oak
Roads	Poorly designed and maintained Levels 1-3 and user-created roads	Yes. Creation of user-created roads not in our control however mitigation or closure is.	Provide pathway for sediments into connected waters. Provide pathway for invasive species into forest matrix. Exposed cutbanks contribute to erosion. Use of road network increased fire risk. Road use can fragment wildlife habitat and create disturbance. Roads can be barriers to some forms of wildlife.
Motorized recreation and Off highway vehicles	Any use of the forest that is tied to a motorized vehicle.	Yes through TMR and Forest Orders	User created roads and includes dispersed camping. Limited removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, reduced soil productivity, impacts to wildlife, and vectors for invasive species dispersal. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk. Increased wildlife disturbance from activities and noise.
Developed	Developed Campgrounds, trails, and	Yes	All localized, except accelerated invasives

Specific Threats	Description of threat	Under FS control/authority	Effects
Recreation	special use permit areas		[covered elsewhere.]
Non-motorized dispersed recreation	Excessive or inappropriate use. Increased fire risk. Ground disturbance, vegetation damage. Poorly located, designed, or maintained trails.	Yes	Localized vegetation removal and disturbance, accelerated erosion down trails and soil compaction, and reduced effectiveness of wildlife habitat due to disturbance. Increased introduction of invasive plants. Increased fire risk as a result of increased potential ignition sources. Greater impacts around developed communities, impact levels tend to correspond with human population size. Provide pathway for sediments into connected waters. Exposed cutbanks contribute to erosion.

Table 3.4. Threat matrix: evaluation of risk severity for the dry mixed conifer PNVT

Note: Threats in Table 3 not under agency authority or control are not carried forward

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months*				**Screened out in Table 3.**		***Risk***	
				Carried forward past Table 4 evaluation.			
THREAT	***Extent***	***Duration***	***Severity***	***Consequences***	***Reversibility***	***Threat Severity overall***	***Likelihood***
Unmanaged Grazing	**H**	**M**	**25%**	Aspen are not regenerating on the Williams RD, except on steeper slopes. Shrub reproduction is also limited. Loosing native species diversity on Williams RD. Not a problem for most of PNVT.	**R**	**L**	**H**
Managed Grazing	**H**	**L**	**25%**	The forest has met the AMU/forage production objectives outlined in the 1982 plan, although some allotments continue in an unsatisfactory condition.	**R**	**L**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Invasive plants	**M**	**H**	**<0.1%**	Composition/structure trends: Loss of native plants, diversity reduction trending toward monoculture of annual and short-lived perennials (homogeneity) of non-native species, from what was previously complex structure (heterogeneous native population) and composition. Process trend-changes the way fire moves across the landscape. Allelopathic processes affect native plant's ability to germinate and establish. The effects of invasive plants on vegetative composition, structure, and processes affect all trophic levels (insects, grazers, animals, birds, etc.).	**R**	**M**	**M**
Herbicides	**L**	**L**	**<0.001%**	Trend is to move vegetation towards reference conditions over the long-term. Effects may last 5-10 years due to repeated applications: killing non-native species, opening up growing space to be occupied by native vegetation, potentially short-term accelerated erosion. Effects to water are negligible because they are mitigated through state regulation. There can be some native plants killed.	**R**	**M**	**M**
Fuelwood cutting (dead, standing and down)	**M**	**M**	**<10%**	In areas closest to roads, medium to large oaks are removed, and large pine snags are removed- affecting structure and composition. Reduction of snags and oak. Greater impacts around communities, impact levels tend to correspond with human population size.	**R**	**L**	**M**
Thinning treatments	**M**	**L**	**25%**	Shift in composition, structure, and process towards desired condition. Trends starting toward reference condition. Best Management Practices mitigate short term negative effects to soil and connected waters, lack of direction for slash pile treatments. There are BMPs for mitigation for invasive plants. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.	**R**	**L**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Fire suppression – line construction, retardant, water usage	**L**	**L**	**100**	Line construction (dozer/handline)- results in removal of herbaceous vegetation, litter and exposing mineral soil along line, and increase in invasive weeds. Reduction in snags along firelines. Burnouts may create stand replacement fire effects. Retardant-minor onsite increase in nitrogen which can affect native/non-native plant competitive abilities.	**R**	**L**	**H**
Lack of fire (Fire Regime 1 & 3: Historic Fire Return Interval of < 35 Yrs. Severity would historically replace less than 75% of the overstory)	**M-H**	**H**		Structural change is increased tree density, changing from open to closed canopy. Composition change reduction in other species such as oak or aspen, with a reduction in herbaceous understory replaced by increases in amount of pine duff and litter. Increases live and dead fuels, increasing burn severity. Process is lost fires on the landscape. In some areas the ability to reintroduce fire is limited until mechanical treatments move the stands towards HRV. Continued lack of fire will result in continued movement away from HRV.	**Y**	**H**	**H**
Insect/disease	**M**	**M**	**100**	Decrease canopy cover, tree density. Increase fuel loadings. Shift to younger trees. Increase snags, logs. Outbreaks are more frequent than prior to the 1950's. This increased frequency has remained consistent in the past 10 years. Change in structure- primarily loss of older trees, reduced tree growth, tree vigor, increases number of snags and eventually downed logs.	**R**	**M**	**M**
Fire Use	**M**	**M**	**20%**	Continued fire use can reduce the threat of mixed severity and stand replacement fire to the PNVT. Can loose control of these fires with serious adverse outcomes. Potential increase of invasive weeds. Increase in smoke emission.	**R**	**L**	**H**
Wildfire	**M**	**L**	**20%**	Structure, composition, and function of this PNVT are at an increasing risk of loss due to changing fuel conditions. Adverse effects to soil, including accelerated erosion, loss of productivity, and degraded water quality. Fire can increase invasive plants. The small scale heterogeneity of structure could be lost.	**R***	**H**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Drought	**H**	**M-H**	**100%**	Reduced plant growth, reduced litter (increased erosion), increased invasive plant infestations, increased plant mortality, increased severity of fire effects, and reduced water recharge.	**R****	**H**	**H and cyclic**
Climate Change	**H**	**H**	**100%**	Permanent changes in climate will likely reduce the extent of this PNVT to higher elevations and north facing slopes. The effects could make the affects of wildland fire and insects permanent.	**I**	**H**	**H**
Minerals (quarries)	**L**	**L**	**1%**	PNVT not at risk because extent of quarries is limited and under permit system.	**R**	**L**	**L**
Motorized Recreation	**M**	**M**	**5%**	User created roads increase the risk of fire starts and the spread of invasive plants.	**R**	**M**	**M**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT	**R**	**L**	**L**
Roads	**H**	**M**	**20%**	PNVT not at risk because most system roads have been re-located from drainage bottoms to ridge tops.	**R**	**L**	**M**

The primary threat to this PNVT is the lack of fire disturbance. Because of that, canopy cover is denser and more continuous across States. When fires occur now, they carry a significant risk of a negative outcome, further departing states and species composition. For this reason, the secondary threats of wildfire and drought are also carried forward for this PNVT. The insect/disease threat (with Moderate ratings) is also a function of canopy cover and species composition shifts.

Tree density and species relative abundance are the primary characteristics that are departed. Older tree states are also missing in some cases, but in others they are present but masked by the overabundance of younger trees.

Although not a threat to the PNVT in general because of its limited extent on the Forest where elk are present, elk browsing represents a high severity, moderate duration threat to aspen on the Williams RD and across the White Mountains – San Francisco Peaks – Mogollon Rim Section. Aspen are declining in the long term from elk pressure and perhaps climate change, along with short-term effects of droughts and diseases. Continued pressures from elk are expected to prevent recovery of aspen from short-term disturbances and substantially reduce aspen presence on Williams RD in a relatively short period.

4. Sagebrush Shrublands PNVT

Table 4.1: Comparison of the sagebrush shrublands PNVT successional states reference, current, and projected conditions

A	B	C	D	E	Closed = >40% canopy cover
Scattered sagebrush and grasses recovering from fire. Little litter	**Mature grass with mid-seral shrubs**	**Late seral mixture of herbaceous and shrub vegetation**	**Uncharacteristic state due to the presence of invasive grasses that shorten the FRI or shrubs that out-compete native grasses**	**Type conversion to crested wheat grass.**	
10	70	20	0	0	Reference condition from LANDFIRE model 251064
18	73	9	0	0	Alternative HRV derivation from Welch and Criddle (RMRS-RP-40)
1.37	20.01	48.12	30.5	0	Current from midscale

Assumptions: Mostly occur in drainage bottoms on the North Kaibab and Tusayan Ranger Districts. On the North Kaibab the PNVT also occurs on a broad flatland near the Twin Alcoves above Marble Canyon.

There is no VDDT model for this PNVT. There is no TNC Assessment for the PNVT. There is reference in the assessments for other low elevation PNVT's. Research has been conducted in this PNVT north and west of Arizona. Some of this work is captured in a review by Welch and Criddle (RMRS-RP-40) and is listed here as an Alternative to HRV. The data is derived primarily from Table 1 of that paper. This paper also challenges the assumption that dense sage precludes or reduces grass cover in State C. See Table 2 in the paper and discussion. (Alternative HRV A – 18%, B – 73%, and C – 9%). Some State D and E areas exist in the Forest. Areas of State E the Crested wheatgrass is diminishing and shrubs are increasing since the work was done in the 1950's to 1970's.

Table 4.2. Trends for structure, composition and process of the sagebrush shrublands PNVT

Structure	Composition	Process
Canopy closure is increasing	PJ encroachment is occurring	Longer FRI slows returning of stands to a young state with productive herbaceous grasses and forbs
	Less cool season grasses and forbs	Longer FRI allows PJ encroachment and development of an open or closed overstory.
PJ is creating an overstory	More cheatgrass and other annual forbs	Less herbaceous cover allows for less retention of water in the soil and great potential for erosion
		Larger fire sizes are leaving little diversity in ages of patches.

		In some cases were fire has occurred in sage the FRI is shorter now because of the presence of cheatgrass.

Table 4.3: Description of threats, Forest Service control/authority and associated effects to the sagebrush shrublands PNVT

Specific Threats	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing grasses, forbs, shrubs and reproduction by deer, elk.	No.	Affects the composition, structure, and productivity of understory vegetation, including decreases in cool season grasses and other palatable species of grasses and forbs while increasing less palatable species.
Unmanaged Grazing	Grazing grasses, forbs, shrubs **by bison.**	Yes. (Buffalo Ranch is covered by an MOU. FS has the authority to control populations in the GC Game Preserve.)	Affects the composition, structure, and productivity of understory vegetation including decreases in cool season grasses and other palatable species of grasses and forbs while increasing less palatable species.
Managed Grazing	Grazing managed under permits.	Yes	Animal are removed before grasses or forbs are fully utilized.
Invasive plants	Cheatgrass, toadflax and non-native thistles exist on < 1% of the PNVT.	Yes	Current threats are to the understory composition of grasses and forbs and possibly at the lower elevations of the PNVT. There are more than 7,000 acres with invasives. Cheatgrass and other exotic annuals are most common, although thistles and Dalmatian toadflax are also present
Herbicides	Use of herbicides to reduce unwanted plants.	Yes	Has localized affects reducing invasive plants. Affects are short term. Affects can be more wide-spread if used improperly.
Thinning	Thinning treatments of trees that move the composition or structure of forest stands towards desired conditions in the LMP	Yes	Does not occur in this PNVT
Regeneration Cutting	Regeneration treatments to move the structure of forest stands towards desired conditions in the LMP	Yes	Mowing occurs on the Tusayan RD. It results in changes in composition & structure. (decreases the amount of mature sage and increases in understory and variation). Reduction in PJ encroachment.
Uncharacteristic Wildland Fire Effects	Mixed and Stand replacement fire that occurs outside of the HRV.	Yes	Fire size is larger due to larger continuous fuel beds. More available fuel results in hotter

Specific Threats	Description of threat	Under FS control/authority	Effects
			burning fires with more severe watershed effects in areas with high erosion potential.
Insect/disease	Increased risk of bark beetles. Increase in mistletoe infections.	No, not under FS authority, but FS can manage stand density/resiliency.	Unknown effects in this PNVT
Fire Use	Prescribed fire use and the use of natural ignitions for resource benefits	Yes	WFU and prescribed fire: reduces fuel hazards, creates openings in canopy. Increases abundance and nutrition of herbaceous understory. Potential loss of snags and downed logs. Potential soil disturbance where fuel loadings are high that contributes to mineralization, hydrophobicity, and loss of soil productivity. These effects tend to be greater under wildland fire use because wider burning window. Limited use at this time.
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Wildfire may reduce short term fuel hazards, reduce shrub densities, and creates openings in canopy and can kill a lot of plants across larges ares in single events. Wildfires can create large shrub-less areas that take a long time to regenerate. Low to medium severity burns increase abundance and nutritional quality (for wildlife) of herbaceous understory, and can alter composition. Wildfire may create areas of moderate to high burn severity that can accelerate erosion resulting in sediment delivery to connected streams, decreased water quality and soil productivity. Where fuel loadings are high, soil mineralization, hydrophobicity, and loss of soil productivity may occur. Invasive species respond positively to disturbance.
Drought	When a region receives below average precipitation over an extended period, usually ranging from several months to several years.	No. Not under FS authority. FS can control stand densities.	Potential increases shrub mortality, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduced cover of litter causes

Specific Threats	Description of threat	Under FS control/authority	Effects
			increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and storage in seeps, springs. Reduces tree growth.
Climate Change	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease precipitation, and may increase annual variability of precipitation amounts. Increased transpiration may more than offset any increases in precipitation even if precipitation increases do occur. A scenario: http://geochange.er.usgs.gov/sw/impacts/biology/veg_chg_model/ Regional model concordance for temp and precip: http://ipcc-wg1.ucar.edu/wg1/Report/suppl/docs/AR4WG1_Pub_Ch11-SM.pdf	No. PNVT expected to move uphill over time.	Potential increases shrub mortality, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduced cover of litter causes increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and storage in seeps, springs. Reduces tree growth.
Minerals (uranium, quarries)	Exploration and extraction	Yes but limited due to Mining Act. Quarries are permit based.	Areas of type conversion from vegetation to bare ground.
Water withdrawal (wells)	Withdrawal of water for domestic purposes.	Yes on NF No on Private	Possible drop in local water table resulting in less water quantity and connected seeps and springs and subsequent decrease in riparian habitat.
Dams/impoundments	Structures that allow for the collection of surface water	Yes	Concentrate water and alters downstream water regime. Water can concentrate wildlife and livestock resulting in soil compaction, decreased herbaceous productivity, altered composition and structure and protective vegetative ground cover. This is most likely within 1/8 mile around the impoundment. An

Specific Threats	Description of threat	Under FS control/authority	Effects
			altered downstream water regime can reduce overall riparian habitat. Riparian habitat could become established adjacent to impoundments.
Firewood cutting (illegal)	Harvest of snags and logs for personal use as fire wood.	Yes	Does not occur in this PNVT
Roads	Poorly designed and maintained Levels 1-3 and user-created roads	Yes. Creation of user-created roads not in our control however mitigation or closure is.	Provide pathway for sediments into connected waters. Provide pathway for invasive species into forest matrix. Exposed cutbanks contribute to erosion. Use of road network increased fire risk. Road use can fragment wildlife habitat and create disturbance. Roads can be barriers to some forms of wildlife.
Motorized recreation and Off highway vehicles	Any use of the forest that is tied to a motorized vehicle.	Yes through TMR and Forest Orders	User created roads and includes dispersed camping. Limited removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, reduced soil productivity, impacts to wildlife, and vectors for invasive species dispersal. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk. Increased wildlife disturbance from activities and noise.
Developed Recreation	Developed Campgrounds, trails, and special use permit areas	Yes	All localized, except accelerated invasives [covered elsewhere.]
Non-motorized dispersed recreation	Excessive or inappropriate use. Increased fire risk. Ground disturbance, vegetation damage. Poorly located, designed, or maintained trails.	Yes	Localized vegetation removal and disturbance, accelerated erosion down trails and soil compaction, and reduced effectiveness of wildlife habitat due to disturbance. Increased introduction of invasive plants. Increased fire risk as a result of increased potential ignition sources. Greater impacts around developed communities, impact levels tend to correspond with human population size. Provide pathway for sediments into connected waters. Exposed cutbanks contribute to

Specific Threats	Description of threat	Under FS control/authority	Effects
			erosion.
Solid waste dumping	Household trash, batteries, landscape waste, meth labs waste, motor oil, appliances, and vehicles.	No/Yes	Contamination of soils and water from industrial waste. Introduction of invasive plants through landscape materials, see effects for Invasive Plants. Potential injury or mortality on wildlife. Greater impacts around communities, impact levels tend to correspond with human population size. Greater impacts also occur adjacent to roads.

Table 4.4. Threat matrix: evaluation of risk severity for the sagebrush shrublands PNVT

Note: Threats in Table 3 not under agency authority or control are not carried forward

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Unmanaged Grazing	**H**	**M**	**25%**	Reduction in forbs/grasses and shrub amounts and diversity.	**R**	**M**	**H**
Unmanaged Grazing (bison)	**M**	**M**	**25%**	Reduction in forbs/grasses and shrub amounts and diversity, when grasses are limited.	**R**	**L**	**H**
Managed Grazing	**M**	**L**	**25%**	The forest has met the AMU/forage production objectives outlined in the 1982 plan, although some allotments continue in an unsatisfactory condition.	**R**	**L**	**L**
Invasive plants	**M**	**H**	**35%**	Composition/structure trends: Loss of native plants, diversity reduction trending toward monoculture of annual and short-lived perennials (homogeneity) of non-native species, from what was previously complex structure (heterogeneous native population) and composition. Process trend-changes the way fire moves across the landscape. Allelopathic processes affect native plant's ability to germinate and establish. The effects of invasive plants on vegetative composition, structure, and processes affect all trophic levels (insects, grazers, animals, birds, etc.).	**R**	**M**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Herbicides	**L**	**L**	**<0.001%**	Trend is to move vegetation towards reference conditions over the long-term. Effects may last 5-10 years due to repeated applications: killing non-native species, opening up growing space to be occupied by native vegetation, potentially short-term accelerated erosion. Effects to water are negligible because they are mitigated through state regulation. There can be some native plants killed.	**R**	**L**	**M**
Fuelwood cutting (dead, standing and down)	**L**	**L**	**0**	Does not occur in this PNVT	**R**	**L**	**L**
Thinning treatments	**L**	**L**	**0**	Shift in composition, structure, and process towards desired condition. Trends starting toward reference condition. Best Management Practices mitigate short term negative effects to soil and connected waters, lack of direction for slash pile treatments. There are BMPs for mitigation for invasive plants. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.	**R**	**L**	**L**
Mowing	**L**	**H**	**L**	Shift in composition, structure, and process with uncertain outcomes towards desired condition. Sub-species of big sagebrush is important in evaluating this threat and is currently unavailable.	**R**	**L**	**H**
Fire suppression – line construction, retardant, water usage	**M**	**L**	**100**	Line construction (dozer/handline)- results in removal of herbaceous vegetation, litter and exposing mineral soil along line, and increase in invasive weeds. Reduction in snags along firelines. Burnouts may create stand replacement fire effects. Retardant-minor onsite increase in nitrogen which can affect native/non-native plant competitive abilities.	**R**	**L**	**M**
Lack of fire (Fire Regime 3: Historic Fire Return Interval of 35 to 200 Yrs. Severity would historically replace 25 to 75% of the overstory)	**M**	**H**	**100**	Structural change is increased shrub density, changing from open to closed canopy. Possible composition change in resulting in reduced herbaceous understory. Increases live and dead fuels, increasing burn severity. Process is lost fires on the landscape. Continued lack of fire will result in continued movement away from HRV.	**Y**	**M**	**M**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Insect/disease	**L**	**L**	**100**	Not known to have adverse outcomes in this PNVT	**R**	**L**	**L**
Fire Use – prescribed fires and lightning started fires	**L**	**L**	**20%**	Continued fire use will reduce thesize of sage patches, increase the amount of young grasses and shrubs. The reduction in dead woody fuels in younger stands results in smaller patches of fire effects, Potential increase of invasive weeds. Increase in smoke emission.	**R**	**L**	**H**
Wildfire	**M**	**M**	**20%**	Structure, composition, and function of this PNVT are at an increasing risk of loss due to changing fuel conditions. Adverse effects to soil, including accelerated erosion, loss of productivity, and degraded water quality. Fire can increase invasive plants. The small scale heterogeneity of structure could be lost.	**R***	**M**	**M**
Drought	**H**	**M-H**	**100%**	Reduced plant growth, reduced litter (increased erosion), increased invasive plant infestations, increased plant mortality, increased severity of fire effects, and reduced water recharge.	**R****	**H**	**H and cyclic**
Climate Change	**H**	**H**	**100%**	Permanent changes in climate will likely reduce the extent of this PNVT to higher elevations and north facing slopes. The effects could make the affects of wildland fire and insects permanent.	**I**	**H**	**H**
Minerals (quarries)	**L**	**L**	**1%**	PNVT not at risk because extent of quarries is limited and under permit system.	**R**	**L**	**L**
Motorized Recreation	**M**	**M**	**5%**	User created roads increase the risk of fire starts and the spread of invasive plants.	**R**	**M**	**M**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT	**R**	**L**	**L**
Roads	**H**	**M**	**20%**	PNVT not at risk because most system roads have been re-located from drainage bottoms to ridge tops.	**R**	**L**	**M**

- ** FS can affect stand composition and structure facilitating drought tolerance.

The primary threats to this PNVT are the combination of lack of fire disturbance, limiting nutrient cycling (and perhaps seed germination), and closed shrub states becoming more common with juniper encroaching – creating larger areas susceptible to single stand-replacing events. A continued departure is forecast. Severe elk pressure on native shrubs, including sensitive species has been demonstrated but is beyond FS authority to address. Also contributing to this is a secondary threat from bison (an exotic wildlife

species) herbivory. Fire disturbance at this point may lead to some negative outcomes for species composition, including reduced presence of Wyoming sagebrush. Increased invasive plants after wildfire is considered a moderate risk at present.

5. Montane Grasslands PNVT

Table 5.1: Comparison of the montane grassland PNVT to reference ecosystem characteristics

Kaibab NF Ecosystem Diversity Analysis													
Montane/Subalpine Grassland PNVT													
	Vegetation State (see description below)												
Vegetation State	**A**	**B**	**C**	**D**	**E**	**Total**							
Reference Condition	7	73	20	0	0		**Departure**	**FRCC**	**A**	**B**	**C**	**D**	**E**
Current Condition													
North Kaibab RD 6,544.76 acres	7	0	51	8	34	100	73	3	5	0	20	2	0
Tusayan RD 2,211,17 acres	5.6	51.7	0.8	13	28.8	99.9	41.9	2	5	51.7	0.8	2	0
Williams RD 39,827.84 acres	0	0	98	1	1	100	80	3	0	0	20	1	0
Forest 48,584 acres	1.5	2.8	84.9	2.8	8.1	100.1	75.7	3	1.5	2.8	20	2	0
Projected Trends -- Forest													
20 Years						0	100	3	0	0	0	0	0
40 Years						0	100	3	0	0	0	0	0
50 Years						0	100	3	0	0	0	0	0
100 Years						0	100	3	0	0	0	0	0
250 Years						0	100	3	0	0	0	0	0
500 Years						0	100	3	0	0	0	0	0
1000 Years						0	100	3	0	0	0	0	0

A	B	C	D	E
Young Grasses & Forbs	Mid Development Grasses & Forbs	Mature Grass & Forbs	Invasive species dominate	Tree Encroachment

Assumptions: TNC Assessment of the Montane Grasslands PNVT is not completed. Reference timeframe had more acres of Montane Grassland than present due to the encroachment of PJ, Ponderosa pine, mixed conifer, and Spruce fir into the PNVT. Midscale vegetation makes no distinction between States A & B. All acres assigned to State B due to the lack of fire in the past 2 years. The areas classified as montane grasslands on the Tusayan and Williams Districts may be Great Basin or Colorado Plateau Grasslands because they have more of a warm climate grass composition and less forb composition than one would expect in montane high elevation grasslands. Areas of PJ and ponderosa pine with a canopy cover of < than 10 percent existed under reference conditions. .

Table 5.2. Trends for structure, composition and process of the montane grassland PNVT

Structure	Composition	Process
Overstory of conifer trees are present	Increase in conifer tree composition.	Natural disturbance processes that prevent the encroachment of competing species has been interrupted.
Grasses are mature with little variety in age classes	Fewer cool season grasses and more warm season grasses	Grasslands have missed multiple FRI.

Table 5.3: Description of threats, Forest Service control/authority and associated effects to the montane grassland PNVT

Specific Threats	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing the understory grasses, forbs, shrubs and reproduction by deer, elk and other wildlife.	No.	Affects the composition, structure, and productivity of vegetation, including decreases in cool season grasses and other palatable species of grasses, forbs while increasing less palatable species.
Managed Grazing	Grazing managed under permits.	Yes	Animal are removed before grasses or forbs are fully utilized.
Invasive plants	Cheatgrass, toadflax and non-native thistles exist on < 1% of the PNVT.	Yes	Current threats are to the understory composition of grasses and forbs and mostly at the lower elevations of the PNVT.
Herbicides	Use of herbicides to reduce unwanted plants.	Yes	Has localized affects reducing invasive plants. Affects are short term. Affects can be more wide-spread if used improperly.
Thinning	Thinning treatments of trees that move the composition or structure of forest stands towards desired conditions in the	Yes	Changes in composition & structure. Can decrease in tree encroachment and maintain grasses in State C.

Specific Threats	Description of threat	Under FS control/authority	Effects
	LMP		The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.
Regeneration Cutting	Regeneration treatments to move the structure of forest stands towards desired conditions in the LMP	Yes	Changes in composition & structure. Can decrease in tree encroachment and maintain grasses in State C. Mechanized equipment can cause loss in soil productivity and minor short term accelerated erosion, and sediment delivery to streams and soil compaction without implementation of Best Management Practices. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity. Potential for non-native thistles at landings.
Uncharacteristic Wildland Fire Effects	Mixed and Stand replacement fire that occurs outside of the HRV.	Yes	Fire in areas that have tree encroachment can promote re-establishment of tree species after fire. Fire creates open growing space for conifers. High severity fire in areas with encroachment can cause soils damage that prevents the re-establishment of native grasses.
Insect/disease	Increased risk of bark beetles. Increase in mistletoe infections.	No, not under FS authority, but FS can manage stand density/resiliency.	Not known to occur in this PNVT. Grasshopper and cricket infestations have been seen on the Kaibab Plateau but the affects are not known.
Fire Use	Prescribed fire use and the use of natural ignitions for resource benefits	Yes	WFU and prescribed fire: reduces fuel hazards and tree encroachment. Fire reduces grass litter and causes a short term decline in herbaceous cover. Longer term fire increases abundance and nutrition of herbaceous understory. Increases aspen regeneration. Potential soil disturbance where fuel loadings are high that contributes to mineralization, hydrophobicity, and loss of soil productivity. These effects tend to be

Specific Threats	Description of threat	Under FS control/authority	Effects
			greater under wildland fire use because wider burning window.
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Wildfire may reduce short term fuel hazards, reduce tree encroachment. Low to medium severity burns increase abundance and nutritional quality (for wildlife) of herbaceous understory, and can alter composition. Wildfire may create areas of moderate to high burn severity that can accelerate erosion resulting in sediment delivery to connected streams, decreased water quality and soil productivity. Where fuel loadings are high, soil mineralization, hydrophobicity, and loss of soil productivity may occur. Invasive species respond positively to disturbance.
Drought	When a region receives below average precipitation over an extended period, usually ranging from several months to several years.	No. Not under FS authority. FS can control stand densities.	Decreased herbaceous productivity and can alter species composition and diversity, Reduced water re charge and storage in seeps, springs.
Climate Change	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease precipitation, and may increase annual variability of precipitation amounts. Increased transpiration may more than offset any increases in precipitation even if precipitation increases do occur. A scenario: http://geochange.er.usgs.gov/sw/impacts/biology/veg_chg_model/ Regional model concordance for temp and precipitation: http://ipcc-wg1.ucar.edu/wg1/Report/	No.	Decreased herbaceous productivity, can alter species composition and diversity, Reduced water re charge and storage in seeps, springs.

Specific Threats	Description of threat	Under FS control/authority	Effects
	suppl/docs/AR4WG1_Pub_Ch11-SM.pdf		
Minerals (uranium, quarries)	Exploration and extraction	Yes but limited due to Mining Act. Quarries are permit based.	Areas of type conversion from vegetation to bare ground. Does not occur in this PNVT
Water withdrawal (wells)	Withdrawal of water for domestic purposes.	Yes on NF No on Private	Possible drop in local water table resulting in less water quantity and connected seeps and springs and subsequent decrease in riparian habitat.
Dams/impoundments	Structures that allow for the collection of surface water	Yes	Concentrate water and alters downstream water regime. Water can concentrate wildlife and livestock resulting in soil compaction, decreased herbaceous productivity, altered composition and structure and protective vegetative ground cover. This is most likely within 1/8 mile around the impoundment. An altered downstream water regime can reduce overall riparian habitat. Riparian habitat could become established adjacent to impoundments.
Firewood cutting (illegal)	Harvest of snags and logs for personal use as fire wood.	Yes	Does not occur in this PNVT. Would reduce tree encroachment.
Roads	Poorly designed and maintained Levels 1-3 and user-created roads	Yes. Creation of user-created roads not in our control however mitigation or closure is.	Provide pathway for sediments into connected waters. Provide pathway for invasive species into forest matrix. Exposed cutbanks contribute to erosion. Use of road network increased fire risk. Road use can fragment wildlife habitat and create disturbance. Roads can be barriers to some forms of wildife.
Motorized recreation and Off highway vehicles	Any use of the forest that is tied to a motorized vehicle.	Yes through TMR and Forest Orders	User created roads and includes dispersed camping. Limited removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, reduced soil productivity, impacts to wildlife, and vectors for invasive species dispersal. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk.

Specific Threats	Description of threat	Under FS control/authority	Effects
			Increased wildlife disturbance from activities and noise.
Developed Recreation	Developed Campgrounds, trails, and special use permit areas	Yes	All localized, except accelerated invasives [covered elsewhere.]
Non-motorized dispersed recreation	Excessive or inappropriate use. Increased fire risk. Ground disturbance, vegetation damage. Poorly located, designed, or maintained trails.	Yes	Localized vegetation removal and disturbance, accelerated erosion down trails and soil compaction, and reduced effectiveness of wildlife habitat due to disturbance. Increased introduction of invasive plants. Increased fire risk as a result of increased potential ignition sources. Greater impacts around developed communities, impact levels tend to correspond with human population size. Provide pathway for sediments into connected waters. Exposed cutbanks contribute to erosion.
Solid waste dumping	Household trash, batteries, landscape waste, meth labs waste, motor oil, appliances, and vehicles.	No/Yes	Contamination of soils and water from industrial waste. Introduction of invasive plants through landscape materials, see effects for Invasive Plants. Potential injury or mortality on wildlife. Greater impacts around communities, impact levels tend to correspond with human population size. Greater impacts also occur adjacent to roads.

Table 5.4. Threat matrix evaluation of risk severity effects to the montane grassland PNVT

Note: Threats in Table 3 not under agency authority or control are not carried forward

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months*	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.**	***Reversibility***	***Risk***	
						Severity	***Likelihood***

THREAT				***Consequences***			
Unmanaged Grazing	**H**	**M**	**25%**	Affects the composition and structure of herbaceous vegetation. Areas around water sources are especially impacted.	**R**	**M**	**H**
Managed Grazing	**H**	**L**	**25%**	The forest has met the AMU/forage production objectives outlined in the 1982 plan, although some allotments continue in an unsatisfactory condition.	**R**	**L**	**H**
Invasive plants	**L**	**H**	**<1%**	Composition/structure trends: Loss of native plants, diversity reduction trending toward monoculture of annual and short-lived perennials (homogeneity) of non-native species, from what was previously complex structure (heterogenous native population) and composition. Process trend-changes the way fire moves across the landscape. Allelopathic processes affect native plant's ability to germinate and establish. The effects of invasive plants on vegetative composition, structure, and processes affect all trophic levels (insects, grazers, animals, birds, etc.).	**R**	**L**	**L**
Herbicides	**L**	**L**	**<0.001%**	Trend is to move vegetation towards reference conditions over the long-term. Effects may last 5-10 years due to repeated applications: killing non-native species, opening up growing space to be occupied by native vegetation, potentially short-term accelerated erosion. Effects to water are negligible because they are mitigated through state regulation. There can be some native plants killed.	**R**	**L**	**L**
Fuelwood cutting (dead, standing and down)	**L**	**L**	**0**	Reduced tree encroachment. Increased soil compaction and erosion from vehicle use. Loss of vegetation from user created roads.	**R**	**L**	**L**
Thinning treatments	**L**	**L**	**0%**	Shift in composition, structure, and process towards desired condition. Trends starting toward reference condition. Best Management Practices mitigate short term negative effects to soil and connected waters, lack of direction for slash pile treatments. There are BMPs for mitigation for invasive plants. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.	**R**	**L**	**L**
Fire suppression – line construction, retardant, water usage	**M**	**M**	**25**	Line construction (dozer/handline)- results in removal of herbaceous vegetation, litter and exposing mineral soil along line, and increase in invasive weeds. Retardant-minor onsite increase in nitrogen which can affect native/non-native plant competitive abilities.	**R**	**L**	**L**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Lack of fire (Fire Regime 2: Historic Fire Return Interval of < 35 Yrs. Severity would historically replace 25 to 75% of the overstory)	**M**	**M**	**25**	Structural change is increased age of grasses and encroachment by trees and shrubs. Composition change reduction in other species such as aspen, pine, or mixed conifer with a reduction in herbaceous understory replaced by increases in amount of duff and litter. Increases live and dead fuels, increasing burn severity. Process is lost fires on the landscape. In some areas the ability to reintroduce fire is limited until mechanical treatments move the stands towards HRV. Continued lack of fire will result in continued movement away from HRV.	**Y**	**M**	**M**
Insect/disease	**L**	**L**	**0**	Not known to occur in this PNVT, although grasshopper and cricket infestations on the Kaibab Plateau have occurred. The affects are not known.	**R**	**L**	**L**
Fire Use – prescribed fires and lightning started fires	**L**	**L**	**5%**	Continued fire use will reduce tree and shrub encroachment. Create mosaics of young herbaceous vegetation. Potential increase of invasive weeds. Increase in smoke emission.	**R**	**L**	**L**
Wildfire	**H**	**M**	**100**	Continued tree encroachment. Garland and Government Prairies and long narrow valleys within this PNVT will convert to pine forest within 50 years at the current rate of encroachment.	**R***	**H**	**H**
Drought	**H**	**M-H**	**100%**	Reduced plant growth and reduced water recharge.	**R****	**H**	**H and cyclic**
Climate Change	**H**	**H**	**100%**	Permanent changes in climate will likely reduce the extent of this PNVT to higher elevations.	**R****	**H**	**H**
Minerals (quarries)	**L**	**L**	**1%**	PNVT not at risk because extent of quarries is limited and under permit system.	**R**	**L**	**L**
Motorized Recreation	**M**	**M**	**5%**	User created roads increase the risk of fire starts, the spread of invasive plants, loss of soil productivity and a reduction in herbaceous vegetation.	**R**	**M**	**M**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT	**R**	**L**	**L**
Roads	**H**	**M**	**20%**	PNVT not at risk because most system roads have been re-located from drainage bottoms to ridge tops.	**R**	**L**	**M**

** FS can affect stand composition and structure facilitating drought tolerance. For long-term climate change, this type will probably change to lower-elevation species.

The primary threat to this PNVT is the lack of fire disturbance, limiting nutrient cycling and perhaps seed germination. Past ungulate pressure and perhaps current ungulate pressure may also play a substantial role, especially unmanaged grazing. Closed shrub states are becoming more common; pine and juniper also are encroaching. A continued departure is forecast. Fire disturbance at this point may lead to some negative outcomes for species composition toward invasive plants but is not deemed a high risk at present.

6. Great Basin Grasslands PNVT

Table 6.1: Comparison of the Great Basin grasslands PNVT to reference system characteristics

Great Basin Grasslands PNVT														
		Vegetation State (see description below)												
Vegetation State		**A**	**B**	**C**	**D**	**E**								
Reference Condition*		5	55	40	0	0	100	**Departure**	**FRCC**	**A**	**B**	**C**	**D**	**E**
Current Condition														
North Kaibab RD							0							
Tusayan RD	3,761.13 acres	0	0.08	27.5	59.4	13	99.98	72.42	3	0	0.08	27.5	0	0
Williams RD	40,419.44 acres	0	0	98	0.99	0.99	99.98	60	2	0	0	40	0	0
Forest	44,181 acres	0	7.09	38.2	52.3	2.4	99.99	54.71	2	0	7.09	38.2	0	0
Projected Trends -- Forest														
20 Years							0	100	3	0	0	0	0	0
40 Years							0	100	3	0	0	0	0	0
50 Years							0	100	3	0	0	0	0	0
100 Years							0	100	3	0	0	0	0	0
250 Years							0	100	3	0	0	0	0	0
500 Years							0	100	3	0	0	0	0	0
1000 Years							0	100	3	0	0	0	0	0

A	B	C	D	E
Young Grasses & Forbs	Mid development grasses &	Late development grasses > 50%	Mid-development closed	Invasives?

recovering from fire	forbs 20 to 50% cover	herbaceous cover		

Assumptions: No TNC Assessment of the Great Basin Grasslands PNVT will be completed. Reference timeframe had more acres of Great Basin Grassland than present due to the encroachment of PJ into the PNVT. Model was developed by the R-3 Herbivory Team. The reference condition percentages are a "compromise" between the R-3 Herbivory Team-developed ranges and some very different percentages in Landfire model (BPS 1511350). They are, for states A through E, < 20 vs. 5, 20 – 50 vs. 70, >= 50 vs. 20, 0 vs. 0, and 0 vs. 0, respectively, for the R3 Herbivory vs. Landfire models.

Midscale vegetation makes no distinction between young and mature grasses. All acres are assigned to State B.
Areas of PJ with a canopy cover of < than 10% existed under reference conditions. It is thought that some of the areas classified as Sagebrush Shrublands on the NKRD are actually Great Basin Grasslands.

Table 6.2. Trends for structure, composition and process of the Great Basin grasslands PNVT

Structure	Composition	Process
Overstory of PJ and ponderosa pine trees has developed in places	Increase in conifer tree cover	Natural disturbance processes that prevent the encroachment of competing species have been interrupted.
Shrub Overstory has developed in places	Increase in shrub cover	Natural processes that maintain an open grassland have been interrupted
Patch size of structural states may be larger	Increase in cheatgrass	
	Decrease in cool season grasses	

Table 6.3: Description of threats, Forest Service control/authority and associated effects to Great Basin grasslands PNVT

Specific Threats	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing the understory grasses, forbs, shrubs and reproduction by deer, elk and other wildlife.	No.	Affects the composition, structure, and productivity of understory vegetation (herbaceous, shrubs), including decreases in cool season grasses and other palatable species of grasses and forbs while increasing less palatable species.
Managed Grazing	Grazing managed under permits.	Yes	Animal are removed before grasses or forbs are fully utilized.

Specific Threats	Description of threat	Under FS control/authority	Effects
Invasive plants	Cheatgrass, toadflax and non-native thistles exist on < 1% of the PNVT.	Yes	Current threats are to the understory composition of grasses and forbs and possibly at the lower elevations of the PNVT.
Herbicides	Use of herbicides to reduce unwanted plants.	Yes	Has localized affects reducing invasive plants. Affects are short term. Affects can be more wide-spread if used improperly.
Thinning	Thinning treatments of trees that move the composition or structure of a PNVT towards desired conditions in the LMP	Yes	Changes in composition & structure. Potential decreases in tree density, decrease in canopy closure, increase in understory and variation from State e TO State C. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.
Regeneration Cutting	Regeneration treatments to move the structure of a PNVT towards desired conditions in the LMP	Yes	Changes in composition & structure. (decreases in tree density, decrease in canopy closure, increase in understory and variation). Moves an area from State E to State C. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity. Potential for non-native thistles at landings.
Uncharacteristic Wildland Fire Effects	Fire effects that occur outside of the HRV.	Yes	Fire in areas with tree encroachment may have fire effects that are more severe than HRV. Damage could occur to soils were tree litter accumulations are high. Loss of soil productivity

Specific Threats	Description of threat	Under FS control/authority	Effects
			can occur. Watershed function and health may be affected. Accelerated soil erosion can occur in areas with moderate to high erosion potential. Re-establishment of grasses may be delayed in areas with soils damage.
Insect/disease	Increased incidence of bark beetles. Increase in mistletoe infections.	No, not under FS authority, but FS can manage stand density/resiliency.	Not known to occur in this PNVT and would be restorative, if it did. Grasshopper and cricket outbreaks have occurred on the Arizona Strip. Their effects are unknown.
Fire Use	Prescribed fire use and the use of natural ignitions for resource benefits	Yes	WFU and prescribed fire: reduces fuel hazards and tree densities. Increases abundance and nutrition of herbaceous understory. Initially increases Gambel oak and alligator juniper regeneration where they have encroached. Repeated fireand drought may decrease shrubs over time. Potential soil disturbance where fuel loadings are high that contributes to mineralization, hydrophobicity, and loss of soil productivity.
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Wildfire may reduce short term fuel hazards and reduce tree densities. May improve Gambel oak, New Mexico locust and alligator juniper regeneration. Low to medium severity burns increase abundance and nutritional quality (for wildlife) of herbaceous understory, and can alter

Specific Threats	Description of threat	Under FS control/authority	Effects
			composition. Wildfire may create areas of moderate to high burn severity that can accelerate erosion resulting in sediment delivery to connected streams, decreased water quality and soil productivity. Where fuel loadings are high, soil mineralization, hydrophobicity, and loss of soil productivity may occur. Invasive species respond positively to disturbance.
Drought	When a region receives below average precipitation over an extended period, usually ranging from several months to several years.	No. Not under FS authority. FS can control stand densities.	May be restorative: Increases tree mortality, susceptibility to disease and insects. But, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduce cover of litter causing increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and storage in seeps, springs. Reduces tree growth.
Climate Change	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease precipitation, and may increase annual variability of precipitation amounts. Increased transpiration may more than offset any increases in precipitation even if precipitation increases do occur. A scenario: http://geochange.er.usgs.gov/sw/impacts/biology/veg_chg_model/ Regional model concordance for temp and precip: http://ipcc-wg1.ucar.edu/wg1/Report/	No.	Increases tree mortality, susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduce cover of litter causes increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and

Specific Threats	Description of threat	Under FS control/authority	Effects
	suppl/docs/AR4WG1_Pub_Ch11-SM.pdf		storage in seeps and springs. Reduces tree growth. See Regional letter on how to address global warming in revision. Longer and more severe droughts. As temperatures rise, the effects of these are more severe. Fire season can start earlier and last longer.
Minerals (uranium, quarries)	Exploration and extraction	Yes but limited due to Mining Act. Quarries are permit based.	Areas of type conversion from vegetation to bare ground.
Water withdrawal (wells)	Withdrawal of water for domestic purposes.	Yes on NF No on Private	Possible drop in local water table resulting in less water quantity and connected seeps and springs and subsequent decrease in riparian habitat.
Dams/impoundments	Structures that allow for the collection of surface water	Yes	Concentrate water and alters downstream water regime. Water can concentrate wildlife and livestock resulting in soil compaction, decreased herbaceous productivity, altered composition and structure and protective vegetative ground cover. This is most likely within 1/8 mile around the impoundment. An altered downstream water regime can reduce overall riparian habitat. Riparian habitat could become established adjacent to impoundments.
Firewood cutting (illegal)	Harvest of snags and logs for personal use as fire wood.	Yes	Does not occur in this PNVT
Roads	Poorly designed and maintained Levels 1-3 and user-created roads	Yes. Creation of user-created roads not in our control however mitigation or	Provide pathway for sediments into connected waters. Provide pathway for invasive species into forest matrix. Exposed cutbanks

Specific Threats	Description of threat	Under FS control/authority	Effects
		closure is.	contribute to erosion. Use of road network increased fire risk. Road use can fragment wildlife habitat and create disturbance. Roads can be barriers to some forms of wildlife.
Motorized recreation and Off highway vehicles	Any use of the forest that is tied to a motorized vehicle.	Yes through TMR and Forest Orders	User created roads and includes dispersed camping. Limited removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, reduced soil productivity, impacts to wildlife, and vectors for invasive species dispersal. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk. Increased wildlife disturbance from activities and noise.
Developed Recreation	Developed Campgrounds, trails, and special use permit areas	Yes	Does not occur in this PNVT
Non-motorized dispersed recreation	Excessive or inappropriate use. Increased fire risk. Ground disturbance, vegetation damage. Poorly located, designed, or maintained trails.	Yes	Localized vegetation removal and disturbance, accelerated erosion down trails and soil compaction, and reduced effectiveness of wildlife habitat due to disturbance. Increased introduction of invasive plants. Increased fire risk as a result of increased potential ignition sources. Greater impacts around developed communities, impact levels tend to correspond with human population size. Provide pathway for sediments into connected waters. Exposed

Specific Threats	Description of threat	Under FS control/authority	Effects
			cutbanks contribute to erosion.
Solid waste dumping	Household trash, batteries, landscape waste, meth labs waste, motor oil, appliances, and vehicles.	No/Yes	Contamination of soils and water from industrial waste. Introduction of invasive plants through landscape materials, see effects for Invasive Plants. Potential injury or mortality on wildlife. Greater impacts around communities, impact levels tend to correspond with human population size. Greater impacts also occur adjacent to roads.

Table 6.4. Threat matrix evaluation of risk severity effects to the Great Basin grassland PNVT

Note: Threats in Table 3 not under agency authority or control were not carried forward

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months*				**Screened out in Table 3.**		***Risk***	
				Carried forward past Table 4 evaluation.			
THREAT	***Extent***	***Duration***	***Severity***	***Consequences***	***Reversibility***	***Threat Severity overall***	***Likelihood***
Unmanaged Grazing	**H**	**M**	**25%**	Reduction in cool season grasses. Reduction in grass amounts and composition diversity. Areas around water sources are especially impacted.	**R**	**M**	**H**
Managed Grazing	**H**	**L**	**15%**	The forest has met the AMU/forage production objectives outlined in the 1982 plan, although some allotments continue in an unsatisfactory condition, especially in this PNVT	**R**	**M**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months*				**Screened out in Table 3.**		***Risk***	
				Carried forward past Table 4 evaluation.			
THREAT	***Extent***	***Duration***	***Severity***	***Consequences***	***Reversibility***	***Threat Severity overall***	***Likelihood***
Invasive plants	**M**	**H**	**<0.1%**	Composition/structure trends: Loss of native plants, diversity reduction trending toward monoculture of annual and short-lived perennials (homogeneity) of non-native species, from what was previously complex structure (heterogenous native population) and composition. Process trend-changes the way fire moves across the landscape. Allelopathic processes affect native plant's ability to germinate and establish. The effects of invasive plants on vegetative composition, structure, and processes affect all trophic levels (insects, grazers, animals, birds, etc.).	**R**	**M**	**M**
Herbicides	**L**	**L**	**<0.001%**	Trend is to move vegetation towards reference conditions over the long-term. Effects may last 5-10 years due to repeated applications: killing non-native species, opening up growing space to be occupied by native vegetation, potentially short-term accelerated erosion. Effects to water are negligible because they are mitigated through state regulation. There can be some native plants killed.	**R**	**L**	**M**
Fuelwood cutting (dead, standing and down)	**L**	**L**	**0%**	Reduction in tree encroachment. Maintain State C.	**R**	**L**	**L**
Thinning treatments	**L**	**L**	**5%**	Shift in composition, structure, and process towards desired condition. Trends starting toward reference condition. Best Management Practices mitigate short term negative effects to soil and connected waters, lack of direction for slash pile treatments. There are BMPs for mitigation for invasive plants. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.	**R**	**L**	**M**
Fire suppression – line construction, retardant, water usage	**L**	**L**	**100**	Line construction (dozer/handline)- results in removal of herbaceous vegetation, litter and exposing mineral soil along line, and increase in invasive weeds. Retardant-minor onsite increase in nitrogen which can affect native/non-native plant competitive abilities.	**R**	**L**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Lack of fire (Fire Regime 2: Historic Fire Return Interval of < 35 Yrs. Severity would historically replace 25 to 75% of the herbaceous cover)	**H**	**H**		Structural change is tree and shrub encroachment resulting in shaded grasses and reduced growing space for herbaceous vegetation. Composition change reduction in herbaceous species replaced by increases in amount of tree and shrub duff and litter. Increases live and dead fuels, increasing burn severity. Process is lost fires on the landscape. Continued lack of fire will result in continued movement away from HRV.	**Y**	**H**	**M**
Insect/disease	**L**	**L**	**0**	Not known to change states in this PNVT	**R**	**L**	**L**
Fire Use – prescribed fires and lightning started fires	**L**	**L**	**20%**	Continued fire use will reduce the threat of uncharacteristic fire effects to the PNVT. Potential increase of invasive weeds. Increase in smoke emission.	**R**	**L**	**M**
Wildfire	**M**	**M**	**20%**	Wildfire reduces encroachment. Fire effects may be more severe than HRV resulting in soil damage and soil loss.	**R***	**M**	**H**
Drought	**H**	**M-H**	**100%**	Reduced plant growth, reduced litter (increased erosion), increased invasive plant infestations, increased plant mortality, increased severity of fire effects, and reduced water recharge.	**R****	**H**	**H and cyclic**
Climate Change	**H**	**H**	**100%**	Permanent changes in climate will likely reduce the extent of this PNVT to higher elevations and north facing slopes. The effects could make the affects of wildland fire and insects permanent.	**R****	**H**	**H**
Minerals (quarries)	**L**	**L**	**1%**	PNVT not at risk because extent of quarries is limited and under permit system.	**R**	**L**	**L**
Motorized Recreation	**L**	**L**	**5%**	User created roads increase the risk of fire starts and the spread of invasive plants.	**R**	**L**	**L**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT	**R**	**L**	**L**
Roads	**L**	**M**	**20%**	PNVT not at risk because most system roads have been re-located from drainage bottoms to ridge tops.	**R**	**L**	**M**

- ** FS can affect stand composition and structure facilitating drought tolerance.

The primary threat to this PNVT is the lack of fire disturbance, limiting nutrient cycling and perhaps seed germination. Closed shrub states are becoming more common and juniper also is encroaching. Past ungulate pressure and perhaps current ungulate pressure may also play a substantial role. A continued departure is forecast. Fire disturbance at this point may lead to some negative outcomes for species composition toward invasive plants but is not deemed a high risk at present.

7. Spruce Fir PNVT

Table 7.1: Comparison of spruce-fir PNVT to midscale ecosystem characteristics

Kaibab NF Ecosystem Diversity Analysis																	
Spruce-fir Forest PNVT																	
	Vegetation State (see description below)																
Vegetation State	**A**	**B**	**C**	**D**	**E**	**F**	**G**										
Reference Condition	0.1	3.54	12.7	27.05	21.95	15.79	18.18	99.31	**Departure**	**FR CC**	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Current Condition																	
North Kaibab RD 29,002.49 acres	1.33	5.48	6.47	1.83	9.92	70.05	4.93	100	57.42	2	0.1	3.54	6.47	1.83	9.92	15.79	4.93
Tusayan RD																	
Williams RD 144.09 acres	0	71.55	0.69	0	10.22	17.54	0	100	69.76	3	0	3.54	0.69	0	10.22	15.79	0
Forest 29,147 acres	1.32	5.8	6.45	1.82	9.92	69.79	4.91	100	57.47	2	0.1	3.54	6.45	1.82	9.92	15.79	4.91
Projected Trends -- Forest																	
20 Years	0.54	8.37	10.6	3.15	8.51	52.14	16.65	100	41.62	2	0.1	3.54	10.6	3.15	8.51	15.79	16.7
40 Years	0.51	9.66	8.99	3.1	6.83	43.6	27.31	100	43.47	2	0.1	3.54	8.99	3.1	6.83	15.79	18.2
50 Years	0.05	9.55	6.93	2.75	6.38	41.48	32.92	100.1	46.38	2	0.05	3.54	6.93	2.75	6.38	15.79	18.2
100 Years	0.045	9.5	4.55	3.09	6.36	28.67	47.78	100	48.445	2	0.05	3.54	4.55	3.09	6.36	15.79	18.2
250 Years	0.47	9.89	2.02	4.41	6.3	19.81	57.1	100	49.66	2	0.1	3.54	2.02	4.41	6.3	15.79	18.2
500 Years	0.53	10.08	1.63	4.16	6.69	19.19	57.72	100	49.91	2	0.1	3.54	1.63	4.16	6.69	15.79	18.2
1000 Years	0.4	9.43	1.78	4.37	7.03	18.21	58.78	100	49.21	2	0.1	3.54	1.78	4.37	7.03	15.79	18.2

	Ecosystem Characteristic -- Vegetation State						
Vegetation State	A	B	C	D	E	F	G
	Grass & forbs with aspen ramlets, and seedlings Open	Aspen and young forest understory Open	Mid aged forest w/regeneration Open	Old forest w/regeneration Open	Young forest with no aspen, shade intolerant conifers Closed	Mid aged forest w/regeneration Closed	Old forest w/regeneration Closed

Assumptions: This is wet mixed conifer model (for the Kaibab) not spruce-fir model.

In states D, G, E, all age classes are represented yet is dominated by large size classes of trees. This would be a result of mixed severity and stand replacement fires as a dominant disturbance.

A comparison of 1940 photos to current shows that aspen is not as dominant because it has been overtopped. Some of current B should be C and F, size classes and composition. C/F is no longer aspen based on classification used in midscale. What was used to move from B to C/F – QMD? SDI?

Table 7.2. Trends for structure, composition and process of the spruce-fir PNVT

Structure	Composition	Process
There is 50% more mid aged forest with closed canopy (state f) than historically. There is less old open forest than historically given the assumption of more open forest historically.	Fulé and TNC suggest there is a trend towards more spruce and cork bark fir on the Kaibab Plateau. Shade tolerant species are replacing shade intolerant or fire adapted species. The trees per acre of white and corkbark fir have doubled since 1880 (Fulé et al 2003c).	
There is a trend towards more state F than reference.	Spruce fir has expanded outside its historical boundaries into mixed conifer, ponderosa pine and montane grasslands.	
	Most of the PNVT is on the North Kaibab. Aspen populations are declining due to competition with overstory conifers. There are 145 acres south of the Grand Canyon on the Williams District on cinder cones such as Kendrick Mountain and perhaps Sitgreaves. On the WRD there is short term increase in aspen reproduction following fire. Herbivore foraging eliminates a percentage of the sprouts before they can grow into poles. Long term trend is declining aspen regeneration.	
	Springs and seeps extent is static (compared to estimated historic numbers). Condition and flow are	

Structure	Composition	Process
	unknown (assumed that they existed historically). Earthen tanks have increased in number since reference due to construction. Other identified wetlands and riparian areas are not present within spruce fir.	
	Soil condition (soil loss) is static. (96% satisfactory current soil condition compared to the same amount historically). It is assumed that human affects to historic soil conditions were minimal.	Soil erosion trend is static except following wildfires where it becomes more extensive and accelerated and poses a threat to watershed function.
	Soil productivity is static.	Soil productivity is not static following wildfires followed by strong monsoonal moisture events on soil with moderate or high erosion hazard due to loss of surface litter and organic layers.
High overstory canopy cover tends to lower herbaceous productivity and cover. (need reference)	Stream flow water yield trend ranges from static to slightly upward (Steinke 2007, short term analysis). This includes Kanab and Lower Colorado drainages but not North Canyon.	Soil hydrology (compaction) and nutrient cycling functions is unknown. The existing protecting surface duff layer is adequate to prevent compaction in most areas except following wildfires.
Fewer large trees because of increased densities and higher competition. Consequently, there may be fewer large snags grown and fewer large downed logs		Western spruce budworm outbreaks did not occur on N. Kaibab prior to 1950's. Outbreaks have occurred in remainder of forest prior to 50s. Severity has increased since then (Lynch et al 2007).
Trend towards less structural variation across landscape. TNC report indicates more heterogeneity in stands and less heterogeneity in structure currently. More even aged and more continuous now and less patchiness. See also Fulé et al 2003c.		Spruce budworm beetle activity increased markedly since the 1950's. Beetle activity has made mixed conifer trees more susceptible to western spruce budworm defoliation (Lynch et al 2007).
Increased density of logs and snags		Trend is towards larger, stand replacement fires and greater acreages of high burn severity resulting in more severe effects to

Structure	Composition	Process
		watershed functions.
The increase in multiple canopy layers results in an increase in ladder fuels.		Trend is towards larger stand replacement fires and canopy consumption.
Fire condition class: 52% CC3, 38% CC2, 9% CC1. About ½ of spruce fir is outside HRV due to interruption of ecological processes and changes of composition and structure. About 9% is within range of HRV. The remainder is on the edge of HRV but trending towards being outside HRV.	Higher surface needle litter, downed woody debris in all size classes increases fuel loading which increases flame length which can lead to higher scorch height and canopy consumption.	Fire regime 4 which is greater than 150 year interval with lethal fire effects to the overstory.

Table 7.3: Description of threats, Forest Service control/authority and associated effects to spruce-fir PNVT

Specific Threats	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing the understory grasses, forbs, shrubs and reproduction by deer, elk and other wildlife.	No – control. Yes – Can mitigate in very limited areas.	Affects the composition, structure, and productivity of understory vegetation (herbaceous forbs and grasses, shrubs, young trees (aspen and conifers), including decreases in cool season grasses and other palatable species of grasses, forbs and aspen while increasing less palatable species.
Managed Grazing	Grazing managed under permits.	Yes	Animal are removed before grasses or forbs are fully utilized.
Invasive plants	Toadflax and non-native thistles exist on < 1% of the PNVT.	Yes	Less than one-tenth of 1 percent of the dry mixed conifer and spruce fir forest has invasive weeds established. Dalmatian toadflax and bull thistle are most common
Herbicides	Use of herbicides to reduce unwanted plants.	Yes	Has localized affects reducing invasive plants. Affects are short term. Affects can be more wide-spread if used improperly.
Thinning	Thinning treatments of trees that move the composition or structure of forest stands towards desired conditions in the LMP	Yes	Changes in composition & structure. (Potential decreases in tree density, decrease in canopy closure, increase in understory and variation). Loss of natural clumping and grouping (canopy interlock) of forest structure. Minor short term accelerated erosion, and sediment delivery to streams and soil compaction

Specific Threats	Description of threat	Under FS control/authority	Effects
			without implementation of Best Management Practices. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.
Regeneration Cutting	Regeneration treatments to move the structure of forest stands towards desired conditions in the LMP	Yes	Changes in composition & structure. (decreases in tree density, decrease in canopy closure, increase in understory and variation). Loss of old and large trees there natural arrangement (legacy trees may not be left in cuts less than 1 acre). Loss of green trees with benefits for wildlife (spike tops, lightning struck, etc). Minor short term accelerated erosion, and sediment delivery to streams and soil compaction without implementation of Best Management Practices. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity. Potential for non-native thistles at landings.
Uncharacteristic Wildland Fire Effects	Mixed and Stand replacement fire that occurs outside of the HRV.	Yes	Increases canopy closure, tree density duff, snags, downed woody material, ladder fuels, fuel loading, decreases composition, diversity, productivity of herbaceous and shrub understory, reduces carbon nitrogen ratio, decreases age and species diversity. Increase fire severity to watershed from sterilized soils and reduction in mychorrizae.
Insect/disease	Increased risk of bark beetles. Increase in mistletoe infections.	No, not under FS authority, but FS can manage stand density/resiliency.	Increased risk of epidemic bark beetle infestations which could cause loss of older age classes in small to large patches. Increases number of snags and eventually downed logs. Increases fire hazard of needle litter, downed woody material, and live understory fuels. Aspen defoliation is occurring at a higher frequency and extent. Increase herbaceous understory where patches of mortality have occurred.

Specific Threats	Description of threat	Under FS control/authority	Effects
Fire Use	Prescribed fire use and the use of natural ignitions for resource benefits	Yes	WFU and prescribed fire: reduces fuel hazards, tree densities, creates openings in canopy. Increases abundance and nutrition of herbaceous understory. Improves aspen regeneration. Potential loss of snags, downed logs, large trees, oak especially when first entry. Potential soil disturbance where fuel loadings are high that contributes to mineralization, hydrophobicity, and loss of soil productivity. These effects tend to be greater under wildland fire use because wider burning window.
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Wildfire may reduce short term fuel hazards, reduce tree densities, and creates openings in canopy and can kill a lot of stuff in a big area in a big hurry. Wildfires can create large treeless areas that take a long time to regenerate back to trees. May improve aspen regeneration. Loss of persistent snags, downed logs, large trees, oak depending on intensity while at the same time, more ephemeral snags and downed logs can be created. Low to medium severity burns increase abundance and nutritional quality (for wildlife) of herbaceous understory, and can alter composition. Wildfire may create areas of moderate to high burn severity that can accelerate erosion resulting in sediment delivery to connected streams, decreased water quality and soil productivity. Where fuel loadings are high, soil mineralization, hydrophobicity, and loss of soil productivity may occur. Invasive species respond positively to disturbance.
Drought	When a region receives below average precipitation over an extended period, usually ranging from several months to several years.	No- authority. Yes - FS can control stand densities.	Increases tree mortality, susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduce cover of litter causes increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand

Specific Threats	Description of threat	Under FS control/authority	Effects
			replacement fire. Reduced water re charge and storage in seeps, springs. Reduces tree growth.
Climate Change	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease precipitation, and may increase annual variability of precipitation amounts. Increased transpiration may more than offset any increases in precipitation even if precipitation increases do occur. A scenario: http://geochange.er.usgs.gov/sw/impacts/biology/veg_chg_model/ Regional model concordance for temp and precipitation: http://ipcc-wg1.ucar.edu/wg1/Report/suppl/docs/AR4WG1_Pub_Ch11-SM.pdf	No.	Increases tree mortality, susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, increase canopy openings, reduce cover of litter causes increased susceptibility to soil erosion and subsequent sediment delivery to connected streams. Increased susceptibility to stand replacement fire. Reduced water re charge and storage in seeps and springs. Reduces tree growth. Longer and more severe droughts. As temperatures rise, the effects of these are more severe. Fire season can start earlier and last longer.
Minerals (uranium, quarries)	Exploration and extraction	Yes but limited due to Mining Act. Quarries are permit based.	Areas of type conversion from vegetation to bare ground.
Water withdrawal (wells)	Withdrawal of water for domestic purposes.	Yes on NF No on Private	Possible drop in local water table resulting in less water quantity and connected seeps and springs and subsequent decrease in riparian habitat.
Dams/impoundments	Structures that allow for the collection of surface water	Yes	Concentrate water and alters downstream water regime. Water can concentrate wildlife and livestock resulting in soil compaction, decreased herbaceous productivity, altered composition and structure and protective vegetative ground cover. This is most likely within 1/8 mile around the impoundment. An altered downstream water regime can reduce overall riparian habitat. Riparian habitat could become established adjacent to impoundments.
Firewood cutting (illegal)	Harvest of snags and logs for personal use as fire wood.	Yes	Reduction of snags and downed woody material

Specific Threats	Description of threat	Under FS control/authority	Effects
Roads	Poorly designed and maintained Levels 1-3 and user-created roads	Yes. Creation of user-created roads not in our control however mitigation or closure is.	Provide pathway for sediments into connected waters. Provide pathway for invasive species into forest matrix. Exposed cutbanks contribute to erosion. Use of road network increased fire risk. Road use can fragment wildlife habitat and create disturbance. Roads can be barriers to some forms of wildlife.
Motorized recreation and Off highway vehicles	Any use of the forest that is tied to a motorized vehicle.	Yes through TMR and Forest Orders	User created roads and includes dispersed camping. Limited removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, reduced soil productivity, impacts to wildlife, and vectors for invasive species dispersal. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk. Increased wildlife disturbance from activities and noise.
Developed Recreation	Developed Campgrounds, trails, and special use permit areas	Yes	All localized, except accelerated invasives [covered elsewhere.]
Non-motorized dispersed recreation	Excessive or inappropriate use. Increased fire risk. Ground disturbance, vegetation damage. Poorly located, designed, or maintained trails.	Yes	Localized vegetation removal and disturbance, accelerated erosion down trails and soil compaction, and reduced effectiveness of wildlife habitat due to disturbance. Increased introduction of invasive plants. Increased fire risk as a result of increased potential ignition sources. Greater impacts around developed communities, impact levels tend to correspond with human population size. Provide pathway for sediments into connected waters. Exposed cutbanks contribute to erosion.
Solid waste dumping	Household trash, batteries, landscape waste, meth labs waste, motor oil, appliances, and vehicles.	No/Yes	Contamination of soils and water from industrial waste. Introduction of invasive plants through landscape materials, see effects for Invasive Plants. Potential injury or mortality on wildlife. Greater impacts around communities, impact levels tend to correspond with human population size. Greater impacts also occur adjacent to

Specific Threats	Description of threat	Under FS control/authority	Effects
			roads.

Table 7.4. Threat matrix evaluation of risk severity effects to the spruce-fir PNVT

Note: Threats in Table 3 not under agency authority or control were not carried forward

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Unmanaged Grazing	**H**	**M**	**25%**	Aspen may be affected by elk on the Williams RD in this type but it is of very limited distribution and may receive little ungulate pressure.	**R**	**L**	**L**
Managed Grazing	**H**	**L**	**25%**	The forest has met the AMU/forage production objectives outlined in the 1982 plan, although some allotments continue in an unsatisfactory condition.	**R**	**L**	**M**
Invasive plants	**L**	**H**	**<0.1%**	Composition/structure trends: Loss of native plants, diversity reduction trending toward monoculture of annual and short-lived perennials (homogeneity) of non-native species, from what was previously complex structure (heterogeneous native population) and composition. Process trend-changes the way fire moves across the landscape. Allelopathic processes affect native plant's ability to germinate and establish. The effects of invasive plants on vegetative composition, structure, and processes affect all trophic levels (insects, grazers, animals, birds, etc.).	**R**	**L**	**L**
Herbicides	**L**	**L**	**<0.001%**	Trend is to move vegetation towards reference conditions over the long-term. Effects may last 5-10 years due to repeated applications: killing non-native species, opening up growing space to be occupied by native vegetation, potentially short-term accelerated erosion. Effects to water are negligible because they are mitigated through state regulation. There can be some native plants killed.	**R**	**L**	**L**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Fuelwood cutting (dead, standing and down)	**L**	**M**	**<10%**	In areas closest to roads, medium to large oaks are removed, and large pine snags are removed- affecting structure and composition. Reduction of snags and oak. Greater impacts around communities, impact levels tend to correspond with human population size.	**R**	**L**	**L**
Thinning treatments	**L**	**L**	**25%**	Shift in composition, structure, and process towards desired condition. Trends starting toward reference condition. Best Management Practices mitigate short term negative effects to soil and connected waters, lack of direction for slash pile treatments. There are BMPs for mitigation for invasive plants. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.	**R**	**L**	**L**
Fire suppression – line construction, retardant, water usage	**L**	**L**	**100**	Line construction (dozer/handline)- results in removal of herbaceous vegetation, litter and exposing mineral soil along line, and increase in invasive weeds. Reduction in snags along firelines. Burnouts may create stand replacement fire effects. Retardant-minor onsite increase in nitrogen which can affect native/non-native plant competitive abilities.	**R**	**L**	**H**
Lack of fire (Fire Regime 3 or 4: Historic Fire Return Interval of < 35 to 250 Yrs. Severity would historically replace 25 to 75% of the overstory)	**M**	**H**	**100**	Given the amount of State F most of the PNVT has missed at least one FRI. Structural change is increased tree density, changing from open to closed canopy. Composition change reduction in other species such as oak or aspen, with a reduction in herbaceous understory replaced by increases in amount of pine duff and litter. Increases live and dead fuels, increasing burn severity. Process is lost fires on the landscape. In some areas the ability to reintroduce fire is limited until mechanical treatments move the stands towards HRV. Continued lack of fire will result in continued movement away from HRV.	**Y**	**H**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Insect/disease	**M**	**M**	**100**	Decrease canopy cover, tree density. Increase fuel loadings. Shift to younger trees. Increase snags, logs. Outbreaks are more frequent than prior to the 1950's. This increased frequency has remained consistent in the past 10 years. Change in structure- primarily loss of older trees, reduced tree growth, tree vigor, increases number of snags and eventually downed logs.	**R**	**L**	**M**
Fire Use – prescribed fires and lightning started fires	**M**	**M**	**20%**	Continued fire use can reduce the threat of mixed severity and stand replacement fire to the PNVT. Can loose control of these fires with serious adverse outcomes. Potential increase of invasive weeds. Increase in smoke emission. Fire use in this PNVT is currently limited.	**R**	**L**	**H**
Wildfire	**M**	**L**	**20%**	Structure, composition, and function of this PNVT are at an increasing risk of loss due to changing fuel conditions. Adverse effects to soil, including accelerated erosion, loss of productivity, and degraded water quality. Fire can increase invasive plants. The small scale heterogeneity of structure could be lost.	**R***	**H**	**H**
Drought	**H**	**M-H**	**100%**	Reduced plant growth, reduced litter (increased erosion), increased invasive plant infestations, increased plant mortality, increased severity of fire effects, and reduced water recharge.	**R****	**M**	**H and cyclic**
Climate Change	**H**	**H**	**100%**	Permanent changes in climate will likely reduce the extent of this PNVT to higher elevations and north facing slopes. The effects could make the affects of wildland fire and insects permanent.	**R****	**H**	**H**
Minerals (quarries)	**L**	**L**	**1%**	PNVT not at risk because extent of quarries is limited and under permit system.	**R**	**L**	**L**
Motorized Recreation	**M**	**M**	**5%**	User created roads increase the risk of fire starts and the spread of invasive plants.	**R**	**M**	**M**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT	**R**	**L**	**L**
Roads	**H**	**M**	**20%**	PNVT not at risk because most system roads have been re-located from drainage bottoms to ridge tops.	**R**	**L**	**M**

- *Reversible because treatments can be done within and adjacent to patches to reduce effects and fires can be suppressed.

- ** FS can affect stand composition and structure facilitating drought tolerance.

The primary threat to this PNVT is the lack of fire disturbance. While generally counter-intuitive for this PNVT, local, peer-reviewed research (Fulé, et al. 2003b) shows this type has been significantly influenced by fires in adjacent PNVTs in close proximity historically. Much of the PNVT as mapped may in fact be Ponderosa Pine or one of the Mixed Conifer Forest PNVTs. A species shift toward Engelmann spruce and corkbark fir – away from aspen, ponderosa pine and Douglas-fir – has been demonstrated. Because of that, canopy cover is denser and more continuous across States. When fires occur now, they carry a significant risk of a negative outcome, further departing states and species composition. For this reason, the secondary threats of wildfire and drought are also carried forward for this PNVT. The insect/disease threat (with Low/Moderate ratings) is also a function of canopy cover and species composition shifts.

Tree density and species relative abundance are the primary characteristics that are departed. Older tree states may also be missing in some cases, but in others they are present but masked by the overabundance of younger trees.

8. Semi-desert Grasslands PNVT

Table 8.1: Comparison of the semi-desert grassland PNVT to reference ecosystem characteristics

Kaibab NF Ecosystem Diversity Analysis				run September 13,2007 rt											
Semi-desert Grassland PNVT				see document - VDDT Inputs for disturbance frequencies											
		Vegetation State (see description below)													
Vegetation State		**A**	**B**	**C**	**D**	**E**	**Total**								
Reference Condition		19.2	80.4	0.4	0.002	0	100	**Departure**	**FRCC**	**A**	**B**	**C**	**D**	**E**
Current Condition															
North Kaibab RD	25,115 acres	0	69.7	10.5	18	1.9	100	29.898	1	0	69.7	0.04	0.002	0
Tusayan RD															
Williams RD															
Forest	25,115 acres	0	69.7	10.5	18	1.9		29.898	1	0	69.7	0.04	0.002	0
Projected Trends -- Forest															
20 Years		0.09	36.56	38.81	22.73	1.81	100	62.948	2	0.09	36.56	0.04	0.002	0
40 Years		0.05	3.72	67.57	26.85	1.81	100	95.828	3	0.05	3.72	0.04	0.002	0
50 Years		0.02	2.24	57.26	38.66	1.82	100	97.338	3	0.02	2.24	0.04	0.002	0
100 Years		0.03	0.68	5.81	91.67	1.81	100	98.888	3	0.03	0.68	0.04	0.002	0
250 Years		0.04	0.66	1.71	95.75	1.84	100	98.898	3	0.04	0.66	0.04	0.002	0
500 Years		0.01	0.68	1.49	95.94	1.88	100	98.908	3	0.01	0.68	0.04	0.002	0
1000 Years		0.01	0.68	1.49	95.94	1.88	100	98.908	3	0.01	0.68	0.04	0.002	0

A	B	C	D	E
Grass & Forb Regeneration <5% shrub cover	Perennial Grasses 5 to 10% shrub cover	Perennial Grasses 11 to 30% shrub cover	Shrubs & Perennial Grasses 31 to 60% Shrub cover	Invasive Species Dominate

Assumptions: Reference conditions from the TNC Model results using a 10 year FRI. Current conditions are from R3 Midscale Vegetation data. Very little wildland fire has occurred within Semi-desert Grasslands in the past 30 years. Using Midscale data there is no way to assign acres to State E. Currently, there is little management occurring in this PNVT.

Table 8.2. Trends for structure, composition and process of the semi-desert grassland PNVT

Structure	Composition	Process
Overstory of shrubs has developed	Increase in Shrubs and Juniper	Lack of herbaceous ground cover has led to more erosion
Overstory of PJ is developing	Increase in cheat grass	There is a lack of disturbance to promote regeneration
		Grasses and forbs complete with shrubs and juniper for available sunlight, moisture and nutrients

Table 8.3: Description of threats, Forest Service control/authority and associated effects to semi-desert grassland PNVT

Specific Threats	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing grasses, forbs and shrubs by deer, elk and other wildlife.	No	Affects the composition, structure, and productivity, including decreases in cool season grasses and other palatable species of grasses and forbs while increasing less palatable species.
Unmanaged Grazing	Grazing grasses, forbs, shrubs and reproduction **by bison.**	Yes. (Buffalo Ranch is covered by an MOU. FS has the authority to control populations in the GC Game Preserve.)	Affects the composition, structure, and productivity, including decreases in cool season grasses and other palatable species of grasses and forbs while increasing less palatable species. May also reduce shrub diversity when grasses become limited.
Managed Grazing	Grazing managed under permits.	Yes	Animal are removed before grasses or forbs are fully utilized.
Invasive plants	Cheatgrass, toadflax and	Yes	Current threats are to the understory composition of grasses

Specific Threats	Description of threat	Under FS control/authority	Effects
	non-native thistles exist on about 2% of the PNVT.		and forbs.
Herbicides	Use of herbicides to reduce unwanted plants.	Yes	Has localized affects reducing invasive plants. Affects are short term. Affects can be more wide-spread if used improperly.
Thinning	Thinning treatments of trees that move the composition or structure of forest stands towards desired conditions in the LMP	Yes	Changes in composition & structure. Reduction of tree encroachment. Creation of bare soils could lead to the spread of invasive plants. Burning of juniper slash could lead to soil sterilization.
Regeneration Cutting	Regeneration treatments to move the structure of forest stands towards desired conditions in the LMP	Yes	Changes in composition & structure. Reduction of tree encroachment. Creation of bare soils could lead to the spread of invasive plants. Burning of juniper slash could lead to soil sterilization.
Uncharacteristic Wildland Fire Effects	Mixed and Stand replacement fire that occurs outside of the HRV.	Yes	Decreases composition, diversity, productivity of herbaceous and shrub vegetation. Increase fire severity to watershed from sterilized soils and reduction in mychorrizae.
Insect/disease	Increased risk of bark beetles. Increase in mistletoe infections.	No, not under FS authority, but FS can manage stand density/resiliency.	Not known to occur in this PNVT, although infestations of grasshoppers and crickets have been seen on the Kaibab Plateau. The affects are unknown.
Fire Use	Prescribed fire use and the use of natural ignitions for resource benefits	Yes	WFU and prescribed fire: reduces fuel hazards tree encroachment. Increases abundance and nutrition of herbaceous understory. Potential soil disturbance where fuel loadings are high that contributes to mineralization, hydrophobicity, and loss of soil productivity.
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Wildfire may reduce short term fuel hazards, reduce tree encroachment. Low to medium severity burns increase abundance and nutritional quality (for wildlife) of herbaceous understory, and can alter composition. Wildfire may create areas of moderate to high burn severity that can accelerate erosion resulting in sediment delivery to connected streams, decreased water quality and soil productivity. Where fuel loadings are high, soil mineralization, hydrophobicity, and loss

Specific Threats	Description of threat	Under FS control/authority	Effects
			of soil productivity may occur. Invasive species respond positively to disturbance.
Drought	When a region receives below average precipitation over an extended period, usually ranging from several months to several years.	No. Not under FS authority. FS can control stand densities.	Decreased herbaceous productivity, can alter species composition and diversity. Reduced water re charge and storage in seeps, springs.
Climate Change	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease precipitation, and may increase annual variability of precipitation amounts. Increased transpiration may more than offset any increases in precipitation even if precipitation increases do occur. A scenario: http://geochange.er.usgs.gov/sw/impacts/biology/veg_chg_model/ Regional model concordance for temp and precip: http://ipcc-wg1.ucar.edu/wg1/Report/	No. (In the long term, this PNVT will probably move upward.)	Decreased herbaceous productivity, can alter species composition and diversity. Reduced water re charge and storage in seeps, springs.

Specific Threats	Description of threat	Under FS control/authority	Effects
	suppl/docs/AR4WG1_Pub_Ch11-SM.pdf		
Minerals (uranium, quarries)	Exploration and extraction	Yes but limited due to Mining Act. Quarries are permit based.	Areas of type conversion from vegetation to bare ground.
Water withdrawal (wells)	Withdrawal of water for domestic purposes.	Yes on NF No on Private	Possible drop in local water table resulting in less water quantity and connected seeps and springs and subsequent decrease in riparian habitat.
Dams/impoundments	Structures that allow for the collection of surface water	Yes	Concentrate water and alters downstream water regime. Water can concentrate wildlife and livestock resulting in soil compaction, decreased herbaceous productivity, altered composition and structure and protective vegetative ground cover. This is most likely within 1/8 mile around the impoundment. An altered downstream water regime can reduce overall riparian habitat. Riparian habitat could become established adjacent to impoundments.
Firewood cutting (illegal)	Harvest of snags and logs for personal use as fire wood.	Yes	Reduction of tree encroachment and an increase in user created roads. Reduce soil productivity, increased soil erosion and damage to pediocactus.
Roads	Poorly designed and maintained Levels 1-3 and user-created roads	Yes. Creation of user-created roads not in our control however mitigation or closure is.	Provide pathway for sediments into connected waters. Provide pathway for invasive species into forest matrix. Exposed cutbanks contribute to erosion. Use of road network increased fire risk. Road use can fragment wildlife habitat and create disturbance. Roads can be barriers to some forms of wildlife.
Motorized recreation and Off highway vehicles	Any use of the forest that is tied to a motorized vehicle.	Yes through TMR and Forest Orders	User created roads and includes dispersed camping. Limited removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, reduced soil productivity, impacts to wildlife, and vectors for invasive species dispersal. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk. Increased wildlife disturbance from activities and noise.
Developed Recreation	Developed Campgrounds, trails, and special use permit areas	Yes	All localized, except accelerated invasives [covered elsewhere.]
Non-motorized	Excessive or	Yes	Localized vegetation removal and disturbance, accelerated

Specific Threats	Description of threat	Under FS control/authority	Effects
dispersed recreation	inappropriate use. Increased fire risk. Ground disturbance, vegetation damage. Poorly located, designed, or maintained trails.		erosion down trails and soil compaction, and reduced effectiveness of wildlife habitat due to disturbance. Increased introduction of invasive plants. Increased fire risk as a result of increased potential ignition sources. Greater impacts around developed communities, impact levels tend to correspond with human population size. Provide pathway for sediments into connected waters. Exposed cutbanks contribute to erosion.
Solid waste dumping	Household trash, batteries, landscape waste, meth labs waste, motor oil, appliances, and vehicles.	No/Yes	Contamination of soils and water from industrial waste. Introduction of invasive plants through landscape materials, see effects for Invasive Plants. Potential injury or mortality on wildlife. Greater impacts around communities, impact levels tend to correspond with human population size. Greater impacts also occur adjacent to roads.

Table 8.4. Threat matrix: evaluation of risk severity to the semi-desert grassland PNVT

Note: Threats in Table 3 not under agency authority or control were not carried forward

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Unmanaged Grazing	**M**	**H**	**50%**	**Affects the composition, structure, and productivity of understory vegetation, including decreases in cool season grasses and other palatable species of grasses, and forbs while increasing less palatable species.**	**R**	**L**	**H**
Unmanaged Grazing (bison)	**M**	**H**	**50%**	Affects the composition, structure, and productivity of understory vegetation, including decreases in cool season grasses and other palatable species of grasses, and forbs while increasing less palatable species. May also reduce shrub diversity when grasses become limited.	**R**	**M**	**H**
Managed Grazing	**H**	**L**	**25%**	The forest has met the AMU/forage production objectives outlined in	**R**	**M**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
				the 1982 plan, although some allotments continue in an unsatisfactory condition.			
Invasive plants	**L**	**H**	**2%**	Composition/structure trends: Loss of native plants, diversity reduction trending toward monoculture of annual and short-lived perennials (homogeneity) of non-native species, from what was previously complex structure (heterogeneous native population) and composition. Process trend-changes the way fire moves across the landscape. Allelopathic processes affect native plant's ability to germinate and establish. The effects of invasive plants on vegetative composition, structure, and processes affect all trophic levels (insects, grazers, animals, birds, etc.).	**R**	**M**	**L**
Herbicides	**L**	**L**	**<0.001%**	Trend is to move vegetation towards reference conditions over the long-term. Effects may last 5-10 years due to repeated applications: killing non-native species, opening up growing space to be occupied by native vegetation, potentially short-term accelerated erosion. Effects to water are negligible because they are mitigated through state regulation. There can be some native plants killed.	**R**	**L**	**M**
Fuelwood cutting (dead, standing and down)	**L**	**L**	**0%**	Reduced tree encroachment. New user created roads can reduce vegetation, soil productivity, soil erosion, and increase the risk of fires and introduce invasive plants	**R**	**L**	**L**
Thinning treatments	**L**	**L**	**0%**	No work done in this PNVT. Potential to reduce tree encroachment and reduce shrub cover.	**R**	**L**	**L**
Fire suppression – line construction, retardant, water usage	**L**	**M**	**5%**	Line construction (dozer/handline)- results in removal of herbaceous vegetation, litter and exposing mineral soil along line, and increase in invasive weeds. Retardant-minor onsite increase in nitrogen which can affect native/non-native plant competitive abilities.	**R**	**M**	**M**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Lack of fire (Fire Regime 2: Historic Fire Return Interval of < 35 Yrs. Severity would historically replace 25 to 75% of the overstory)	**M**	**H**	**75%**	Structural change is increased tree density, changing from open to closed canopy. Composition change reduction in herbaceous understory replaced by increases in amount of tree duff and litter. Increases live and dead fuels, increasing burn severity. Process is lost fires on the landscape. In some areas the ability to reintroduce fire is limited until mechanical treatments move the stands towards HRV. Continued lack of fire will result in continued movement away from HRV.	**Y**	**H**	**H**
Insect/disease	**L**	**L**	**0%**	Not known to occur in this PNVT, although grasshopper and cricket infestations have been seen on the Kaibab Plateau. The affects are not know.	**R**	**L**	**L**
Fire Use – prescribed fires and lightning started fires	**L**	**L**	**10%**	Fire use will reduce the tree encroachment and the threat of mixed severity and stand replacement fire to the PNVT. Potential increase of invasive weeds. Increase in smoke emission.	**R**	**L**	**M**
Wildfire	**L**	**M**	**20%**	Structure, composition, and function of this PNVT are at an increasing risk of loss due to changing fuel conditions. Adverse effects to soil, including accelerated erosion, loss of productivity, and degraded water quality. Fire can increase invasive plants. The small scale heterogeneity of structure could be lost.	**R***	**M**	**M**
Drought	**H**	**M-H**	**100%**	Reduced plant growth, reduced litter (increased erosion), increased invasive plant infestations, increased plant mortality, increased severity of fire effects, and reduced water recharge.	**R****	**H**	**H and cyclic**
Climate Change	**H**	**H**	**100%**	Permanent changes in climate will likely increase the extent of this PNVT to higher elevations. The effects could make the affects of wildland fire and insects permanent.	**R****	**H**	**H**
Minerals (quarries)	**L**	**L**	**1%**	PNVT not at risk because extent of quarries is limited and under permit system.	**R**	**L**	**L**
Motorized Recreation	**M**	**M**	**5%**	User created roads increase the risk of fire starts and the spread of invasive plants.	**R**	**M**	**M**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT	**R**	**L**	**L**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Roads	**H**	**M**	**20%**	PNVT not at risk because most system roads have been re-located from drainage bottoms to ridge tops.	**R**	**L**	**M**

- ** FS can affect stand composition and structure facilitating drought tolerance.

The primary threat to this PNVT is the lack of fire disturbance, limiting nutrient cycling and perhaps seed germination. Closed shrub states are becoming more common and juniper also is encroaching. A rapid departure is forecast. Contributing to this is a secondary threat from bison (an exotic wildlife species) herbivory. Fire disturbance at this point may lead to some negative outcomes for species composition toward invasive plants but is not deemed a high risk at present.

9. Desert Communities PNVT

Table 9.1: Comparison of the desert communities PNVT to Reference ecosystem characteristics

Kaibab NF Ecosystem Diversity Analysis															
Desert Communities PNVT															
	Vegetation State (see description below)														
Vegetation State	**A**	**B**	**C**	**D**	**E**										
Reference Condition	5	20	75	0	0	100		**Departure**	**FRCC**		**A**	**B**	**C**	**D**	**E**
Current Condition															
North Kaibab RD 13,773.46 acres	0	0	41.96	58.04	0	100		58.04	2		0	0	41.96	0	0
Tusayan RD						0									
Williams RD						0									
Forest 13,733.46 acres	0	0	41.96	58.04	0	100		58.04	2		0	0	41.96	0	0
Projected Trends -- Forest															
20 Years						0		100	3		0	0	0	0	0
40 Years						0		100	3		0	0	0	0	0
50 Years						0		100	3		0	0	0	0	0

100 Years						0		100	3		0	0	0	0	0
250 Years						0		100	3		0	0	0	0	0
500 Years						0		100	3		0	0	0	0	0
1000 Years						0		100	3		0	0	0	0	0

A	B	C	D	E	Closed = >30% canopy cover
Young Grasses & Forbs	Mature Grasses & Forbs	Grass & Open Shrubs	Closed Shrubs & Grasses	Invasive Species	

Assumptions: Currently, there is little management occurring in this PNVT. There is no region wide assessment for this PNVT. Reference condition proportions are those for Semi-desert Grasslands from the TNC Assessment. Current conditions are derived from the R3 Midscale Vegetation Data. This PNVT occurs within the North Kaibab Ranger District and is mostly near the southern end of Kanab Creek. Some portions of this PNVT include critical winter habitat for mule deer.

Table 9.2. Trends for structure, composition and process of the desert communities PNVT

Structure	Composition	Process
Overstory of shrubs has developed	Increase in Shrubs and Juniper	Lack of herbaceous ground cover has led to more erosion
	Increase in cheat grass	There is a lack of disturbance to promote regeneration
	Decrease in desert succulent plants	Grasses and forbs complete with shrubs and juniper for available sunlight, moisture and nutrients

Table 9.3: Description of threats, Forest Service control/authority and associated effects to desert communities PNVT

Threat	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing the grasses, forbs and shrubs deer , sheep and other wildlife, as well as unauthorized/tresspass livestock.	No for wildlife herbivory. Yes for livestock grazing.	Affects the composition and structure of herbaceous vegetation. Substantially decreases fire return interval by promoting invasive species spread. Reduces productivity of herbaceous community, favoring increased development of shrubs.
Managed Grazing	Grazing managed under permits.	Yes	The area has been removed from grazing allotments. There are no further effects. Past effects are similar to unmanaged grazing.
Invasive plants	Non-native grasses and forbs that out compete native plants	Yes	Increase FRI. Less than 1 percent of the PNVT, according to current estimates, has invasive species established (cheatgrass, Russian thistle, fillaree).
Fire suppression	The response to an unwanted wildland fire.	Yes	Give the long FRI for this PNVT, effects are quite slow to manifest. In short term, fire suppression helps avoid further uncharacteristic effects resulting from increased shrub density and fuel continuity from invasive species.
Insect/disease	Increased risk insects or diseases that infect and kill trees.	No..	Insects or disease effects on States are unknown in this PNVT.
Fire management	Fire Use – Prescribed and the use of lightning fires for resource benefits	Yes	[Probably contra-indicated.] Mortality to many native species. Potential soil disturbance, with accelerated erosion and loss of soil productivity. Invasive species respond positively to disturbance created by wildfire.
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Mortality to many native species. Potential soil disturbance, with accelerated erosion and loss of soil productivity. Invasive species respond positively to disturbance created by wildfire.

Threat	Description of threat	Under FS control/authority	Effects
Drought	Below average precipitation over an extended period, usually ranging from several months to several years.	No. Not under FS authority. FS can control stand densities.	Decreases herbaceous productivity, can alter species composition and diversity. Reduced water re-charge and runoff into connected streams such as Kanab Creek and it tributaries. Reduced water re-charge and storage in seeps, springs and earthen tanks. Periodically these may dry entirely.
Global warming	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease precipitation, and may increase annual variability of precipitation amounts. Increased transpiration may more than offset any increases in precipitation even if precipitation increases do occur. A scenario: http://geochange.er.usgs.gov/sw/impacts/biology/veg_chg_model/ Regional model concordance for temp and precip: http://ipcc-wg1.ucar.edu/wg1/Report/suppl/docs/AR4WG1_Pub_Ch11-SM.pdf/	No.	Over time, may increase the extent of this PNVT upward.
Minerals (quarries & uranium)	Exploration and extraction	Yes. Area of PNVT withdrawn from mineral entry.	Type conversion from vegetation to bare ground.
Off highway vehicles	Motorized vehicles off of designated roads, including dispersed camping.	Yes. Area of PNVT in a Wilderness.	Very small scale. Limited and localized removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, and reduced soil productivity. Localized areas of increased soil compaction under wet soil conditions.
Dams impoundments	Structures that allow for the collection of surface water	Yes	None within this PNVT
Roads	Current transportation infrastructure that includes designated and user created roads	Yes. Area of PNVT in a Wilderness.	None within this PNVT

Threat	Description of threat	Under FS control/authority	Effects
Forest product gathering	Collection of any forest product not covered under timber, firewood, or mineral permits.	Yes	None within this PNVT
Non-motorized recreation	Any use of the forest that is not tied to a motorized vehicle.	Yes	Increased fire risk, limited damage to herbaceous ground cover and soil crusts that would increase erosion from wind or water.
Motorized recreation	Any use of the forest that is tied to a motorized vehicle.	Yes. Area of PNVT in a Wilderness.	None within this PNVT
Sewage/Septic	Disposal of human waste through an approved system within the forest	Yes	Does not occur in this PNVT
Solid Waste	Dumping of household or industrial waste	Yes	Does not occur in this PNVT
Predator Removal	Hunting or trapping of wildlife species that prey on other wildlife	No	Not known to occur in this PNVT
Industrial Recreation	Commercial recreation activities under permit by the forest	Yes	Impact, duration and extent are very small, if at all.

Table 9.4. Threat matrix: evaluation of risk severity to the desert communities PNVT

Note: Threats in Table 3 not under agency authority or control were not carried forward

Low means: <25% PNVT, 0-4 months, < 25% of PNVT ***Moderate means: 4-8 months, 25-75% PNVT*** ***High means: >75% PNVT, > 8 months***				**Screened out in Table 3.**		**Risk**	
				Carried forward past Table 4 evaluation.			
THREAT	**Extent**	**Duration**	**Severity**	**Consequences**	**Reversibility**	**Threat Severity overall**	**Likelihood**
Unmanaged grazing	**M**	**H**	**50%**	Reduced native herbaceous vegetation. Increased shrub cover.	**R**	**M**	**H**
Managed Grazing	**L**	**L**	**25%**	Does not occur in this PNVT	**R**	**L**	**L**
Invasive plants	**H**	**H**	**45%**	Cheat grass can carry fires, spread after wildland fires and increase it's extent.	**R**	**H**	**H**
Fuelwood Harvest	**L**	**L**	**0%**	None		**L**	**L**
Fuelwood cutting	**L**	**L**	**0%**	None		**L**	**L**
Powerlines & Utility Cooridors	**L**	**L**	**0%**	None		**L**	**L**
Vegetative treatments (commercial & non	**L**	**L**	**00%**	None. Potential to reduce shrubs	**R**	**L**	**L**

commercial)				and juniper			
Fire suppression	**L**	**M**	**5%**	Dozer use can damage fragile soils in limited areas.	**R**	**L**	**L**
Insect/disease	**L**	**L**	**0%**	None		**L**	**L**
Fire management	**L**	**L**	**0%**	None.		**L**	**L**
Wildfire	**M**	**H**	**45%**	Mortality to many native species. Accelerated erosion and loss of soil productivity. Invasive species response.	**R**	**H**	**M**
Drought	**H**	**M-H**	**100%**	Reduced area of herbaceous cover	**R****	**H**	**H and cyclic**
Global Warming	**H**	**M-H**	**100%**	Reduced area of herbaceous cover	**I**	**H**	**H**
Minerals (quarries & uranium)	**L**	**L**	**1%**	None		**L**	**L**
Off highway vehicles	**L**	**L**	**1%**	PNVT not at risk because PNVT located in remote area with low population, or on steep slopes.		**L**	**L**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT		**L**	**L**
Roads	**L**	**M**	**20%**	PNVT not at risk		**L**	**L**
Forest Product Gathering	**L**	**L**	**10%**	PNVT not at risk		**L**	**L**
Non-motorized Recreation	**M**	**L**	**10%**	PNVT not at risk		**L**	**H**
Motorized Recreation	**L**	**M**	**10%**	PNVT not at risk		**L**	**L**
Sewage/Septic	**L**	**L**	**1%**	PNVT not at risk		**L**	**L**
Solid Waste	**L**	**L**	**1%**	PNVT not at risk		**L**	**L**
Predator Removal	**L**	**L**	**1%**	PNVT not at risk		**L**	**L**
Industrial Recreation	**L**	**L**	**10%**	PNVT not at risk		**L**	**L**

- ** FS can affect stand composition and structure facilitating drought tolerance.

The primary threat to this PNVT is invasive species increasing the FRI and changing composition. Secondarily, closed shrub states are becoming more common and juniper also is encroaching, increasing the risk of uncharacteristic fire disturbance. This could create a feedback loop that further reduces native plant diversity and structure, increases invasive plant cover and erosion.

10. Gambel Oak Shrublands PNVT

Table 10.1: Comparison of the oak-shrubland PNVT to reference ecosystem characteristics

A	B	C	D	E	

Grass/forb oak ramets	Young oak	Mature Oak Open/Closed	Old Oak Open/Closed	Resprouter-dominated	
4.6	27.1	25.1	68.3*	0.04	Reference condition from TNC report
1	0	99		0	Current from midscale
3.6	27.1				Departure: ~ 27.1

* - After adjusting for mistake in TNC report (Madrean Pine Oak Woodland, Table 16-3, Old Pine Oak w/ Understory.

Assumptions: Occurs on the North Kaibab RD at the lower elevations of East Little and Saddle Mountains in patches up to 300 acres. Occurs on the Williams RD within MSO protected activity centers (Bill Williams Mountain). It also occurs in small patches on low elevation ridge lines.

Williams RD Oak Shrublands possibly should be classified as Madrean Pine Oak.

No TNC Assessment or Model. Inference can be made from the Madrean Pine Oak Woodlands assessments.

Invasive plant occurrence similar intermediate to that of Pinyon-Juniper Woodland and Ponderosa Pine Forest.

Table 10.2. Trends for structure, composition and process of the oak-shrubland PNVT

Structure	Composition	Process
Overstory of Pine and Mixed Conifer developing	Increase in conifer tree species	Interruption of FRI has allowed conifer trees to increase
Most of the oak shrublands is mature	Increase in cheatgrass	Interruption of the FRI promote little young oak
Very little mature oak on the Williams RD		
Very little mature oak on the NKRD		
Canopy cover increasing an dmore continuous.		

Table 10.3: Description of threats, Forest Service control/authority and associated effects to the oak-shrubland PNVT

Threat	Description of threat	Under FS control/authority	Effects
Herbivory (Managed/Unmanaged Grazing)	Grazing the understory grasses, forbs, shrubs and reproduction by cows, deer , elk and other wildlife.	Yes for livestock grazing. No for wildlife herbivory.	Affects the composition and structure of understory vegetation herbaceous, shrubs. Affects regeneration of oak on the Williams District in local areas. Affects fire return interval. Reduces productivity of herbaceous and shrub community. Most of PNVT is on steep slopes and isn't

Threat	Description of threat	Under FS control/authority	Effects
			used by cattle.
Invasive plants	Slow movement into the PNVT, particularly after stand-replacing or mixed-severity fire.	Yes	More than 1 percent of the PNVT has invasive weeds established. Dalmatian toadflax, thistles, and cheatgrass are most common
Fuelwood harvest (commercial)	Harvest of trees or logs from specific areas for resale as firewood.	Yes	Does not occur in this PNVT
Fuelwood collection (dead, standing and down)	Harvest of snags and logs for personal use as fire wood.	Yes	Loss of snags, downed woody material. Potential rutting and compaction from motorized vehicles when soil is wet. (This is low because machinery tends to be pickups instead of larger machinery in Pipo). No increase in user created roads because of steep terrain or remoteness. Oak trees are of great value for firewood and ceremonial purposes.
Powerlines, utility corridors	Existing corridors for power, telephone, or other infrastructure lines that pass though the forest. Lines can above ground or buried.	Yes	Does not occur within this PNVT
Vegetative treatments (commercial & non commercial)	Thinning treatments that move the composition or structure of forest stands towards desired conditions in the LMP. Trees may be sold for timber or personal use. Slash is treated on site by burning, hand piling, or mechanical piling.	Yes	Changes in composition & structure. (Potential decreases in tree density, decrease in canopy closure, increase in understory abundance and diversity (find references). Sometimes thinning slash is piled with bobcats or dozers. Retention of downed woody material may vary and occurs to level required in FLMP. Improve herbaceous composition, ground cover and productivity and reduce soil erosion.
Fire suppression	The response to an unwanted wildland fire.	Yes	Increases canopy closure, tree density, duff, snags, downed woody material, ladder fuels, fuel loading, decreases composition, diversity, productivity of herbaceous and shrub understory. Reduces the speed of nutrient cycling resulting in less productive soil. Decreases age and species diversity. Increased fire intensity results in higher severity effects to watershed. Stands are less resilient to natural disturbance processes.
Insect/disease	Increased risk insects or diseases that infect and kill	Not under FS authority. FS can control stand	May help prevent encroachment by conifers. Increases number of snags and eventually downed logs. Increases

Threat	Description of threat	Under FS control/authority	Effects
	trees.	densities and resiliency.	fire hazard because of more dead fuels available. Increases understory where patches of mortality have occurred.
Fire management	Fire Use – Prescribed and the use of lightning fires for resource benefits	Yes	Reduces fuel hazards, tree densities, creates openings in canopy. Increases abundance and nutrition of herbaceous understory. Enhances nutrient cycling. Mortality to fire intolerant species with moderate to high intensity burns. Potential loss of snags, downed logs, large trees, oak. Potential soil disturbance where fuel loadings are high that contributes to mineralization, hydrophobicity, accelerated erosion and loss of soil productivity. Invasive species respond positively to disturbance created by wildfire. Carries a risk of escaping MMA, with adverse outcomes. WFU is not used on the south Kaibab due to the presence of a PAC (with high desired tree densities) and risk to a municipal watershed.
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Wildfire creates areas of young oak shrubland. Prevents conifer encroachment. Loss of snags, downed logs, and large trees depending on intensity while at the same time, snags and downed logs can be created. Increases abundance and nutritional quality (for herbivores) of herbaceous understory, and can alter composition (keep if research supports). Where fuel loadings are high, soil mineralization, hydrophobicity, and loss of soil productivity may occur. Wildfire may create areas of moderate to high burn severity that can accelerate erosion resulting in sediment delivery to connected streams, decreased water quality and soil productivity. Invasive species respond positively to disturbance created by wildfire.
Drought	When a region receives below average precipitation over an extended period, usually ranging from several months to several years.	No. Not under FS authority. FS can control stand densities.	Increases mortality, susceptibility to disease and insects, decreases herbaceous productivity, can alter species composition and diversity, increases canopy openings. Reduced water re-charge and runoff into connected streams such as North Canyon. Reduced water re-charge and storage in seeps, springs and earthen tanks. Periodically these may dry entirely. Reduces tree growth. Fire season can start earlier and last longer.
Global warming	The increase in the average	No	Long-term effects upon PNVT uncertain. Type is limited to

Threat	Description of threat	Under FS control/authority	Effects
	temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease precipitation, and may increase annual variability of precipitation amounts. Increased transpiration may more than offset any increases in precipitation even if precipitation increases do occur. A scenario: http://geochange.er.usgs.gov/sw/impacts/biology/veg_chg_model/ Regional model concordance for temp and precip: http://ipcc-wg1.ucar.edu/wg1/Report/suppl/docs/AR4WG1_Pub_Ch11-SM.pdf		steeper areas and may not adapt to flat ground above. Longer and more severe droughts.
Minerals (quarries)	Exploration and extraction	Yes. Over half of PNVT is withdrawn from entry.	Areas of type conversion from vegetation to bare ground.
Off highway vehicles	Motorized vehicles off of designated roads, including dispersed camping.	Yes through TMR and through Forest Orders.	Does not occur in this PNVT. Limited and localized removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, and reduced soil productivity. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk. Increased opportunities for fuelwood theft e.g. large green trees especially juniper, snags etc.

Threat	Description of threat	Under FS control/authority	Effects
Dams impoundments	Structures that allow for the collection of surface water	Yes	There are earthen tanks on flatter slopes. Concentrate water and alters downstream water regime. Water can concentrate wildlife and livestock resulting in soil compaction, decreased herbaceous productivity, altered composition and structure and protective vegetative ground cover. This is most likely within 1/8 mile around the impoundment. An altered downstream water regime can reduce overall riparian habitat. Riparian habitat could become established adjacent to impoundments
Roads	Current transportation infrastructure that includes designated and user created roads	Yes. Creation of user-created roads not in our control however mitigation or closure is.	Provide pathway for sediments into connected stream courses. Exposed cutbanks contribute to erosion. Use of road network increased fire risk. Road use can fragment wildlife habitat and create disturbance. Roads can be barriers to some forms of wildlife.
Forest product gathering	Collection of any forest product not covered under timber, firewood, or mineral permits.	Yes	User created roads cause minor rutting and loss of soil productivity. Minor and localized collection of ceremonial oak using a permit.
Non-motorized recreation	Any use of the forest that is not tied to a motorized vehicle.	Yes	Localized vegetation removal, erosion down trails, disturbance.
Motorized recreation	Any use of the forest that is tied to a motorized vehicle.	Yes	User created roads and includes dispersed camping. Limited removal of protective vegetative cover results in accelerated erosion, sediment delivery to connected streams, impairment of water quality, and reduced soil productivity. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk. Increased wildlife disturbance from activities and noise.
Sewage/Septic	Disposal of human waste through an approved system within the forest	Yes	Does not occur in this PNVT
Solid Waste	Dumping of household or industrial waste	Yes	Does not occur in this PNVT
Predator Removal	Hunting or trapping of wildlife species that prey on other wildlife	No	Does not occur in this PNVT
Industrial Recreation	Commercial recreation activities under permit by the	Yes	Does not occur in this PNVT

Threat	Description of threat	Under FS control/authority	Effects
	forest		

Table 10.4. Threat matrix: evaluation of risk severity to the -shrubland PNVT

Note: Threats in Table 3 not under agency authority or control were not carried forward

Table 4. Threat Matrix to Evaluate Severity of Risk

Low means: <25% PNVT, 0-4 months, Moderate means: 4-8 months, 25-75% PNVT High means: >75% PNVT, > 8 months				**Screened out in Table 3.**		**Risk**	
				Carried forward past Table 4 evaluation.			
THREAT	**Extent**	**Duration**	**Severity**	**Consequences**	**Reversibility**	**Threat Severity overall**	**Likelihood**
Herbivory (Unmanaged grazing)	**M**	**M**	**10%**	Oak regen still occurring, no changes in composition or structure of understory	**R**	**L**	**H**
Invasive plants	**M**	**H**	**1-10%**	Cheatgrass can easily spread	**R**	**M**	**H**
Fuelwood cutting (dead, standing and down)	**L**	**M**	**<10%**	Slight reduction snags & downed logs	**R**	**L**	**L**
Vegetative treatments (commercial & non commercial)	**L**	**L**	**0%**	Reduction tree density towards historic levels. Increase in understory forb and shrubs. Decrease in canopy cover.		**L**	**L**
Fire suppression	**H**	**M**	**100**	Continued fire suppression will result in continued encroachment and less diversity	**R**	**H**	**H**
Insect/disease	**M**	**L**	**100**	Decrease canopy cover, tree density. Increase fuel loadings. Shift to younger trees. Increase snags, logs.	**R**	**M**	**M**
Fire management	**L**	**L**	**10%**	Reduction of conifer encroachment. Conversion of oak shrubs to a younger state. Limited application of fire.	**R**	**L**	**L**
Wildfire	**L**	**M**	**20%**	No one fire should burn through entire PNVT at one time because the	**R**	**M**	**H**

				PNVT is distributed in patches. Intense fires can cause soils damage			
Drought	**H**	**M-H**	**100%**	PNVT at risk due to increased fire hazard during droughts.	**R****	**H**	**H and cyclic**
Global Warming	**H**	**M-H**	**100%**	PNVT at risk due to increased fire hazard during droughts.	**I**	**H**	**H**
Minerals (quarries)	**L**	**L**	**1%**	Does not occur in this PNVT		**L**	**L**
Off highway vehicles	**L**	**L**	**1%**	PNVT not at risk because PNVT located in steep remote areas, or wilderness.		**L**	**L**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT		**L**	**L**
Roads	**L**	**M**	**20%**	PNVT not at risk because portions in wilderness & roads have been re-located from drainage bottoms to ridge tops.	**R**	**L**	**M**
Forest product gathering	**L**	**L**	**1%**	No consequences		**L**	**L**
Non-motorized recreation	**L**	**L**	**1%**	No consequences		**L**	**L**
Motorized recreation	**L**	**L**	**5%**	PNVT not at risk because of limited activity		**L**	**L**
Sewage/Septic	**L**	**L**	**0%**	Does not occur in this PNVT		**L**	**L**
Solid Waste	**L**	**L**	**1%**	Does not occur in this PNVT		**L**	**L**
Predator Removal	**L**	**L**	**1%**	No consequences		**L**	**L**
Industrial Recreation	**L**	**L**	**0%**	No consequences		**L**	**L**

- ** FS can affect stand composition and structure facilitating drought tolerance.

The primary threats to this PNVT are the combination of lack of fire disturbance, leading to an increase in closed tree-shrub states and conifers encroaching – creating larger areas susceptible to single stand-replacing events. Drought plays a role in raising the risk this will occur. A continued departure is forecast. Fire disturbance at this point may lead to some negative outcomes for soils and increased invasive plants.

11. Wetland/Cienega PNVT

Table 11.1: Comparison of the wetland/cienega PNVT to reference ecosystem characteristics

A	B	C	D	E	
Young Grasses & Forbs	Mid Development	Mature Grass & Forbs	Invasive species dominate	Tree Encroachment	

	Grasses & Forbs				
					Reference condition from TNC report
	89	3	0.5	7	Current from midscale

Assumptions: There is no TNC Assessment or VDDT Model for the Wetland/Cienega PNVT. Inferences can be drawn from the draft Montane Grassland Assessment. This PNVT occurs on the North Kaibab and Williams Ranger Districts. Grassy and Coleman Lakes are examples.

A portion of this PNVT on the NKRD may really be Montane Grasslands.
Midscale vegetation makes no distinction between States A & B. All acres assigned to State B because of the lack of fire since 1960.

Table 11.2. Trends for structure, composition and process of the wetland/cienega PNVT

Structure	Composition	Process
Overstory of conifer trees	Increase in conifer tree cover	Natural disturbance processes that prevent the encroachment of competing species have been interrupted.
Conversion of PNVT to forest because of tree encroachment	Reduction in vegetation diversity.	Grasses are maintain in a mature state due to the lack of fire.

Table 11.3: Description of threats, Forest Service control/authority and associated effects to the wetland/cienega PNVT

Specific Threats	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing the understory grasses, forbs, shrubs and reproduction by deer, elk and other wildlife, or from over utilization under permit.	No.	Affects the composition, structure, and productivity of understory herbaceous vegetation, including decreases in cool season grasses and other palatable species of grasses and forbs while increasing less palatable species.
Managed Grazing	Grazing managed under permits.	Yes	Animal are removed before grasses or forbs are fully utilized.
Invasive plants	Cheatgrass, toadflax and non-native thistles exist on < 1% of the PNVT.	Yes	Current threats are to the understory composition of grasses and forbs and possibly at the lower elevations of the PNVT.
Herbicides	Use of herbicides to reduce unwanted plants.	Yes	Has localized affects reducing invasive plants. Affects are short term. Affects can be more wide-

Specific Threats	Description of threat	Under FS control/authority	Effects
			spread if used improperly.
Thinning/Tree removal	Thinning/removal treatments of trees that move the composition or structure of forest stands towards desired conditions in the LMP	Yes	Changes in composition & structure. Can decrease in tree encroachment and maintain grasses in State C. Mechanized equipment can cause loss in soil productivity and minor short term accelerated erosion, and sediment delivery to streams and soil compaction without implementation of Best Management Practices. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity. Potential for non-native thistles at landings.
Uncharacteristic Wildland Fire Effects	Mixed and Stand replacement fire that occurs outside of the HRV.	Yes	Fire in areas that have tree encroachment can promote re-establishment of tree species after fire. High severity fire in areas with encroachment can cause soils damage that prevents the re-establishment of native grasses and leave them susceptible to non-native plant invasion..
Insect/disease	Increased risk of bark beetles. Increase in mistletoe infections.	No, not under FS authority, but FS can manage stand density/resiliency.	Grasshopper and cricket infestations have been seen on the Kaibab Plateau but are not known to affect State changes. Chthonic species have unknown effects to soil structure.
Fire Use	Prescribed fire use and the use of natural ignitions for resource benefits	Yes	WFU and prescribed fire reduces fuel hazards and tree encroachment. Fire reduces grass litter and causes a short term decline in herbaceous cover. Longer term fire increases abundance and nutrition of herbaceous understory. Increases aspen regeneration. Potential soil disturbance where fuel loadings are high that contributes to mineralization, hydrophobicity, and loss of soil productivity. These effects tend to be greater under wildland fire use because wider burning window.
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Wildfire may reduce short term fuel hazards, reduce tree encroachment. Low to medium severity burns increase abundance and nutritional quality of herbaceous understory, and

Specific Threats	Description of threat	Under FS control/authority	Effects
			can alter composition. Wildfire may create areas of moderate to high burn severity that can accelerate erosion resulting in decreased soil productivity. Where fuel loadings are high, soil mineralization, hydrophobicity, and loss of soil productivity may occur. Invasive species respond positively to disturbance.
Drought	Below average precipitation over an extended period, usually ranging from several months to several years.	No. Not under FS authority. FS can control stand densities, including adjacent PNVTs.	Decreased herbaceous productivity and can alter species composition and diversity, Reduced water re charge and storage in seeps, springs.
Climate Change	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease perciptitation, and may increase annual variability of percipitation amounts. Increased transpiration may more than offset any increases in perciptitation even if percipitation increases do occur. A scenario: http://geochange.er.usgs.gov/sw/impacts/biology/veg_chg_model/ Regional model concordance for temp and precip: http://ipcc-wg1.ucar.edu/wg1/Report/suppl/docs/AR4WG1_Pub_Ch11-SM.pdf	No.	In the long term, this PNVT would be reduced or lost. Decreased herbaceous productivity, can alter species composition and diversity, Reduced water re charge and storage in seeps, springs.
Minerals (uranium, quarries)	Exploration and extraction	Yes but limited due to Mining Act. Quarries are permit based.	Areas of type conversion from vegetation to bare ground. Does not currently occur in this PNVT
Water withdrawal (wells)	Withdrawal of water for domestic purposes.	Yes on NF No on Private	Possible drop in local water table resulting in less water quantity and connected seeps and springs and subsequent decrease in riparian habitat.
Dams/impoundments	Structures that allow for the collection of surface water	Yes	Concentrate water and alters downstream water regime. Water can concentrate wildlife and

Specific Threats	Description of threat	Under FS control/authority	Effects
			livestock resulting in soil compaction, decreased herbaceous productivity, altered composition and structure and protective vegetative ground cover. This is most likely within 1/8 mile around the impoundment. An altered downstream water regime can reduce overall riparian habitat. Riparian habitat could become established adjacent to impoundments.
Firewood cutting (illegal)	Harvest of snags and logs for personal use as fire wood.	Yes	Does not occur in this PNVT. Would reduce tree encroachment.
Roads	Poorly designed and maintained Levels 1-3 and user-created roads	Yes. Creation of user-created roads not in our control however mitigation or closure is.	Provide pathway for sediments into connected waters. Can disrupt flow pathways. Provide pathway for invasive species into forest matrix. Exposed cutbanks contribute to erosion. Increased fire risk. Fragmented wildlife habitat (barriers) and disturbances.
Motorized recreation and Off highway vehicles	Any use of the forest that is tied to a motorized vehicle. User created roads and includes dispersed camping.	Yes through TMR and Forest Orders	Can disrupt flow pathways. Limited removal of protective vegetative cover results in accelerated erosion, reduced soil productivity and vectors for invasive species dispersal. Localized areas of increased soil compaction under wet soil conditions. Increased fire risk. Disturbance to wildlife from activities and noise.
Developed Recreation	Developed Campgrounds, trails, and special use permit areas	Yes	All localized, except accelerated invasives [covered elsewhere.]
Non-motorized dispersed recreation	Excessive or inappropriate use. Increased fire risk. Ground disturbance, vegetation damage. Poorly located, designed, or maintained trails.	Yes	Localized vegetation removal and disturbance, accelerated erosion down trails and soil compaction, and reduced effectiveness of wildlife habitat due to disturbance. Increased introduction of invasive plants. Increased fire risk as a result of increased potential ignition sources. Greater impacts around developed communities, impact levels tend to correspond with human population size. Local erosion. Exposed cutbanks contribute to erosion.
Solid waste dumping	Household trash, batteries, landscape waste,	No/Yes	Contamination of soils and water from industrial

Specific Threats	Description of threat	Under FS control/authority	Effects
	meth labs waste, motor oil, appliances, and vehicles.		waste. Introduction of invasive plants through landscape materials, see effects for Invasive Plants. Potential injury or mortality on wildlife. Greater impacts around communities, impact levels tend to correspond with human population size. Greater impacts also occur adjacent to roads.

Table 11.4. Threat matrix: evaluation of risk severity to the wetland/cienega PNVT

Note: Threats in Table 3 not under agency authority or control were not carried forward

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Unmanaged Grazing	**H**	**M**	**25%**	Affects the composition and structure of herbaceous vegetation. Areas around water sources are especially impacted.	**R**	**M**	**H**
Managed Grazing	**H**	**L**	**25%**	The forest has met the AMU/forage production objectives outlined in the 1982 plan, although some allotments continue in an unsatisfactory condition.	**R**	**L**	**H**
Invasive plants	**L**	**H**	**<1%**	Composition/structure trends: Loss of native plants, diversity reduction trending toward monoculture of annual and short-lived perennials (homogeneity) of non-native species, from what was previously complex structure (heterogeneous native population) and composition. Process trend-changes the way fire moves across the landscape. Allelopathic processes affect native plant's ability to germinate and establish. The effects of invasive plants on vegetative composition, structure, and processes affect all trophic levels (insects, grazers, animals, birds, etc.).	**R**	**L**	**L**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Herbicides	**L**	**L**	**<0.001%**	Trend is to move vegetation towards reference conditions over the long-term. Effects may last 5-10 years due to repeated applications: killing non-native species, opening up growing space to be occupied by native vegetation, potentially short-term accelerated erosion. Effects to water are negligible because they are mitigated through state regulation. There can be some native plants killed.	**R**	**L**	**L**
Fuelwood cutting (dead, standing and down)	**L**	**L**	**0**	Reduced tree encroachment. Increased soil compaction and erosion from vehicle use. Loss of vegetation from user created roads.	**R**	**L**	**L**
Thinning treatments	**L**	**L**	**0%**	Shift in composition, structure, and process towards desired condition. Trends starting toward reference condition. Best Management Practices mitigate short term negative effects to soil and connected waters, lack of direction for slash pile treatments. There are BMPs for mitigation for invasive plants. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity.	**R**	**L**	**L**
Fire suppression – line construction, retardant, water usage	**M**	**M**	**25**	Line construction (dozer/handline)- results in removal of herbaceous vegetation, litter and exposing mineral soil along line, and increase in invasive weeds. Retardant-minor onsite increase in nitrogen which can affect native/non-native plant competitive abilities.	**R**	**L**	**L**
Lack of fire (Fire Regime 2: Historic Fire Return Interval of < 35 Yrs. Severity would historically replace 25 to 75% of the overstory)	**M**	**M**	**25**	Structural change is increased age of grasses and encroachment by trees and shrubs. Tree transpiration may dry wetlands at edges and move further into PNVT. Composition change increase in tree species such as aspen, pine, or mixed conifer with a reduction in herbaceous understory replaced by increases in amount of duff and litter. Increases live and dead fuels, increasing burn severity. In some areas the ability to reintroduce fire is limited until mechanical treatments move the stands towards HRV. Continued lack of fire will result in continued movement away from HRV.	**Y**	**H**	**H**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Insect/disease	**L**	**L**	**0**	Not known to occur in this PNVT, although grasshopper and cricket infestations on the Kaibab Plateau have occurred. The affects are not known.	**R**	**L**	**L**
Fire Use – prescribed fires and lightning started fires	**L**	**L**	**5%**	Continued fire use will reduce tree and shrub encroachment. Create mosaics of young herbaceous vegetation. Potential increase of invasive weeds. Increase in smoke emission.	**R**	**L**	**L**
Wildfire	**H**	**M**	**100**	Continued tree encroachment. Garland and Government Prairies and long narrow valleys within this PNVT will convert to pine forest within 50 years at the current rate of encroachment.	**R***	**M**	**M**
Drought	**H**	**M-H**	**100%**	Reduced plant growth and reduced water recharge.	**R****	**H**	**H and cyclic**
Climate Change	**H**	**H**	**100%**	Permanent changes in climate will likely reduce the extent of this PNVT to higher elevations.	**I**	**H**	**H**
Minerals (quarries)	**L**	**L**	**1%**	PNVT not at risk because extent of quarries is limited and under permit system.	**R**	**L**	**L**
Motorized Recreation	**M**	**M**	**5%**	User created roads disrupt flows, increase the risk of fire starts, the spread of invasive plants, loss of soil productivity and a reduction in herbaceous vegetation.	**R**	**M**	**M**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT	**R**	**L**	**L**
Roads	**H**	**M**	**20%**	PNVT not at risk because most system roads have been re-located from drainage bottoms to ridge tops.	**R**	**L**	**M**

** FS can affect stand composition and structure facilitating drought tolerance.

The primary threat to this PNVT is the lack of fire disturbance, limiting nutrient cycling and perhaps seed germination. Adjacent forest/woodland species are encroaching. Contributing to this is a secondary threat from drought. Tree encroachment and tree density of adjacent PNVTs serve to lower water input and flow in this system. A slow departure is forecast. Fire disturbance at this point may lead to some negative outcomes for species composition toward invasive plants and is deemed a moderate risk at present.

12. Cottonwood Willow Riparian PNVT

Table 12.1: Comparison of the cottonwood willow PNVT to reference ecosystem characteristics

Reference Conditions from LANDFIRE Model 1511550 for the desert riparian BPS
Current conditions from the Mid-scale Vegetation Data & Desired Conditions from the current plan

Ecosystem Characteristic -- Vegetation State					
Vegetation State	A	B	C	D	E
Reference Condition	20	25	35	20	
Plan Desired Condition	10	10	10	70	
Current Condition			6.87	1.03	92.10

State	Estimated Age (yrs)	Canopy Closure	Description	Vegetative Structural Stage (VSS)
A	0 to 4	< 10%	Young grass and shrubs. Some tree sprouts. Little litter	N/A
B	5 to 29	10 to 30%	Grasses, shrubs, and saplings	N/A
C	30 to 49	10 to 30%	Young cottonwood and willow	N/A
D	50 plus	30 to 60%	Mature cottonwood and willow	N/A
E	All ages	All	Uncharacteristic state due to the presence of invasive grasses or shrubs that shortens the FRI or out competes trees	N/A

Assumptions: There is no model for the PNVT. Current conditions are from R3 Midscale Vegetation data. Very little stand-replacement flooding wildland fire has occurred within Cottonwood Willow Riparian in the past 60 years. Using Midscale data there is no way to assign acres to State E but a site visit to Kanab Creek shows most of the type is dominated by invasive species – tamarisk and Russian-olive..

All of this PNVT occurs on the North Kaibab Ranger District in the Kanab Creek drainage in the Wilderness, where little management occurs.

Table 12.2. Trends for structure, composition and process of the cottonwood willow PNVT

Structure	Composition	Process
Dense structure of shrubs has developed	Increase in Tamarisk and Russian olive	Potential exists for an shorter FRI with the invasion of Tamarisk

Reduction in the number of old large cottonwood trees	Increase in cheat grass	Grasses and forbs complete with Tamarisk for available sunlight, moisture and nutrients
	Decrease in cottonwood trees	Cottonwood reproduction is not occurring.
	Reduction in grass/forb diversity and amount	

Table 12.3: Description of threats, Forest Service control/authority and associated effects cottonwood willow PNVT

Specific Threats	Description of threat	Under FS control/authority	Effects
Unmanaged Grazing	Grazing the understory grasses, forbs, shrubs and reproduction by deer and other wildlife, or from unauthorized use/trespass by livestock.	Yes for livestock grazing. No for wildlife herbivory.	Affects the composition, structure, and productivity of understory vegetation (herbaceous, shrubs, young trees, including decreases in cottonwood, willows, cool season grasses and other palatable species of grasses and forbs while increasing less palatable species.
Managed Grazing	Grazing managed under permits.	Yes	The area has been removed from grazing allotments. There are no effects.
Invasive plants	Tamarisk and Russian-olive	Yes	Significant reduction in cottonwood trees. Reduction in herbaceous vegetation. Reduction in available soil moisture, further reducing area available for cottonwood/willow regeneration.
Herbicides	Use of herbicides to reduce unwanted plants.	Yes	Has localized affects reducing invasive plants. Affects are short term. Affects can be more wide-spread if used improperly.
Thinning	Thinning treatments of trees that move the composition or structure of forest stands towards desired conditions in the LMP (does not occur in this PNVT)	Yes	None
Regeneration Cutting	Regeneration treatments to move the structure of forest stands towards desired conditions in the LMP (does not occur in this PNVT, but may be a tool to reduce invasive tamarisk in the future)	Yes	Changes in composition & structure. (decreases in tree density, decrease in canopy closure, increase in understory and variation). Minor short term accelerated erosion, and sediment delivery to streams and soil compaction without implementation of Best Management Practices. The effect of burning large slash piles may be localized soil sterilization, invasive weed establishment, loss of soil productivity. Potential for non-native species to establish in areas

Specific Threats	Description of threat	Under FS control/authority	Effects
			where piles were burned..
Uncharacteristic Wildland Fire Effects	Stand replacement fire that occurs outside of the HRV.	Yes	Because of currently invaded state, could prevent the re-establishment of cottonwood and willow (by removing seed source and favoring redevelopment of tamarisk). .
Insect/disease	Unwanted affects to trees, shrubs, grasses, and forbs.	No, the agency can maintain stands that do not promote outbreaks outside of HRV.	Effects unknown in this PNVT
Fire Use	Prescribed fire use and the use of natural ignitions for resource benefits	Yes	Contraindicated. The FRI is >250 years. Fire effects would be similar to Uncharacteristic Wildland Fire Effects.
Wildfire	Unplanned ignitions with a threat to life, resources and property	Yes – Decision to suppress under authority and control	Wildfire may reduce short term fuel hazards, reduce tree densities, and create a mosaic of age classes. However, because of currently invaded state, could prevent the re-establishment of cottonwood and willow (by removing seed source and favoring redevelopment of tamarisk).
Drought	When a region receives below average precipitation over an extended period, usually ranging from several months to several years.	No.	Decreases water flow, increasesing tree mortality, susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, favoring tamarisk. Reduced water re charge and storage in seeps, springs. Reduces tree growth.
Climate Change	The increase in the average temperature of the Earth's near-surface air and oceans in recent decades and its projected continuation on a global or regional level. Locally, this may include temperature increases, may increase or decrease precipitation, and may increase annual variability of precipitation amounts. Increased transpiration may more than offset any increases in precipitation even if precipitation increases do occur. A scenario:	No.	May reduce or eliminate this PNVT. Decreases water flow, increasing tree mortality, susceptibility to disease and insects, decreased herbaceous productivity, can alter species composition and diversity, favoring tamarisk. Reduced water re charge and storage in seeps, springs. Reduces tree growth. Longer and more severe droughts. As temperatures rise, the effects of these are more severe.

Specific Threats	Description of threat	Under FS control/authority	Effects
	http://geochange.er.usgs.gov/sw/impacts/ biology/veg_chg_model/ Regional model concordance for temp and precip: http://ipcc-wg1.ucar.edu/wg1/Report/suppl/docs/AR4WG1_Pub_Ch11-SM.pdf		
Minerals (uranium, quarries)	Exploration and extraction	Yes – area removed from mining	Does not occur in this PNVT
Water withdrawal (wells)	Withdrawal of water for domestic purposes.	Yes on NF No on Private	Possible drop in local water table resulting in less water quantity in connected seeps and springs and subsequent decrease in riparian habitat.
Dams/impoundments	Structures that allow for the collection of surface water	No. (Upstream areas are off the Forest.)	Reduces flooding disturbance and cottonwood/willow regeneration dependent upon it, reducing overall riparian habitat.. Concentrate water and alters downstream water regime. Reduced perennial water flow occurs.
Firewood cutting (illegal)	Harvest of snags and logs for personal use as fire wood.	Yes	Does not occur in this PNVT
Roads	Poorly designed and maintained Levels 1-3 and user-created roads	Yes. Creation of user-created roads not in our control however mitigation or closure is.	Does not occur in this PNVT
Motorized recreation and Off highway vehicles	Any use of the forest that is tied to a motorized vehicle.	Yes through TMR and Forest Orders	Does not occur in this PNVT
Developed Recreation	Developed Campgrounds, trails, and special use permit areas	Yes	Does not occur in this PNVT
Non-motorized dispersed recreation	Excessive or inappropriate use. Increased fire risk. Ground disturbance, vegetation damage. Poorly located, designed, or maintained trails.	Yes	Localized vegetation removal and disturbance, accelerated erosion down trails and soil compaction, and reduced effectiveness of wildlife habitat due to disturbance. Increased introduction of invasive plants. Increased fire risk as a result of increased potential ignition sources. Greater impacts around developed communities, impact levels tend to correspond with human population size. Provide pathway for sediments into connected waters.

Specific Threats	Description of threat	Under FS control/authority	Effects
			Exposed cutbanks contribute to erosion.
Solid waste dumping	Household trash, batteries, landscape waste, meth labs waste, motor oil, appliances, and vehicles.	No/Yes	Does not occur in this PNVT

Table 12.4. Threat matrix: evaluation of risk severity to the cottonwood willow PNVT

Note: Threats in Table 3 not under agency authority or control were not carried forward

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months*				**Screened out in Table 3.** **Carried forward past Table 4 evaluation.**		***Risk***	
THREAT	***Extent***	***Duration***	***Severity***	***Consequences***	***Reversibility***	***Threat Severity overall***	***Likelihood***
Unmanaged Grazing	**H**	**M**	**25%**	Reduction of cottonwood/willow regeneration	**R**	**M**	**M**
Managed Grazing	**L**	**L**	**25%**	Does not occur in this PNVT	**R**	**L**	**L**
Invasive plants	**H**	**H**	**90%**	Composition/structure trends: Loss of native plants, diversity reduction trending toward monoculture of annual and short-lived perennials (homogeneity) of non-native species, from what was previously complex structure (heterogeneous native population) and composition. Process trend-changes the way fire moves across the landscape. Allelopathic processes affect native plant's ability to germinate and establish. The effects of invasive plants on vegetative composition, structure, and processes affect all trophic levels (insects, grazers, animals, birds, etc.).	**R**	**H**	**H**
Herbicides	**L**	**L**	**<0.001%**	Trend is to move vegetation towards reference conditions over the long-term. Effects may last 5-10 years due to repeated applications: killing non-native species, opening up growing space to be occupied by native vegetation, potentially short-term accelerated erosion. Effects to water are negligible because they are mitigated through state regulation. There can be some native plants killed. Currently does not occur in this PNVT.	**R**	**L**	**L**
Fuelwood cutting (dead, standing and down)	**L**	**L**	**0**	Does not occur in this PNVT	**R**	**L**	**L**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Thinning treatments	**L**	**L**	**0**	Does not occur in this PNVT	**R**	**L**	**L**
Fire suppression – line construction, retardant, water usage	**L**	**L**	**10%**	Handline can cause localized pathways for sediment movement. Retartant may have affects on wildlife.	**R**	**L**	**L**
Lack of fire (Fire Regime 4: Historic Fire Return Interval of > 200 Yrs. Severity would historically replace 25 to 75% of the overstory)	**M**	**H**	**1%**	PNVT is not departed from this Threat.	**Y**	**L**	**L**
Insect/disease	**L**	**M**	**100**	Largest threat is likely grasshopper infestations. Reductions to herbaceous cover.	**R**	**L**	**L**
Fire Use – (prescribed fires and lightning started fires)	**L**	**L**	**1%**	Fire Use could allow establishment of a mosaic of age classes if invasive species weren't so prevalent. Because of currently invaded state, could prevent the re-establishment of cottonwood and willow (by removing seed source and favoring redevelopment of tamarisk). .	**R**	**H**	**L**
Wildfire	**M**	**H**	**20%**	Function of the PNVT is at risk due to the potential for shorter FRI than historic. Tamarisk vegetation tends towards shorter FRI than other vegetation. This would prevent the re-establishment of cottonwoods.	**R***	**M**	**M**
Drought	**H**	**M-H**	**100%**	Reduced plant growth, reduced litter (increased erosion), increased invasive plant infestations, increased plant mortality, increased severity of fire effects, and reduced water recharge.	**I**	**H**	**H and cyclic**
Climate Change	**H**	**H**	**100%**	Permanent changes in climate will likely reduce the extent of this PNVT to higher elevations and north facing slopes. The effects could make the affects of wildland fire and insects permanent.	**I**	**H**	**H**
Minerals (quarries)	**L**	**L**	**1%**	Does not occur in this PNVT	**R**	**L**	**L**
Motorized Recreation	**M**	**M**	**5%**	Does not occur in this PNVT	**R**	**M**	**M**
Dams impoundments	**L**	**H**	**1%**	Impoundments upstream restrict water flow to periods of rain that occur near the PNVT	**R**	**H**	**H**
Roads	**H**	**M**	**20%**	Does not occur in this PNVT	**R**	**L**	**M**

Low (L) *means: <25% PNVT, 0-4 months* ***Moderate (M)*** *means: 4-8 months, 25-75% PNVT* ***High (H)*** *means >75% PNVT, > 8 months* ***THREAT***	***Extent***	***Duration***	***Severity***	**Screened out in Table 3.** **Carried forward past Table 4 evaluation.** ***Consequences***	***Reversibility***	***Risk***	
						Threat Severity overall	***Likelihood***
Off highway vehicles	**L**	**L**	**0%**	PNVT not at risk because PNVT located in remote area with low population, or on steep slopes.		**L**	**L**
Dams impoundments	**L**	**L**	**1%**	PNVT not at risk because earthen tanks not altering composition and structure in the PNVT		**L**	**L**
Roads	**L**	**L**	**0%**	PNVT not at risk		**L**	**L**
Forest Product Gathering	**L**	**L**	**0%**	Does not occur in this PNVT		**L**	**L**
Non-motorized Recreation	**L**	**L**	**10%**	Increased risk of human caused fires. Increased introduction of invasive plants.		**L**	**L**
Motorized Recreation	**L**	**L**	**0%**	Does not occur in this PNVT		**L**	**L**
Solid Waste	**L**	**L**	**0%**	Does not occur in this PNVT		**L**	**L**

The primary threat within FS control in this PNVT is posed by the nearly continuous cover of tamarisk, and, to some degree, Russian-olive. It is possible, if logistically difficult to reduce the presence of these species and keep them reduced through various management efforts. Biological controls are being developed which may be more effective in time.