# APPENDIX V FIRE REGIME AND CONDTION CLASS

Fire regimes describe the historical ecological role of fire in creating and maintaining vegetation communities for a period before European American settlement activities and active fire suppression began. Fire regimes, or more generally, disturbance regimes, are a key component of historical range of variability (HRV) characterizations for forest and vegetation types. HRV reference conditions are also the basis for developing desired future conditions (DFC) which can be used as guidelines in developing program strategy and designing fuels restoration projects.

This discussion focuses on fire; however, we acknowledge the role of other disturbances, but do not directly deal with them. Fire regime condition class (FRCC) is a standardized interagency tool that utilizes the concept of HRV to assess a current landscape's departure from historical (natural) conditions (Hann et al., 2003). The fire regime description includes HRV characterizations of our local forest or vegetation type and their assigned biophysical group (Bps) as defined by FRCC protocol. Fire regimes are typically described by fire frequency, intensity, size, and vegetation type (Heinselman, 1981; Kilgore, 1981; Sando, 1978):

Vegetation types by fire regime are listed in Table V.1 based on fire regime condition class definitions (Hann et al., 2003). Existing vegetation types are found in the in the Vegetation Diversity section of this chapter, which describes current vegetation and the potential natural vegetation community that would develop in the absence of disturbance. However, each existing vegetation type has experienced a characteristic pattern of succession and natural disturbances (i.e., fires, insect outbreaks) that occurred at varying intervals and characteristic intensities. These natural disturbances were key to maintaining a diversity of seral communities, and therefore a variety of plant and wildlife habitat across the landscape.

Local data is preferable for determining local fire regimes and the SJPL is developing a local fire-history database for its major fire-dependent vegetation types. Our most extensive data is for the ponderosa pine and warm-dry mixed conifer types (Brown and Wu 2005, Grissino-Mayer et al. 2004, Romme et al. 2003, Wu 1999). Local or regional data for aspen, cool-moist mixed conifer, and piñon-juniper is also available (Floyd, 2004, Grissino-Mayer et al., 2004; Romme et al., 2003; Floyd et al., 2000; Wu 1999). Where local data is lacking, relevant literature and expert input were used to create the following regime descriptions.

**Table V.1 - Historic Fire Regimes for the San Juan Public Lands Geographic Area**

| Fire Regime Class | Frequency (Fire Return Interval) | Severity | Existing Vegetation Types | Acres of SJPL | % of SJPL Land |
|---|---|---|---|---|---|
| I | 0 - 35 + years, frequent | Predominantly Low | Ponderosa Pine | 411,790 | 11 |
| | | | Warm-Dry Mixed Conifer | 95,392 | 3 |
| | | | Mtn Grasslands | 304,314 | 8 |
| II | 0-35 + years, frequent | Replacement | Semi-Desert Shrubland | 95,380 | 3 |
| | | | Sagebrush Shrublands | 210,030 | 6 |
| III | 35 – 100 + years, less infrequent | Mixed and Low | Cool-Moist Mixed Conifer | 199,412 | 6 |
| IV | 35 – 100+ years, less infrequent | Replacement | Aspen | 346,384 | 10 |
| | | | Mtn Shrubland | 450,190 | 12 |
| | | | Sagebrush | ** | |
| | | | Piñon-Juniper Shrubland | ** | |
| | | | Semi-Desert Grassland | 301,538 | 8 |
| | | | Semi-Desert Shrubland | 95,380 | |
| | | | Riparian & Wetland | 77,964 | |
| V | 200+ years | Replacement and Other Fires Occurring Within this Frequency Range | Spruce-Fir | 510,220 | 14 |
| | | | Piñon-Juniper Woodland | 444,147 | 12 |
| | | | Alpine | 186,494 | 5 |

## FIRE REGIME I (LOW SEVERITY, 0–35+ YEARS)

This regime applies to **ponderosa pine** and **warm-dry mixed conifer** forests.

### *HRV fire regime and forest structure*

Local studies have shown these forests were dominated by frequent surface fires. The reference period for these studies spanned from the mid-1600s to the present. Smaller, spatially localized fires occurred on the order of one or more times a decade (6–10 years). Landscape-scale fires or fires that burn larger areas occurred less frequently, but still on a "short" decadal time scale (13–30 years) (Brown and Wu, 2005; Grissino-Mayer et al., 2004; Wu unpublished data).

The warm-dry mixed conifer is similar to ponderosa pine stands having the same general type of stand structure and similar fire regime with slightly longer fire intervals and denser forest conditions than ponderosa pine.

*Trail Ridge Ponderosa w/ Dense White Fir Understory*

### *Current conditions – ponderosa pine*

Fire exclusion across the lower-elevation forests started in the late 1800s to early 1900s, first because of heavy livestock-grazing and later because of fire suppression (Covington and Moore, 1994; Swetnam and Betancourt, 1998; Grissino-Mayer et al., 2004). Grazing, fire suppression, and logging have greatly changed the structure of our ponderosa pine forests. The general pattern observed in stand structure is an overall densification of forests and homogenization of forest structure across the landscape. Instead of being predominantly open forest structure with groups and clumps of large trees, much of the ponderosa pine now has dense, continuous canopies lacking size and age diversity.

Second Growth Ponderosa

### *Current conditions – warm-dry mixed conifer*

The pattern in warm-dry mixed conifer has added complexity, due to the presence of competing tree species. Fire exclusion has caused forest densification and a shift in tree-species dominance from ponderosa pine toward white fir and Douglas-fir. Historically, fire gave ponderosa pine a competitive edge over the other species found in the warm-dry mixed conifer.

## FIRE REGIME II (REPLACEMENT, 0–35 YEARS)

### *Natural history*

Reconstructing historic fire intervals for grasslands is problematic because no evidence for empirical research has lasted, such as basal fire scars. However, it is reasonable to assume that the fire frequency in grassy meadows is largely linked to the forests surrounding it. If the forest type burned often, as ponderosa pine forests did, then the meadows probably burned relatively often as well. Meadows at higher elevations in forest types that have longer fire intervals would burn less often. In addition, Native Americans may have burned meadow areas regularly to maintain pasture for their animals or game, or to promote specific plants, creating areas of locally increased frequency.

Mountain grasslands were probably always associated with forests even during the reference period and fire appears to have played a maintenance role. Periodic fires would have prevented encroachment from woody species and renewed bunch grasses by removing the buildup of dead plant material.

#### *Current conditions*

Today, mountain grasslands occur as openings in forest-dominated landscapes (see Ecosystem Diversity). During the historic reference period (pre-1900), ponderosa pine stands were more open and park-like, having an abundant herbaceous understory. Forest densification in ponderosa pine has decreased grass cover to the point of exclusion in the densest stands and the pattern may be similar in warm-dry mixed conifer. No formal assessment of meadow encroachment has been conducted in the planning area, but the pattern of forest densification in ponderosa pine strongly suggests that grassy understories have greatly diminished compared to the reference period.

### FIRE REGIME III (MIXED SEVERITY, 35–100+ YEARS)

This regime applies to **cool-moist mixed conifer**. Cool-moist mixed conifer forests are generally found between the warm-dry mixed conifer and spruce-fir forests with aspen intermixed throughout. It is a complex, heterogeneous band of forest where trees and understory of the wet and dry extremes mix, depending on specific site conditions. Drier sites can have small amounts of ponderosa pine, while white fir and Douglas-fir dominate wetter sites.

#### *Natural history*

Forest studies have shown that fire intervals range in the multi-decadal to century time scale in the cool-moist mixed conifer, with evidence of both surface and crown fire (Grissino-Mayer et al., 2004; Wu 1999). Fires in cool-moist mixed conifer forests were not fuel-limited systems because these productive mesic sites always have enough live and dead fuels to carry fire. Fuel moisture, linked to climate, was the most limiting factor. Intra-annual drying (i.e., seasons) creates a potential for fire in most years. During typical seasonal climate and weather patterns, fires were probably predominantly surface fires with limited high-intensity patches. The sizes of those fires ranged from small to large. Larger fires with a greater ratio of crown-fire to surface-fire area would burn in significantly dry years. Overall size, intensity, and severity of any fire would depend on fuel moisture, weather conditions, and climate context. This fire regime promotes a complex and heterogeneous forest.

2002 Missionary Ridge Fire From Durango

### *Current conditions*

Forest fuel loading in terms of woody debris and live biomass have increased over the period of fire exclusion. The increases, however, are not necessarily out of HRV on stand level. HRV concerns are for diversity in tree species and seral stages across the cool-moist mixed conifer on a landscape level. The landscape structure was probably more diverse during the pre-1900 reference period with early to late seral stands in various proportions, and more variety in stand densities than what is observed on the landscape currently. Periodic surface and crown fires are particularly important to the persistence of ponderosa pine and aspen stands in this landscape.

Ponderosa pine is a small yet important component of the cool-moist mixed conifer, occurring where fires burned more frequently due to topography, aspect, or warm climatic periods that supported more fire. The individuals or small groups are likely to disappear over time from old age, insects and disease, or crown fire under current conditions.

Aspen stands are aging uniformly within the cool-moist mixed conifer landscape. In the past, periodic fires would have renewed these stands. If the aspen stands are to persist over the long term, they will need to burn again. Current aspen distribution is probably not outside HRV conditions (Romme et al., 2003), and mixed-severity fires under normal fire weather conditions could adequately rejuvenate the patch mosaic over time.

## FIRE REGIME IV (STAND REPLACEMENT, 35–100+ YEARS)

### *Mountain and sage shrublands, semi-desert shrub and grasslands*

Mountain shrublands, semi-desert shrub and grasslands, and sage shrublands are classified under Fire Regime IV; however, shorter intervals than 35 years can probably occur.

Climate conditions and the time needed for an adequate fuel complex to develop are likely factors that control fire frequency in these ecosystems. Therefore, in the driest and least productive systems, such as the semi-desert shrub and grasslands, fuel load is the more limiting factor. In these systems, vegetation develops very slowly under conditions of scant rainfall and poor soils. Bare ground is prevalent even in the more productive of these sites. There is a lack of information about fire regimes for semi-desert shrub and grasslands. Fire may not be a primary disturbance in these ecosystems.

Mountain shrubland ecosystems occur at higher elevations and moister climates, making them more productive and giving them a greater potential to burn more often than semi-desert systems.

### *Natural history*

The only pre-1900 fire history data available for any mountain shrublands in the study area comes from a study conducted in Mesa Verde National Park (Floyd et al., 2000). Floyd calculated a 100-year fire-rotation period for Gambel oak (the time to burn an area equal to the total extent of shrubland in the study area). One hundred years may pass and all of the Gambel oak in the Mesa Verde study area could burn at once, or patches of various sizes could burn in the study area until an area equal to the study area has burned. In this latter scenario, some stands may burn more than once, while others may completely escape burning during that 100-year period. This scenario is reasonable, given the frequency that favorable fuel and weather conditions for fire occur.

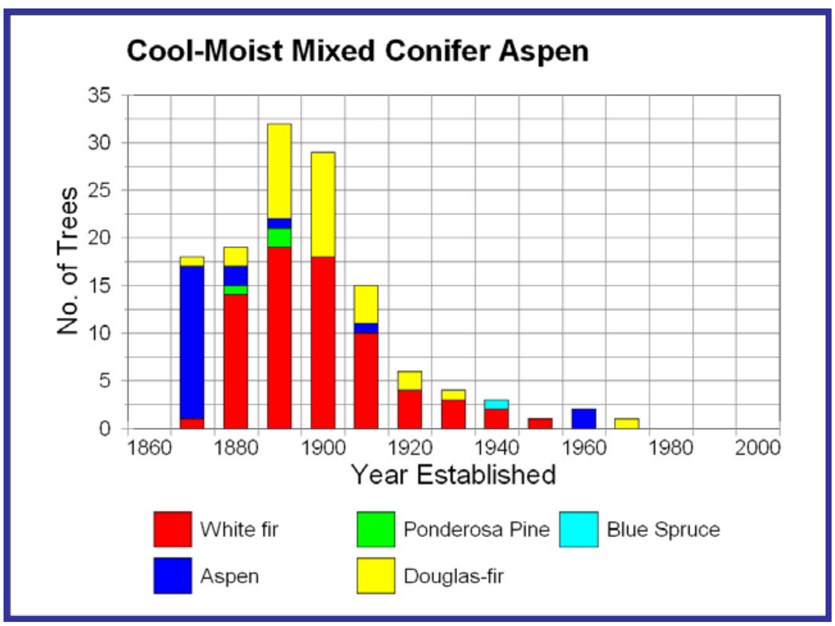
#### *Current conditions*

Further study on Gambel oak fire frequency and landscape structure is warranted because it occurs across a large elevational gradient across the SJPL. Furthermore, the fire rotation found at Mesa Verde National Park may not hold true across the SJPL. The Gambel oak in Mesa Verde National Park is associated with piñon-juniper woodlands, which burn less often than Gambel oak. Gambel oak is also associated with ponderosa pine, warm-dry and cool-moist mixed conifer, and also occurs in extensive stands of Gambel oak alone.

Sage shrublands are assumed to function similarly to Gambel oak shrublands. Regional studies from the Great Basin, Montana, and Oregon have reported a range of fire intervals, mostly in the multi-decadal time scale. There is limited localized information for the planning area; however, there is an adequate basis for assuming that fire played a large role in structuring sagebrush ecosystems much as fire does in other major vegetation types.

In summary, more productive shrublands such as Gambel oak are not seriously outside their HRV in terms of fire intervals; however, landscape diversity of patch sizes and seral stages should be of concern. Sage shrublands and the semi-desert grass and shrublands are also not outside HRV. However, these drier ecosystems are currently experiencing an invasion of cheatgrass (*Bromus tectorum*). Cheatgrass is not only crowding out native vegetation, but will also alter this low-frequency fire regime to a high-frequency one by creating a fine-fuel bed able to carry fire more frequently and extensively than during the reference period.

**Figure V.2 - Cool-Moist with Aspen Age and Fire History**




*Stable and seral aspen*

Fire Regime IV also includes *stable and seral aspen.*

#### *Natural history*

The importance of fire to aspen regeneration is well-documented (Figure V.2). Romme et al. (2003) conducted a landscape assessment of aspen on the west side of the SJNF. They found a fire occurred in every decade from 1740 through 1910 within their 77 $km^2$ study area, with stands establishing in every decade from the 1760s through the 1870s. They calculated the median age of aspen stands to be 70 years in 1880 and interpreted the fire rotation to be 140 years for an area equal to the study area to burn. An individual stand may go more than a century before burning, whereas another could re-burn at a much shorter interval.

These data show that fires occurred frequently across an aspen landscape. Significant climatic events (drought) could synchronize large areas of aspen, but stands would diversify again over time, with subsequent random fire occurrences and burn patterns.

#### *Current conditions*

Current aspen distribution does not differ greatly from the 1880 landscape (Romme et al. 2003). Continued fire exclusion could cause a decrease in aspen on the landscape if clones become so decadent over time that their underground root systems die with no overstory stems to maintain them. However, no conclusive information is available about the duration for which aspen roots remain viable. Small stems that go undetected may be able to sustain root systems for many years.

## FIRE REGIME V (STAND REPLACEMENT, 200+ YEARS)

This regime applies to forest or vegetation types that rarely burn, due to fuel or moisture limitations. On the SJPL, spruce-fir and piñon-juniper forests seldom burn.

### *Spruce-fir*

Cold-wet mixed conifer and spruce-fir are assumed to have the same fire regimes. Romme et al. (2003) estimate centuries passed between fires in a spruce-fir stand on the landscape. They could not determine exact fire intervals, because too many of their sampled stands were too old to estimate the time since the last fire. A summary of their age structure data does show that mature (>150 years) spruce-fir stands were common on the landscape during the reference period (pre-1900). Young stands (<100 years) made up just less than 40 percent of the landscape and a small amount of the landscape was of intermediate ages (100–150 years). No significant fires have burned in their study area since their reference period; therefore, their entire study landscape has aged over 100 years.

Spruce-fir forests with such long fire intervals do not have quantifiable landscape equilibrium in stand structure or age over practical management time scales.

Spruce-fir forests with such long fire intervals do not have quantifiable landscape equilibrium in stand structure or age over practical management time scales. Old or young stands will dominate a landscape depending on when the last major fires burned. Aspen stands within the spruce-fir are a concern: they must burn or be succeeded by conifer. Questions remain about how long an aspen clone can remain viable without fire. Overall, the spruce-fir landscape is likely within HRV limits in its current condition.

### *Piñon-juniper*

Piñon-juniper woodlands also have very long fire intervals. The fire-rotation period for stands in Mesa Verde National Park is about 400 years, while some have not burned for 700 years (Floyd et al., 2000). Another study from the Uncompahgre Plateau estimates piñon-juniper fire intervals to be 200–1000 years (Eisenhardt 2004).

Long fire intervals seem unlikely for forests that experience hot, dry summers with ample lightning strikes. Unlike the spruce-fir that is typically too wet to burn, piñon-juniper forests often do not have the fuel continuity for fires to spread easily. These stands have scant herbaceous understory to lay the fine-fuel bed fires would need to spread. Only wind-driven fires burn significant numbers of acres.

These piñon-juniper forests have not been affected by fire suppression, and they appear to be within their HRV. However, noxious weeds pose a threat to their ecological integrity. Cheatgrass has proliferated throughout the planning area's piñon-juniper, especially in beetle-killed stands, introducing surface fires to this forest type. The long-term ecological consequences are serious, because cheatgrass is such an aggressive colonizer, and fire appears to promote it. Its presence will increase fire frequency, and its persistence may delay or completely alter typical post-fire successional pathways in piñon-juniper woodlands.

Piñon-juniper shrublands are common throughout the SJPL. Sagebrush (*Artemisia tridentate and other spp.*) is found on dry, low-elevation sites and Gambel oak on moister, higher-elevation ones. Fires may burn more often in the shrubland type than the forest type, because the shrubs and trees would develop a continuous fuel complex more quickly. The shrubland type may have been moderately affected by fire suppression, decreasing the diversity of the over- and midstory structure across the landscape. As in the piñon-juniper woodland, noxious weeds are a serious problem. Cheatgrass, especially, will promote more-frequent fire. If fires do burn, the post-fire successional trajectory will be altered, with cheatgrass or thistle dominating the stand.

## OTHER FIRE REGIMES (SPECIAL VEGETATION TYPES)

Important vegetation types that do not appear in Table V.1 are riparian areas and wetlands. Information about disturbance is scarce for these vegetation types. Fire frequency in these vegetation types is influenced by the vegetation type surrounding them. Thus riparian and wetland areas in the subalpine will rarely burn compared to those found in ponderosa pine forests. Riparian and wetlands in lower elevations probably did not burn as often as their surrounding vegetation either, because of persistent mesic conditions. Therefore the occurrence of fires is most likely controlled by drought. Native burning may have played a role in these areas, but that topic must be researched.

### *Condition class*

The first step of FRCC[1] characterizes historical (natural) conditions for vegetation types which are the reference conditions used to assess whether a landscape (forest type) is outside its HRV. The second step of FRCC is the condition class assessment of a landscape's degree of departure from its historical (natural) conditions. For the SJPL geographic area, the reference period for this analysis spans the $17^{th}$ century to late $19^{th}$ century (1700s – 1800s). This period is based on the most reliable span in fire history data. The reference period is the time period when ecosystems along with their natural disturbance regimes were still intact and functioning in sustainable landscapes before Euro-American settlement activities. Tree-ring fire chronologies show the last widespread fire occurred in the 1880s. 1890 is a good date to designate the

[1] Fire Regime Condition Class (FRCC) is a standardized interagency tool for assessing a current landscape's departure from historical (natural) conditions (Hann et al., 2003). Historical or reference period is defined as the time period when ecosystems along with their natural disturbance regimes were still intact and functioning in sustainable landscapes before Euro-American settlement activities. Current condition departure assessments are based on fire frequency and intensity, current species composition, structural stage, age and canopy closure, and fuel accumulations compared to conditions under the historic disturbance regimes.

beginnings of fire exclusion (Brown and Wu, 2005; Grissino-Mayer et al., 2004; Wu 1999). Current condition departure assessments are based on missed or increased fire occurrences, uncharacteristic fire behavior, current species composition, structural stage, age and canopy closure, and fuel accumulations compared to conditions under the historic disturbance regimes.

Table V.2 defines the three FRCC condition classes. Low departure (CC1) is considered to be within HRV. Moderate departure (CC2) indicates that components of the fire regime, such as fire frequency, have been altered, resulting in changes in vegetation and landscape patterns. These areas may require varying levels of management actions before fire can be restored and allowed to plays its historical natural role.

**Table V.2 - Fire Regime Condition Class Descriptions**

| Condition Class | Descriptions |
|---|---|
| CC1 | Fire regimes are within the historical range and the risk of losing key ecosystem components is low. Vegetation attributes (species composition and structure) are intact and functioning within their historical range. |
| CC2 | Fire regimes have been moderately altered from their historical range. The risk of losing key ecosystem components is moderate. Fire frequencies have departed from historical frequencies by one or more return intervals (either increased or decreased). This may result in moderate changes to one or more of the following: fire size, intensity and severity and landscape patterns. Vegetation attributes have been moderately altered from their historical range. |
| CC3 | Fire regimes have been significantly altered from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals. This may result in dramatic changes to one or more of the following: fire size, intensity, and severity and landscape patterns. Vegetation attributes have been significantly altered from their historical range. |

High departure (CC3) means that fire regimes and vegetation are significantly altered from historical conditions. Uncharacteristic fire behavior and fire effects will occur under certain conditions, resulting in vegetation composition and assemblages not known to exist during reference conditions. Condition class is a calculated number and the protocols are outlined in the FRCC Guidebook v1.2 (Hann et al., 2003). However, the SJPL's condition class map presents assigned CC values based on a vegetation polygon's type and fire regime and will be updated with the new FRCC map when available.

Table V.3 shows each major vegetation type by its assigned CC. More detailed HRV discussion is found in the Fire Regime section above. In general, ecosystems with longest return-fire intervals, such as spruce-fir and piñon-juniper, have not missed fire intervals and therefore on a stand level their structure and species composition is well within estimated HRV conditions. From an ecological perspective, fires can be allowed to burn in these forests under any conditions and it will burn with characteristic intensity with characteristic effects. Some concerns about landscape structure and mosaic exist and need to be assessed, but because of the very long fire intervals the landscape is probably still within HRV. Thus spruce-fir is in CC1. Piñon-juniper is in CC2. Even though its fire regime and macro woody structure is intact, piñon-juniper is only considered CC2 because of grazing, chainings, and degraded herbaceous composition. The current cheatgrass invasion may push piñon-juniper further out to CC3 over time. Cheatgrass cover will introduce frequent surface fire to this low-frequency, high-intensity fire regime and alter post-fire successional pathways.

Aspen is currently assigned to CC1, but is trending towards CC2. The current distribution and age structure across the landscape is an assemblage within HRV; however, it appears to be on the longer extreme of its HRV. Many stands succeeding to conifer would benefit from burning to regenerate the stands. An important question to aspen persistence on the landscape is how long a clone can remain viable after its last stand-replacement fire.

Cool-moist mixed conifer is assigned to CC2 because, although it has missed some fire intervals, its vegetation composition and landscape mosaics are still within HRV, with fires still behaving characteristically and producing characteristic effects. This is true for the other vegetation types listed in CC2; however, the semi-desert vegetation types and sagebrush type are threatened by cheatgrass and other noxious weeds and have the same situation described for piñon-juniper.

**Table V.3 - Fire Regime Condition Class by Existing Vegetation Type**

| Condition Class (assigned) | Existing Vegetation Type | Acres of Public Lands | Percent of Public Lands |
|---|---|---|---|
| 1 | Spruce-Fir | 510,220 | 14 |
| | Alpine | 186,494 | 5 |
| 2 | Aspen | 346,384 | 10 |
| | Cool-Moist Mixed Conifer | 199,412 | 6 |
| | Mtn. Grasslands | 304,314 | 8 |
| | Mtn. Shrubland | 450,190 | 12 |
| | Piñon-Juniper Woodland | 444,147 | 12 |
| | Piñon-Juniper Shrubland | ** | |
| | Semi-Desert Grassland | 301,538 | 8 |
| | Semi-Desert Shrubland | 95,380 | 3 |
| | Sage Shrublands | 210,030 | 6 |
| 3 | Ponderosa Pine | 411,790 | 11 |
| | Warm-Dry Mixed Conifer | 95,392 | 3 |
| 0 | Riparian & Wetland | 77,964 | 2 |

Ponderosa pine and warm-dry mixed conifer are both frequent surface fire regimes and have been the most affected by fire suppression, logging, and grazing since Euro-American settlement; therefore, they are assigned to CC3. They have missed numerous fires relative to historic patterns, their stand structures are overly dense, understory herbaceous life is degraded, and white fir is overtaking ponderosa pine in the warm-dry mixed conifer. Forest fire regimes have shifted from high-frequency, low-intensity surface fire to low-frequency, high-intensity stand-replacement fire.