Draft Assessment

Forest Plan Revision

Terrestrial Ecosystems Detailed Draft Report

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for:
Malheur, Umatilla, and Wallowa-Whitman National Forests

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Terrestrial Ecosystems

Introduction

Terrestrial ecosystems are comprised of land-based vegetation relevant to the Blue Mountains national forests. Vegetation is complex and subject to an array of interacting ecosystem processes. The extent, type, and condition of forested vegetation is dependent upon relatively fixed site capability features on the landscape, such as soils, combined with the influences of system drivers that may impact forest vegetation such as climate, ecological disturbances (insects, disease, wildfire), and human activities (vegetation treatments).

The Blue Mountains contain diverse landscapes made up of complex topography, from plateaus and valleys to large mountain ranges, with elevations ranging from 267 to 3,000 meters. The southern portion of the Blues experience warmer, drier conditions while the northern portion is influenced by marine climatic conditions and experiences higher precipitation and less seasonally varied temperatures. Climatic differences, created in part by elevation gradients and complex topography, further contribute to diversity in the Blue Mountains.

Figure 1: Coniferous forest stringers border open meadows across the diverse landscape of the Blue Mountains. Walla Walla RD, Umatilla NF.

This report discusses the major and rare or unique terrestrial ecosystems found within the Blue Mountains national forests. Table 1 shows the proportion of each major terrestrial ecosystem type that occurs within each national forest of the plan area. Ecologically important terrestrial ecosystems with limited extent in the planning area include whitebark pine, aspen, and sagebrush steppe. These rare terrestrial ecosystems were included because of the unique and significant habitats they provide across the Blue Mountains national forests. Maps of each ecosystem type are located in the Appendix at the end of this report.

Table 1: Major terrestrial ecosystem types and proportion in plan area

Terrestrial Ecosystem Type	Percentage of Plan Area		
	Malheur	Umatilla	Wallowa-Whitman
Dry Upland Forest	72%	42%	36%
Moist Upland Forest	6%	31%	21%
Cold Upland Forest	9%	8%	21%
Grasslands	2%	14%	11%

Process and Methods

The primary sources of information used for this report include the following: the existing 1990 Malheur, Umatilla, and Wallowa-Whitman forest plans, as amended; 1994 Eastside Screens; the withdrawn Final Environmental Impact Statement for the Malheur, Umatilla, and Wallowa-Whitman National Forests Land Management Plans (USDA FS FEIS 2018); 2018 Management Situation report (USDA FS SR 2018), withdrawn 2018 Malheur, Umatilla, and Wallowa-Whitman Forest Plans (USDA FS 2018); other agency reports and analyses; published literature; and other updated information. Geographic Information System (GIS) technology was used where appropriate and available to assess terrestrial vegetation conditions on each forest.

These sources continue to describe the current status, trends, and scientific understanding of the ecological context for terrestrial ecosystems. Updates are provided with more current information where appropriate, as indicated by a referenced citation.

The metrics used to develop an understanding of existing conditions and trends, including the impacts of climate change, for terrestrial ecosystems include the following:

- Ecological Integrity
- Range of Variation (RV)
    - Forest Structural Stages
    - Forest Species Composition
    - Forest Stand Density
- Wildland Fire Regimes
- Fire Regime Condition Class and Vegetation Departure Index

Ecological Integrity

The purpose of assessing for ecosystem integrity is to determine whether ecosystems are functioning normally and are uncompromised. Ecosystems have integrity when their composition, structure, function, and connectivity are operating normally over multiple spatial and temporal scales. Ecological integrity is defined as the degree to which ecosystems are represented across the forest and functioning properly. For example, meadows are still well represented and are not substantially reduced in extent and forests still provide habitat for native plant and animal species at levels that allow them to persist through fire, drought, and climate change. The 2012 Planning Rule directives define ecological integrity as "the quality or condition of an ecosystem when its dominant ecological characteristics (for example composition, structure, function, connectivity, and species composition and diversity) occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence". Wildfire still plays an important ecological role in maintaining and restoring ecosystem functions, vegetation conditions, and reducing hazardous fuels.

Terrestrial ecosystems are assessed for ecosystem integrity to determine whether they are functioning normally and are uncompromised and are assigned a ranking. Each ecological integrity ranking is defined below.

Criteria for Ranking Level of Ecological Integrity: High, Moderate, Low, and Poor

High Ecological Integrity: If the ecosystem remains on current trajectory, it is expected to continue delivering major functions and services including supporting biodiversity and productivity expected for this ecosystem without human interference. Drivers, stressors, and key ecosystem characteristics exhibit the range of variation that was common in the past.

Moderate Ecological Integrity: If the system remains on current trajectory it is expected to deliver major functions and services including supporting biodiversity and productivity at a reduced level relative to expectations for this ecosystem. One or more drivers, stressors, and key ecosystem characteristics are compromised in a way that disrupts disturbance regimes or characteristics of the system. However, compromised features are not those that determine the identity of this system or significant characteristics are only modestly compromised. Drivers, stressors, and key ecosystem characteristics exhibit a range of variation that was not common in the past but well within the range that resulted in resilience.

Low Ecological Integrity: If the system remains on current trajectory it is expected to deliver some major functions and services including supporting a portion of the biodiversity and productivity at a reduced level relative to expectations for this ecosystem without restoration. One or more drivers, stressors, and key ecosystem characteristics are significantly compromised. However, compromised features are not those that determine the identity of this system. Drivers, stressors, and key ecosystem characteristics exhibit a range of variation that was not common in the past but within the range and resilience is possible.

Poor ecological integrity: The ecosystem currently is (or is trending toward) experiencing a type-change or is incapable of delivering major functions and services including supporting biodiversity and productivity expected for this ecosystem type without herculean human interference and maintenance. Drivers, stressors, and key ecosystem characteristics exhibit a range of variation rarely or never exhibited in the past.

Range of Variation (RV)

Terminology note: Some sources refer to RV as a "natural range of variability" (NRV) or a "historical range of variability" (HRV). The term "natural" is ambiguous but a frequently used term to signify something of esthetic or spiritual importance (Powell 2019). To avoid this ambiguity, and to align with Forest Service handbook and directives, (FSH 1909.12, section 43.13 – Range of Variation; and FSM 1920, section 1921.73a – Ecosystem Diversity), the term "Range of Variation", or RV, will be used throughout this report.

Recently, in response to climate change, some sources suggest that “historical range of variability” is no longer a relevant concept, that it should be abandoned altogether, or perhaps it should be replaced with “future range of variability” (Powell 2019). Through a critical evaluation of possible alternatives to RV, we believe it is the best measure of forest conditions at this time. RV, with all its faults and limitations, is the most viable approach for the near-term because it has the least amount of uncertainty, particularly when compared with the uncertainty associated with magnitude, timing, scale, and spatial extent of climate change impacts (Powell 2019). Historical reference conditions are used appropriately to guide management decisions and inform discussions on the effects of different management actions. However, as our understanding of historical conditions and anticipated future conditions increases, managers need the flexibility and adaptability to respond to current information and data and are open to other tools that may be appropriate as conditions change in the future (Halofsky and Peterson 2017).

A key idea behind the use of range of variability is that if landscapes are maintained within a historical, reference range, then the conditions should be sustainable over time. This is based on the premise that since native plant and animal species have evolved with, and are adapted to, the historical disturbance regimes and resulting conditions of an area, ecosystem components occurring within their historical range should represent sustainable conditions (Aplet and Keeton 1999, Swanson et al. 1994). However, it is impractical to expect forested conditions to return to, and be maintained, within historic conditions in all areas or for all attributes.

An RV analysis was completed to evaluate current vegetation conditions across the Blue Mountains national forests. RV has been used to describe fluctuations in ecosystems, using conditions prior to Euro-American settlement as a reference point. RV reference conditions provide an ecological basis from which to compare existing conditions and determine status and trends based on departure of the existing condition from the reference condition. Current forest vegetation conditions can be evaluated against these reference conditions, not only to determine degrees of change, but to design management decisions and treatments. RV helps to inform discussions on the effects and trends of different management actions that provide human society with valuable resources and services while returning highly departed, at-risk ecosystems to a more sustainable condition (Powell 2019). RV provides insight into the temporal dynamics and key characteristics of an ecological system and provides a context for assessing whether an ecosystem has integrity.

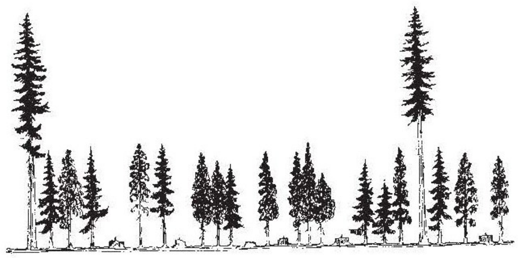
For this assessment, terrestrial ecosystems were grouped into categories using the potential vegetation concept (USDA FS 2018). Potential vegetation is the resulting dominant flora within a temperature and moisture regime and determined by environmental factors such as elevation, slope, aspect, and soil type (Powell 2007). Ecosystem conditions fluctuate over time, within some range of variability related to the type and intensity of disturbances that occur.

Estimates of the range of variability by potential vegetation group for forest structural stages, species composition, and stand density were developed for this analysis in 2007 through modeling using the Vegetation Dynamics Development Tool (VDDT). VDDT is a state and transition model designed to examine vegetative change for landscape-scale planning (Powell 2019).

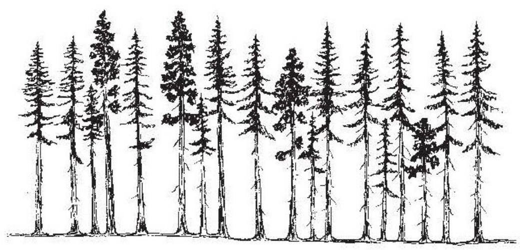
Forest Structural Stages

The range of variability for the distribution of forest structural stages reflects the natural fire regimes by each potential vegetation group. Forest structure describes the density, species composition, size classes, canopy characteristics, and other physical descriptive metrics of trees in an area. Following disturbances, forests regenerate and progresses through structural stages over time according to the vegetation potential, fire regime, and other environmental factors. The five forest structural stages, stand initiation, stem exclusion, understory reinitiation, old forest single stratum, and old forest multi strata, are depicted in Figure 2 (Countryman and Justice 2006).

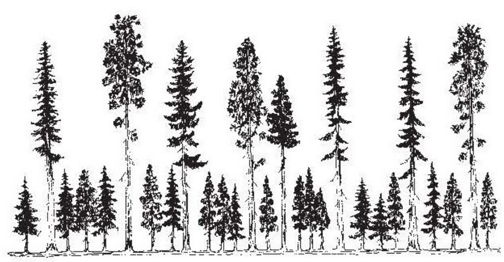
The vertical and horizontal structural arrangement of forest vegetation as well as the size and arrangement of grasses and shrubs are all important components of stands and influence disturbance agents like fire behavior and insect and disease dynamics as well as ecosystem services like wildlife habitat, wildfire hazard, scenic integrity, carbon stocks, and social and economic products, such as timber and culturally significant foods.



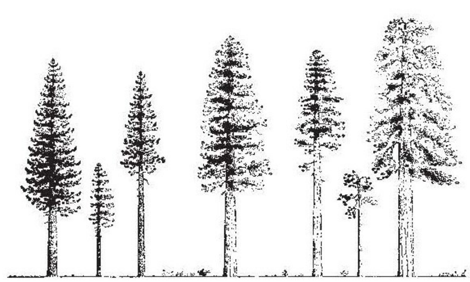
Stand Initiation (SI). Following a stand-replacing disturbance such as wildfire or tree harvest, growing space is occupied rapidly by vegetation that survives, or colonizes the area afterward. Survivors survive above ground, or they initiate new growth from underground organs or from seed stored on site. Colonizers disperse seed into disturbed areas, it germinates, and then new plants establish and develop. A single canopy stratum of tree seedlings and saplings is dominant in this stage.



Stem Exclusion (SE). In this single-cohort stand structure, trees initially grow fast and quickly occupy their growing space, competing strongly for sunlight and moisture. Because trees are tall and reduce subcanopy light levels, understory plants (including smaller trees) are shaded and grow slowly. Species needing sunlight often die; shrubs and herbs may go dormant. In this stage, establishment of new trees is precluded by a lack of sunlight (stem exclusion closed canopy) or soil moisture (stem exclusion open canopy).



Understory Reinitiation (UR). As a forest develops, a new tree cohort eventually gets established as overstory trees begin to die, or because they no longer fully occupy growing space. A period of overstory crown shyness occurs when tall trees abrade each other in the wind (Putz et al. 1984). Regrowth of understory seedlings and other vegetation then occurs; trees begin stratifying into vertical layers. UR consists of overstory trees at low to moderate density, with small trees underneath.



Old Forest (OF). Many age classes and vegetation layers mark this structural stage containing large, old trees. Snags and decayed fallen trees may also be present, leaving a discontinuous overstory canopy. The drawing shows a single-layer ponderosa pine stand reflecting the influence of frequent surface fire on dry-forest sites (old forest single stratum; OFSS). Surface fire is not common on cold or moist sites, so these environments generally have multi-layer stands with large trees in an uppermost stratum (old forest multi strata; OFMS).

Figure 2: Description of forest structural stages used to classify vegetation for the Blue Mountain national forests.

Species Composition

Tree species compositions within different potential vegetation groups can significantly influence the climate resilience, wildfire, and insect and disease hazards in an area. The shade tolerance of tree species is a characterization of a species ability to grow and regenerate successfully under shaded conditions. Common tree species of the Blue Mountains that are more intolerant of shaded conditions include ponderosa pine, lodgepole pine *(Pinus contorta*), western larch (*Larix occidentalis)*, and western white pine *(Pinus monticola*). Tree species that are relatively tolerant of shade include Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), and grand fir (*Abies grandis*). The inland variety of Douglas-fir (*Pseudotsuga menziesii*) found in the Blue Mountains is generally considered intermediate along the shade tolerance continuum. See Table 269 of USDA FS FEIS (2018) for a crosswalk of species shade tolerance by potential vegetation group used for this report.

Figure 3: Mixed conifer regeneration on the Walla Walla Ranger District. Tree species from left to right: lodgepole pine, western larch, and grand fir.

Common shade-intolerant tree species like ponderosa pine and western larch and intermediate Douglas-fir tend to be better adapted to low-severity surface fires. Ponderosa pine and Douglas-fir also possess greater tolerance to drought conditions (Niinemets and Valladares 2006). Conversely, shade-tolerant species like grand fir or subalpine fir are poorly adapted to resist wildfire damage, and their branching habits facilitate torching and crowning fire behaviors. These species of fir trees are also generally associated with a high susceptibility to attack from defoliating insects, root diseases, fir engraver beetles, stem decay, and other insects and diseases. Stress from drought and excessive stocking often exacerbate mortality caused by these agents and can contribute to the accumulation of uncharacteristically high levels of surface fuels (USDA FS FEIS 2018).

The exclusion of wildfire and past timber harvesting and grazing practices have all contributed to a significant shift away from fire- and drought-tolerant tree species, as well as the introduction of invasive plant species (USDA FS FEIS 2018).

Tree species compositions in a project planning area can be characterized by using cover types, a classification of existing vegetation composition (USDA FS FEIS 2018). Vegetation cover type assignments, such as ponderosa pine or Douglas-fir, reflect the majority or plurality of tree species abundance found within a stand, and they apply to both pure and mixed stands.

In general, changes to vegetation types have been most significant in the lower elevations and least significant in the higher elevations, and historical timber harvest has influenced many vegetation types and associated wildlife habitats. Some changes in ecological function have occurred because of these changes to vegetation. Change in ecological function helps identify where the potential for active restoration is often higher, such as in ponderosa pine, and where the potential is lower, such as in higher elevation spruce-fir and alpine tundra types where deviation from historical conditions is less (USDA FS FEIS 2018). Approximately 31 percent of the Plan Area is in inventoried roadless areas, designated wilderness areas, or other specially designated areas that contain representative vegetation types.

Stand Density

Stand density refers to the degree to which an area is occupied by trees and, hence the intensity by which trees are competing for site resources (USDA FS FEIS 2018). Stand density is important as it directly relates to the availability of limited resources that are critical in terms of both stand-level productivity and individual tree vigor. It is also important in terms of determining wildfire behavior, providing wildlife habitat, storing carbon, and influencing insect or disease disturbance (See Carbon Report).

Wildland Fire Regimes

Fire has been a significant disturbance process within the plan area historically and is essential to maintain key ecological processes. An understanding of fire regimes, ecological departure from reference conditions, and landscape pattern and process is an important part of modern land management. Approximately 88 percent of the Blue Mountains are classified as historical fire Regime I, II, or III, which are short to mixed return interval ecosystems. Sixty percent of the Blue Mountains are classified Fire Regime I, which are sites historically dominated by low to mixed severity frequent fires such as dry upland forest (Reinhardt and Crookston 2003).

Fire Regime Condition Class and Vegetation Departure Index

Fire regime condition class is a way of classifying the current degree of change from the natural fire regimes and their characteristic vegetation and fuel conditions (Barrett et al 2010). The vegetation departure index is used in this analysis as an inference of the overall fire regime condition class (USDA FS FEIS 2018).

Scale

The area of analysis for terrestrial ecosystems should be large enough to capture broad-scale trends and the natural range of variation in disturbance intensity, frequency, and areal extent. The assessment of terrestrial ecosystems evaluates ecological integrity at two spatial scales, *spatial* and *plan*:

The three Blue Mountains national forests – Malheur, Umatilla, Wallowa-Whitman – make up the *spatial* scale for the analysis area of terrestrial ecosystems, encompassing 5.4 million acres of land managed by the Forest Service. The extent of each major and rare type terrestrial ecosystem has set the *plan* scale, 4.3 million acres, from which current condition and trends can be determined. Departure and disturbance patterns for key ecosystem characteristics can be described by grouping terrestrial ecosystems using the "potential vegetation" concept. Potential vegetation is defined as the community of plants that would become established if all successional sequences were completed, without interference by humans, under existing environmental conditions including elevation, slope, aspect, and soil type (Powell 2007). Potential vegetation, the theoretical endpoint of plant succession in the absence of disturbance, results in a dominant flora within a temperature and moisture regime.

Current conditions for potential vegetation can be determined and compared to a reference range of variation. For rare type ecosystems such as aspen, whitebark pine, and sagebrush-steppe, stand-level data was utilized to help determine existing condition, distribution, and occurrence across the landscape.

Current Forest Plan Direction

The current forest plans of the Blue Mountains national forests (1990), as amended, do not outline direction explicitly for "terrestrial ecosystems." The Goals, Objectives, and Desired Future Conditions related to terrestrial ecosystems are presented indirectly in part through various resource areas, and each forest breaks them out differently: Timber, Wildlife, Fish and Wildlife, Diversity, Ecosystems & Diversity, and/or Old Growth.

In 1994, the Pacific Northwest Regional Forester of the Forest Service issued Interim Direction Establishing Riparian, Ecosystem, and Wildlife Standards for Timber Sales on Eastside Forests that amended the Forest Plans by establishing riparian, ecosystem, and wildlife standards for timber sales on eastside forests (USDA 1995). This Regional Amendment, known as "Eastside Screens", amended all three forest plans with direction on old growth and large tree management. In 2021, the Forest Service published a Decision Notice and Finding of No Significant Impact (DN/FONSI) for an amendment to Eastside Screens. The *Forest Management Direction for Large Diameter Trees in Eastern Oregon and Southeastern Washington Project* amended the Eastside Screens, which again amended all three forest plans. The DN/FONSI is currently under litigation.

Existing Condition

Best Available Scientific Information (BASI) and Data Sources

Vegetation conditions used for this assessment were developed from methodologies, models, and procedures consistent with consideration of best available scientific information. The data sources and methodologies presented are commonly accepted techniques for assessing terrestrial vegetation conditions, providing the best available accuracy for analysis within reasonable, practical budgetary and technical constraints. When present, limitations of each method are identified as well as mitigation measures that can be reasonably taken when available.

Existing vegetation data is compiled into a corporate database for all three Blue Mountains national forests. Estimates of the range of variability for forest structural stages, species composition, and stand density were developed for this analysis in 2007 through modeling using the Vegetation Dynamics Development Tool (VDDT) (USDA FS FEIS 2018).

The following methods were used for the 2018 withdrawn Forest Plans and are still considered the best approach for assessing existing conditions for terrestrial ecosystems:

- **Walk-through examinations:** Visual observations of ground conditions conducted by resource specialists to compare findings with other data sources. Field visits are used to validate the accuracy of the data or to make updates and corrections when needed.
- **Photo-interpretation and aerial photogrammetry:** Aerial photos and remotely sensed data such Light Detection and Ranging, commonly known as LIDAR, were utilized to supplement and support imputed datasets where field reconnaissance and stand examinations were limited or infeasible due to inaccessible terrain. Aerial photos were used to provide information on vegetation composition, structure, density, and susceptibility to insects and diseases. The resolution of aerial photos for vegetation composition, density, and structure over large areas is of high quality; however, uncertainty exists regarding sub-canopy vegetation (small trees, shrubs, etc.). Aerial imagery generally underestimates the extent of suppressed and sub-dominant canopy layers in multi-cohort stands. However, further examination of ground-based field data and professional experience in the Blue Mountains have led to the conclusion that these underestimates are minor relative to the scale of the plan area. Additionally, the underestimation was mitigated by assigning many early to mid-aged stands an understory component based on ecological knowledge of the local area and processes of competition, succession, and disturbance.
- **Intensive stand examinations:** Ground-level information collected for individual tree and stand attributes following Common Stand Exam (CSE) protocols. Field sampled data is used to impute and attribute vegetation conditions of geographically and biotically similar adjacent stands using the Most-Similar Neighbor (MSN) method. As with any sample of a larger population, collected data is subject to statistical uncertainties and margins of error. In general, however, stand conditions indicated by this data are suitably accurate for project-level analysis.
- **Most Similar Neighbor (MSN) modeling:** A program used to impute and populate attributes from vegetation polygons that have been measured to vegetation polygons that have not been measured. See Crookston et al., 2002 for information on the MSN program and application.
- **Vegetation Dynamics Disturbance Tool (VDDT):** The Vegetation Dynamics Disturbance Tool is a non-spatial state and transition model used to model historic (pre-1860) conditions for dominant types of forested and non-conifer vegetation types within the Blues. The states within the model are described by combinations of vegetation structure and composition, including structural stage, species composition, number of tree layers, stand density (canopy closure), and tree diameter. The combinations of structure and composition for all the models

produced 403 distinct states. The transition part of the model describes how stands move between different states through time. See (USDA FS FEIS 2018).

- **Professional expertise:** Vegetation analysis was performed by trained, experienced, professional foresters with considerable on-the-ground experience and familiarity with potential management actions and their likely effects. Additional subject matter expertise came from peer reviews of the analysis and methodologies.

The following data sources are also used to determine existing conditions, trends, stressors, threats, and climate change context to terrestrial ecosystems:

- **Historic and scientific documents:** The Blue Mountains national forests maintain an extensive collection of historical reference documents and the USDA Forest Service maintains a vast collection of scientific documents (https://www.fs.usda.gov/research/treesearch), of which were accessed to provide information on patterns and processes of terrestrial ecosystems. The uses of specific scientific or historical documents is noted via reference citations, which include:
    - Climate Change Vulnerability and Adaptation in the Blue Mountains Region (Halofsky and Peterson 2017)
    - Range of Variation Recommendations for Dry, Moist, and Cold Forests (Powell 2019)
    - USDA Forest Health Protection Insect and Disease Assessments, maintained in forest project records.

Terrestrial Ecosystem Types

Dry Upland Forest

Dry upland forests are the most common forest type in the Blue Mountains, generally occurring at low to moderate elevations in the montane vegetation zone. Climate generally includes warm, dry summers, with warm to hot daytime temperatures and cool nighttime temperatures, and cold, wet winters. Most of the annual precipitation falls as snow in winter or during spring rainstorms. Dry upland forests are water-limited, meaning water stress during the warm growing season is the primary factor limiting tree growth at low elevations (USDA FS FEIS 2018). Stands are dominated by ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), or grand fir (*Abies grandis*). Dry forests generally begin where the lower elevation woodlands and shrublands begin to transition into higher sites capable of carrying more substantial forest cover. The moist upland forests form their upper elevation transition boundary. See Figure 4.

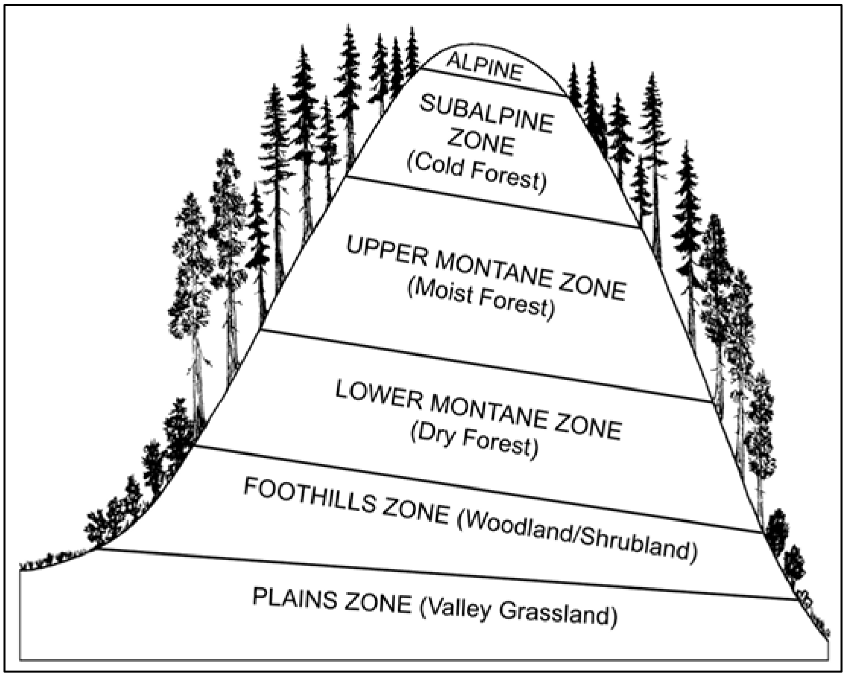


Figure 4: Vegetation zones of the Blue Mountain national forests (Powell 2000)

Table 2: Summary of Dry Upland Forest

Forest	Extent, acres	Proportion of Plan Area
Malheur	1,230,000	72%
Umatilla	595,000	42%
Wallowa-Whitman	640,000	36%

Historically, dry upland forests experienced disturbance regimes that included frequent low-severity surface fires occurring at a frequency of 0 to 35 years (USDA FS FEIS 2018), but mixed-severity and some high-severity fire also occurred (USDA FS FEIS 2018). Ponderosa pine and Douglas-fir were the dominant species because they were best adapted to survive and reproduce with frequent fire. While larger-diameter, old trees typically survived these low-severity fires, younger, smaller-diameter trees and tree species that were less fire-tolerant were often killed. The historical fire regime created and maintained a generally open forest structure with a small-scale mosaic pattern of clumps of trees often dominated by large diameter, old ponderosa pines, scattered individual trees, and openings that contained an abundance of native grasses and shrubs (USDA FS FEIS 2018). This spatial heterogeneity is a key structural element of a properly functioning dry upland forest. The frequent fires in the dry upland forests also maintained relatively low fuel loadings (USDA FS FEIS 2018).

Processes, drivers, and key ecosystem characteristics that have influenced ecological integrity in this ecosystem include fire regime, tree density, tree species composition, tree size and age, insects and disease, snag size and density, and invasive species. A long history human uses and management such as livestock grazing, logging practices, and fire suppression have negatively impacted ecosystem integrity. With a large proportion of the dry upland forest currently altered in density and structure and with a reduced proportion of fire-resistant species and older individual trees, large areas now predicted to support unusually severe wildfire behavior (Hagmann et al 2021, Heyerdahl et al 2018, Merschel et al 2021).

Status and Trends

The dry upland forest is the most common forest zone in the Blue Mountains, and it has a long history of human use for commodity purposes (such as livestock grazing and timber production). Prior to European settlement of the west, Native American Indians used fire to modify natural environments to augment food supply and manage natural resources (Armstrong et al 2021, Hessburg and Agee 2003, Roos et al 2021). Most dry forest environments were intentionally burned by relatively frequent low and mixed-severity fires over a long period of time (Hessburg and Agee 2003). European settlement began broadly impacting the frequent-fire forests in the mid-19th century (Hessburg and Agee 2003). Since that time, numerous factors, including fire exclusion and suppression, timber harvest, introduction of nonnative plant species, and grazing, have altered the natural fire regimes in the Blue Mountains. Historic levels of livestock grazing reduced ground fuels and grasses that would have normally carried the low and mixed severity surface fires that naturally thinned the forest. Suppression of grass and shrub competition also created conditions more favorable to tree regeneration (Noss et al. 2006). Extensive logging of the accessible portions of the dry and moist forests began with local settlement and utilization of timber resources. Initially logging focused on selecting individual trees of the larger merchantable species. These practices tended to promote the regeneration of shade tolerant, less fire-adapted species like grand fir.

Wildfire suppression was formally adopted as policy by the Forest Service over 100 years ago, and remains another major influence on current dry upland forest structure, composition, and integrity. Dry upland forests and areas of moist upland forests that historically experienced relatively frequent, low- and mixed-severity fires have now missed a natural recurrence of several fires due to decades of fire exclusion and suppression. Tree regeneration that naturally would have been thinned by fire continued to grow into dense stands of fire-vulnerable species, ultimately forming multi-storied, closed canopy structures. The historically open stands within the dry upland forest potential vegetation group, with their mosaic pattern of tree clumps or patches and openings, have now filled in with younger trees, resulting in a more uniform stand structure, increased ladder fuels, increased stand densities, increased fuel continuity, and decreased variety of spatial patterns (Hessburg et al 2005). Increased stand densities and a reduction in low-severity fire events on dry and moist sites have also contributed to a shift from shade-intolerant/fire-tolerant tree species, such as ponderosa pine or western larch, to more shade-tolerant and fire- or disease-prone species such as grand fir. Because of these altered processes, some of the key changes that have developed, particularly within the dry upland forests and moist upland mixed conifer forests, include:

- Creation of a simplified landscape vegetation mosaic dominated by a surplus of dense young and mid-aged forests and a lack of less dense and more open mature forests.
- Increased moisture stress and inter-tree competition for site resources due to overly dense stands, changes in moisture availability due to changing climatic conditions, and increased evaporative demand.
- A shifting of tree species composition away from a species mix that is well adapted and resilient to historical levels of disturbance agents like fire, drought, insects, and diseases.
- An increased susceptibility to large and severe fires, insect outbreaks, and widespread disease.

Fire Regime Condition Class and Vegetation Departure Index

A higher Vegetation Departure Index scores indicate forest vegetation and fuel conditions that are more greatly departed from the conditions expected under a natural fire regime. Scores less than 33 are considered low; 33 to 66 are considered moderate and over 66 is high degree of departure.

Moderate departure is indicated in dry upland forest on all three forests (Table 3) (USDA FS FEIA 2018). Although all three forests have moderate scores, they are approaching a high degree of departure.

Table 3: Existing condition vegetation departure index values for Dry UF Potential Vegetation Group by National Forest

Forest	Score
Malheur National Forest	62
Umatilla National Forest	60
Wallowa-Whitman National Forest	57

Range of Variability

Forest Structural Stages

Within the dry upland forest potential vegetation group, the range of variability analysis indicates that the landscape was historically dominated by old forest structural stages, particularly in the single-storied stage, characterized by large trees with little understory development.

In general, existing conditions within the dry upland forest potential vegetation group exhibit the greatest amount of departure from the range of variation across all potential vegetation groups in the Blue Mountain national forests (Figure 5) (USDA FS FEIS 2018). The multi-strata understory reinitiation stage is overrepresented in terms of range of variability, while at the same time, single-storied old forests are now very uncommon. Old forest was reduced primarily by historical selective harvesting practices (Hessburg et al 2005). The observed overabundance of mid-aged, multi-strata understory reinitiation stages is a result of successful suppression of what would have been low- and moderate-severity wildfires. The absence of fire has allowed uncharacteristic development of understory layers within areas that were historically maintained in more single-storied structures by relatively frequent surface wildfires.

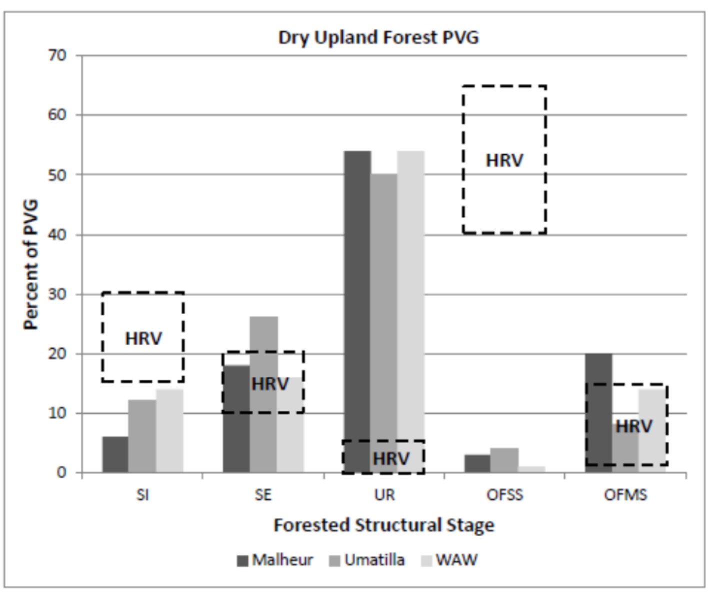


Figure 5: Existing Forest structural stages (percent of potential vegetation group (PVG)) and the range of variability (desired conditions) by national forest within the dry upland forest potential vegetation group

(HRV = range of variability; SI = stand initiation; SE = stem exclusion; UR = understory reinitiation; OFSS = old forest single story; OFMS = old forest multi-story)

In time, some of what are now mid-aged understory reinitiation stages will likely develop into additional mature old forest. However, without either low- to moderate-severity surface fire or active management treatments to control the understory density, these understory reinitiation stands are likely to either continue developing into multi-storied old forest stages or will undergo stand replacement fires rather than develop into the under-represented single-stored old forests.

The present structural distribution of large areas of the dry upland forest now supports an unusually severe wildfire regime and insect outbreak potential (Halofsky and Peterson 2017). A high-severity fire regime within the current dry upland forest is more likely to "reset" large areas into the stand initiation stage or convert stands to shrublands and grasslands than it is to allow future development into more mature, fire-resistant, old single-storied forest structures.

Forest Species Composition –

The ecosystems with the greatest departure of species compositions from the range of variability is within the dry and moist upland forests. Except for the Malheur's dry upland forest, the shade tolerant species groups are now greatly overrepresented (Table 4) (USDA FS FEIS 2018). Many landscape and stand-level species compositions have been modified by past harvests that removed large ponderosa pines, western larches, Douglas-firs and western white pines, creating conditions favorable for regeneration of fire-sensitive shade-tolerant species. There have been significant increases in the distribution of grand fir noted across the region (USDA FS 2018). In the absence of the natural thinning and weeding effect of low severity surface fires, the dense multi-layered structure that often results can greatly increase the potential high severity and high intensity fire behavior. Much of the increase in insect and disease activity and increasing vulnerability to stand replacing wildfire within the dry upland forest is related to the increased proportion of grand fir across the landscape (USDA FS 2018).

Species compositions altered in this way can also result in increased moisture stress, increased susceptibility to insects and diseases, and decreased forest health (Stine et al. 2014; Hessburg et al. 2015).

Table 4: Existing species composition as a percent of the Dry upland forest potential vegetation group by national forest compared to range of variability.

Upland Forest PVG/Species Composition Group	Range of Variability	MAL - current	UMA - current	WAW - current
Dry Upland Forest Shade Intolerant	75% - 90%	76%	45%	45%
Dry Upland Forest Shade Tolerant	5% - 20%	24%	55%	55%

Forest Stand Density

Prior to Euro-American settlement, dry upland forests of the Northwest, including the Blue Mountains region, were burned by frequent low or mixed severity fires. The result was that these fires, which burned mostly on the surface, maintained relatively low tree density stand conditions throughout most of the dry upland forest (Hessburg et al. 2005). The estimate of the range of variability is that 80 to 90 percent of the dry upland forest would be expected to exist in open, low-density conditions if natural disturbance regimes and ecological processes were functioning.

Decades of wildfire suppression and exclusion, livestock grazing, and timber harvest have interacted to alter the structure, composition, and disturbance regimes of the Blue Mountains national forests. In particular, the dry upland forest has become much denser. See Table 5 (USDA FS FEIS 2018). Most of the Umatilla and Wallowa-Whitman's dry upland forest is uncharacteristically dense. The Malheur National Forest is in better condition in relation to the range of variability but still has a significant surplus of dense, dry forest stands.

The current excess of over-stocked dry upland forest stands, combined with the imbalances in structural stages and species compositions already discussed, means the existing dry upland forests no longer appear or function as they once did. Large landscapes of dry forest are now more uniform in terms of their species composition and densities, and they are dominated by atypical dense, multi-layered structures.

Table 5: Existing low and high stand density proportions in dry upland forest potential vegetation group compared to the range of variability.

Potential Vegetation Group & Density	Range of Variability	MAL-current	UMA-current	WAW-current*
Dry Upland Forest Low Density	80% to 90%	60%	30%	32%
Dry Upland Forest High Density	5% to 20%	40%	70%	67%

*Due to rounding, these numbers do not add up to 100%

Ecological Integrity

See page 4 for a description of Ecological Integrity rankings. Frequent fire dry upland forests currently exhibit moderate but declining ecological integrity. If the dry upland forest ecosystems remain on the current trajectory, it is expected to deliver major functions and services at a reduced level relative to expectations. A large proportion of the dry upland forest is altered in density and structure and lacking its historical representation of fire-resistant species and older individual trees. The present condition of large areas of the dry upland forest now supports unusually severe wildfire behavior (Parks and Abatzoglou 2020). The Malheur Forest has the highest departure from the dry upland forests historical fire regime RV, followed by the Umatilla and the Wallowa-Whitman (See Table 3).

Climate Change Context

Dry upland forests in the Blue Mountains are water limited, and productivity is projected to decline in a warmer climate (Halofsky and Peterson 2017). Water stress during the warm season is the primary factor limiting tree growth at low elevations and is common in the dry upland forest potential vegetation group. Generally, increased drought stress will likely result in decreased tree growth and forest productivity in the dry upland forests of the Blue Mountains. Areas with increased tree density due to fire exclusion may be particularly vulnerable to future climate change because of increased competition, especially in times of drought stress. Areas of dry upland forest may become unsuitable to sustain this forest type, although habitat currently occupied by moist upland forest may offset these potential losses as future suitable habitat (Halofsky and Peterson 2017).

Some areas of the dry upland forest potential vegetation group may undergo undesirable changes in the face of future climate change. These forests have already experienced a long history of human land use. Many dry upland forests are already experiencing severe and uncharacteristic wildfire and equally atypical insect and disease outbreaks, which will most likely increase in the future (See Climate Change Report). Shifts in the distribution of dry upland forests, changes in relative abundance of different plant associations, or the formation of novel plant associations, might be expected (Halofsky and Peterson 2017). The synergistic effects of tree overstocking in the absence of fire, climate change-driven drought, and insect outbreaks are likely to cause significantly more tree mortality across the

Blues than wildfire (Reilly and Spies 2016, Littell et al 2009, Raffa et al 2008, Williams and Birdsey 2003).

Moist Upland Forest

Moist upland forests occur at moderate elevations in the montane vegetation zone, or at the lower end of the subalpine zone. They are adjoined by cold upland forests at their upper edge and by dry upland forests at their lower edge. See Figure 4. They are characterized by slightly longer growing seasons compared to the cold upland forest, and generally have cooler temperatures and higher precipitation than the lower elevation dry upland forests. Late-successional stands are generally dominated by subalpine fir, grand fir, or Engelmann spruce. However, most successional phases are dominated by a diverse mix of early seral species like western larch, Douglas-fir, and lodgepole pine in conjunction with late seral species like grand fir and Engelmann spruce. Western white pine is also present as a mid-seral species.

Figure 6: Moist upland forest on the Walla Walla Ranger District, Umatilla National Forest.

Historically, the moist upland forest potential vegetation group was generally characterized by moderate or mixed-severity fires occurring every 40 to100 years (USDA FS FEIS 2018). In a mixed-severity fire regime, fire alternates between stand-replacing crown fires that kill all trees, to nonlethal, low-intensity surface fires that leave patches of living trees. Historically, the moist upland forest fire landscape was a mosaic of fire severity, driven by variation in climate, soils, topography. It is overwhelmingly dominated by moderate to severe fire, with occasional low severity fire, and repeated fires of moderate severity (Naficy et al, in press). Mixed-severity fires create patchy forest structure, composition, and seral status that can be observed and quantified at an intermediate scale. Patch sizes range from a fraction of an acre to tens or hundreds of acres, depending on locale and climatic drivers. In moist upland forest types that were naturally dominated by mixed-severity fire regimes, the resulting highly variable structures and compositions make them among the most diverse and complex of all forest types (USDA FS FEIS 2018).

As shown in Table 6, the Malheur National Forest is comprised of only 6 percent moist upland forest, whereas this potential vegetation group makes up an estimated 31 and 21 percent of the Umatilla and Wallowa-Whitman National Forests respectively.

Table 6. Summary of Moist Upland Forest

Forest	Extent, acres	Proportion of Plan Area
Malheur National Forest	90,300	6%
Umatilla National Forest	510,300	31%
Wallowa-Whitman National Forest	438,000	21%

Status and Trends

The moist upland forests of the Blue Mountains experienced similar management history as dry upland forests including unsustainable grazing practices and timber harvest, and fire suppression. According to Naficy et al (In press), the results have included the following:

- Homogenization of the diverse vegetation mosaic of different successional and compositional patches
- Loss of old, mature forests and trees
- Increased fragmentation where road building and past timber harvest has occurred
- A lack of early successional phases, and a surplus of dense young and mid-aged forests
- A shifting of tree species composition towards a more homogenized species mix, and away from a species mix that is well adapted and resilient to historical levels of disturbance agents like fire, drought, insects, and diseases, and resilient to projected future disturbance frequencies and intensities expected under a changing climate
- An increased susceptibility to large and severe fires, insect outbreaks, and widespread disease

The effects of climate change on moist upland forests may impact their productive capacity, which is an important part of their resilience. The more mesic, productive setting of these forests is an important part of their resilience to stressors and future disturbance frequencies and intensities that are expected under a changing climate. If climate change impairs this productivity buffering mechanism, they may be less resilient to higher severity fire regimes, insect outbreaks, and disease than they were historically.

Fire Regime Condition Class and Vegetation Departure Index

A higher Vegetation Departure Index scores indicate forest vegetation/fuel conditions that are more greatly departed from the conditions expected under a natural fire regime. Higher values indicate forest vegetation and fuel conditions that are significantly departed from the conditions expected under a natural fire regime. Scores less than 33 are considered low; 33 to 66 are considered moderate and over 66 is high degree of departure. The Umatilla and Wallowa-Whitman indicate low departure and the Malheur is indicating moderate departure in moist upland forest (Table 7) (USDA FS FEIS 2018).

Table 7. Existing condition vegetation departure index values for Moist UF Potential Vegetation Group by National Forest

National Forest	Score
Malheur National Forest	37
Umatilla National Forest	27
Wallowa-Whitman National Forest	23

Range of Variability

Forest Structural Stages –

The range of variability for the moist upland forest potential vegetation group indicates relatively even distribution between each of the forest structural stages, with a slightly higher percent of the landscape in both of the old forest structural stages, as depicted in Figure 7 (USDA FS FEIS 2018).

The historical fire regime in the moist upland forest potential vegetation group was generally characterized by moderate or mixed-severity fire events that occurred every 40-100 years. After many decades of mostly successful fire suppression and exclusion efforts, some of these areas may have missed one to three natural wildfire cycles. Fire suppression has had measurable effects on existing forest structures. As shown in Figure 7 (USDA FS FEIS 2018), all three National Forests share an underrepresentation of both young stand initiation stages and mid-aged stem exclusion stages compared to the range of variability. Multi-storied stages of old moist upland forest are overrepresented on all three national forest landscapes, but the Umatilla's old multi-storied moist upland forest is noticeably closer to being within the range of variability than the other two National Forests. Potential for high severity fire behavior in the moist upland forests of the Blue Mountains exists in about 30 to40 percent of the area, which is close to estimated natural levels (USDA FS 2018).

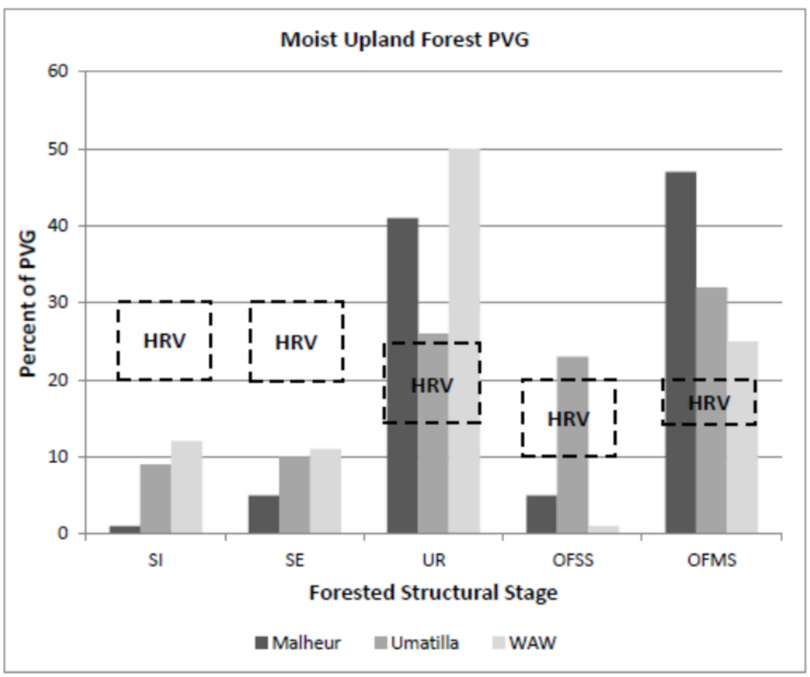


Figure 7: Existing forest structural stages (percent of potential vegetation group (PVG)) and the range of variability (desired conditions) by national forest within the moist upland forest potential vegetation group (HRV = range of variability; SI = stand initiation; SE= stem exclusion; UR= Understory reinitiation; OFSS= old forest single story; OFMS= old forest multi-story)

Forest Species Composition –

The exclusion of wildfire and past timber harvesting and grazing practices have all contributed to a significant shift away from fire- and drought-tolerant tree species, as well as the introduction of invasive plant species (USDA FS 2018).

Dry and moist upland forests show the greatest areas of departure from the range of variability in terms of species composition. Shade-tolerant species groups are now greatly overrepresented. Many landscape and stand-level species compositions have been modified by past harvests that removed large ponderosa pine, western larch, Douglas-fir and western white pine while creating conditions favorable for regeneration of fire-sensitive shade tolerant species (USDA FS 2018). See Table 8 (USDA FS FEIS 2018).

In the absence of the natural thinning and weeding effect of low severity surface fires, the dense multi-layered structure that often results can greatly increase the potential fire behavior. These shifts in species compositions can also result in increased moisture stress, increased susceptibility to insects and diseases, and decreased forest health (USDA FS 2018). The anticipated temperature increases and moisture stress from climate change will likely exacerbate these effects (See Climate Change Report).

Table 8. Existing species composition as a percent of the moist upland forest potential vegetation group by national forest compared to range of variability

Upland Forest PVG/Species Composition Group	Range of Variability	MAL - current	UMA - current	WAW - current
Moist Upland Forest Shade Intolerant	30% - 60%	21%	15%	27%
Moist Upland Forest Shade Intermediate Tolerance	20% - 40%	6%	21%	27%
Moist Upland Forest Shade Tolerant	10% - 30%	73%	65%	46%

Forest Stand Density –

Prior to Euro-American settlement, moist upland landscapes likely consisted of a high proportion of high-density stands, but a portion of those potential vegetation groups would also have likely existed in a low-density condition. Currently, the proportion of high-density stands on each forest is lower than RV, and the proportion of low-density stands is higher than RV. See Table 9 below (USDA FS FEIS 2018).

Table 9: Existing stand density as a percent area of moist upland forest potential vegetation group compared to the historical range of variability.

Potential Vegetation Group & Density	Range of Variability	MAL - current	UMA - current	WAW - current
Moist Upland Forest Low Density	30%-40%	58%	55%	41%
Moist Upland Forest High Density	60%-80%	42%	45%	59%

Ecological Integrity

See page 4 for a description of Ecological Integrity rankings. Moist upland forests are highly productive and important habitat for a diverse array of plant and wildlife species. Processes and drivers that influence ecological integrity in this ecosystem include fire regime, weather and drought, climate change, invasive species, and insect and disease dynamics. Key ecosystem characteristics that can be used to describe and define ecological integrity include tree density, tree species composition, large old trees, snag size and density, invasive species, and down wood.

Fire diverse moist upland forests currently exhibit moderate but declining ecological integrity. If the system remains on the current trajectory, it is expected to deliver major functions and services at a reduced level relative to expectations. Potential for high severity fire behavior in the moist upland forests is close to natural levels; however, species composition has shifted away from fire- and drought-tolerant tree species, and the proportion of low versus high density stands is not within the range of variability. The Umatilla and Wallowa-Whitman Forests currently have low (approaching moderate) RV departure scores, and the Malheur has a moderate RV departure score. See Table 7.

Climate Change Context

Many (but not all) productive moist upland forests at higher elevation are more energy-limited than water-limited. Moderate warming along with increased atmospheric carbon dioxide may lead to a positive response and increased productivity within some of these energy-limited moist upland forests (McKinley et al. 2022a, McKinley et al. 2022b, McKinley and Halofsky 2022). However, in the Blue Mountains, lower elevation moist upland forests may transition to being primarily water-limited, particularly areas without much ash or loess that enhance water holding capacity. Warming and increased moisture stress, particularly at lower elevations and in the southern portion of the Blue Mountains (Malheur National Forest) will likely cause decreased tree growth and forest productivity in areas of moist upland forest. However, future suitable habitat currently occupied by cold upland forests may offset these losses (Halofsky and Peterson 2017).

Paleoecological and some model evidence suggest that climate change may cause moderate to extreme loss of moist upland forests and characteristic species throughout the Blue Mountains national forests (Halofsky and Peterson 2017). However, MC2 model results suggest future warming with increased precipitation may lead to the moist upland forest expanding into new available habitats across the landscape (Halofsky and Peterson 2017). Increased summer drought stress may make these forests more vulnerable to other stressors, particularly at lower elevations and on southern sites in the Blue Mountains (Malheur National Forest) (Halofsky and Peterson 2017). Wildfire activity and insect and disease outbreaks will most likely increase in severity with future warming and may reduce the distribution of this potential vegetation group (Halofsky and Peterson 2017).

Cold Upland Forest

Cold upland forests occur at moderate or high elevations in the subalpine zone and are characterized by cold, wet winters, and mild, relatively cool and dry summers. Deep, persistent winter snowpacks have been historically common. Cold upland forests have relatively short growing seasons, low air and soil temperatures, and slow nutrient cycling rates (USDA FS FEIS 2018). Late successional stands are typically dominated by subalpine fir, grand fir, Engelmann spruce, whitebark pine (*Pinus albicaulis*), and lodgepole pine. Whitebark pine, lodgepole pine and western larch are more common as early successional species, but they often persist in older stands. Cold upland forests are adjoined by a treeless alpine zone at their upper edge (often separated by a narrow zone of dwarf or krummholz trees), and by moist upland forests at their lower elevation transition boundary. See Figure 4.

Figure 8: Cold upland forest with Engelmann spruce, grand fir, and subalpine fir overstory, and grand fir and subalpine fir regeneration in the understory

Smaller scale disturbances such as windthrow are common in the cold upland forests, but the fire regime is characterized by high severity or stand-replacing fire events that occur very infrequently, generally at return intervals of 150 to 300 years. On drier high-elevation sites, high-severity fires sometimes perpetuate forests of lodgepole pine. These stand-replacing fires have usually occurred every 100 to 200 years (USDA FS FEIS 2018). However, when these fires do not occur, these lodgepole stands often succumb to attacks by mountain pine beetle (*Dendroctonus ponderosae*) or are gradually replaced by more shade-tolerant species such as fir and spruce.

The Malheur National Forest is comprised of 9 percent cold upland forest, whereas this potential vegetation group makes up an estimated 8 and 21 percent of the Umatilla and Wallowa-Whitman National Forests respectively. See Table 10.

Table 10. Summary of Cold Upland Forest

National Forest	Extent, acres	Proportion of Plan Area
Malheur National Forest	188,400	9%
Umatilla National Forest	151,600	8%
Wallowa-Whitman National Forest	441,900	21%

Cold upland forests are important to whitebark pine (*pinus albicaulis*), which is now listed as a threatened species under the Endangered Species Act. See Species At Risk Report.

Status and Trends

Fire Regime Condition Class and Vegetation Departure Index

Table 11 displays the vegetation departure index values for the cold upland potential vegetation group on each national forest. The higher values indicate forest vegetation and fuel conditions that are significantly departed from the conditions expected under a natural fire regime. Scores less than 33 are considered low, 33 to 66 are considered moderate and over 66 is high degree of departure. Cold upland forests on the Umatilla and the Wallowa-Whitman have a low vegetation departure score, while the Malheur has a moderate score that is approaching a high degree of departure (USDA FS FEIS 2018).

Table 11. Existing condition vegetation departure index values for Cold UF Potential Vegetation Group by National Forest.

National Forest	Score
Malheur National Forest	54
Umatilla National Forest	13
Wallowa-Whitman National Forest	18

Range of Variability

Forest Structural Stages –

The historical fire regime in the cold upland forest potential vegetation group was characterized by high-severity, stand-replacing fire events that occurred every 150 to 300 years or more (USDA FS FEIS 2018). With such infrequent natural fire events, fire suppression has had less noticeable effects on the existing forest structures of the cold upland forest.

As shown in Figure 9, (USDA FS FEIS 2018), the Wallowa-Whitman's cold upland forest is the most departed from the range of variability of the Blue Mountains national forests. None of the Wallowa-Whitman's cold forest structural stages is currently within the historical range. The Wallowa-Whitman has a particularly large excess of the understory reinitiation stages. The Malheur's stand initiation and multi-storied old forest stages are within the range of variability, but the Malheur's mid-aged understory reinitiation stages are overrepresented in the cold upland forest. The single-storied old forest stage is underrepresented. The early and mid-aged stages of the Umatilla's cold forest are all currently within range of variability. The Umatilla has a modest excess of multi-storied old forests in the cold uplands, and a scarcity of single-storied old forest. These similar patterns, which are noted across the Blue Mountains national forests, may be indicative of the combination of past harvesting practices within old forest along with other management practices that have disrupted natural disturbance regimes.

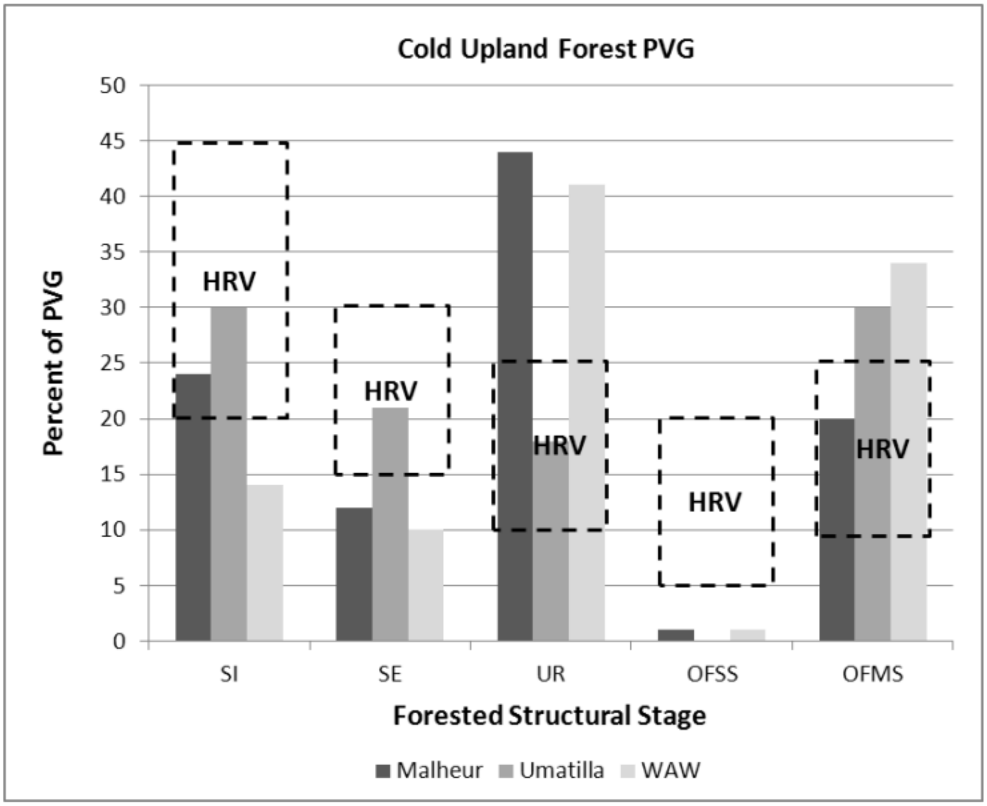


Figure 9: Existing forest structural stages (percent of potential vegetation group (PVG)) and the range of variability (desired conditions) by national forest within the cold upland forest potential vegetation group (HRV = range of variability; SI = stand initiation; SE= stem exclusion; UR= Understory reinitiation; OFSS= old forest single story; OFMS= old forest multi-story)

Forest Species Composition –

Historically, large-scale disturbances have been infrequent in cold upland forest but can still play an important role in shaping vegetation distribution and abundance. Smaller scale disturbances, such as windthrow, are common in cold upland forests. Forest vegetation can be greatly altered by rare wildfire events, and tree establishment following stand-replacing wildfires can take decades to centuries and requires nearby seed sources, an extended period of favorable climate, and favorable biotic and abiotic microsite conditions (Halofsky and Peterson 2017).

Cold upland forests show the least departure from the range of variability in terms of species composition across the Blue Mountain landscape.

As shown in Table 12, (USDA FS FEIS 2018), shade-tolerant species groups are underrepresented and shade intolerant species groups are overrepresented on the Malheur and Umatilla National Forests. On the Wallowa-Whitman National Forest, species compositions are close to being within historic ranges for all groups, with moderate departures in shade tolerant and shade intermediate species groups.

Table 12. Existing species composition as a percent of the cold upland forest potential vegetation group by national forest compared to the range of variability.

Upland Forest PVG/Species Composition Group	Range of Variability	MAL – current*	UMA - current	WAW - current
Cold Upland Forest Shade Intolerant	40% - 60%	63%	70%	38%
Cold Upland Forest Shade Intermediate Tolerance	5% - 20%	31%	10%	24%
Cold Upland Forest Shade Tolerant	25% - 50%	7%	20%	38%

*Due to rounding, these numbers do not add up to 100%

Forest Stand Density-

Prior to Euro-American settlement, cold upland landscapes likely consisted of a high proportion of high-density stands, but a portion of those potential vegetation groups would also have likely existed in a low-density condition. Today, the cold upland forests in the Blue Mountains have predominantly low stand density, with the Malheur National Forest being furthest from historic conditions with respect to this key ecological characteristic. See Table 13 (USDA FS FEIS 2018).

Table 13: Existing stand density as a percent of cold upland forest potential vegetation group compared to the range of variability.

Potential Vegetation Group & Density	Range of Variability	MAL- current	UMA- current	WAW- current
Cold Upland Forest Low Density	20%-30%	88%	44%	62%
Cold Upland Forest High Density	65%-80%	12%	56%	38%

Ecological Integrity

Cold upland forests currently exhibit moderate but declining ecological integrity. If the system remains on the current trajectory, it is expected to deliver major functions and services at a reduced level relative to expectations.

Climate Change Context

The cold upland forest potential vegetation group is a high-elevation energy-limited forest ecosystem. Productivity is projected to increase in subalpine and alpine zones across the Pacific Northwest in response to moderate warming and elevated atmospheric carbon dioxide (Halofsky and Peterson 2017). Longer growing seasons and warmer summer temperatures associated with projected future warming may promote increased tree growth within the treeline areas. Others, (Zald et al. 2012) point out that it is difficult to understand how these areas may respond to future climate conditions due complex mountain terrain and its interacting factors, and the anticipated climate change impacts on snowpack amount and residence time (See Climate Change Report).

Species distribution modeling completed for Halofsky and Peterson (2017) project that suitable climate available for most cold upland tree species will be either moderately reduced or nonexistent in the Blue Mountains by the end of the 21st century. Based on this modeling output, high-elevation mountains (like the Wallowa Mountains and Seven Devils) may serve as climate refugia for subalpine species.

Although results from experimental and observational studies are not entirely clear, multiple lines of evidence suggest climate change is likely to produce significant changes in the cold upland forests over time, including altered growth and altered tree life cycle events. Cold upland forests may be converted to high-elevation herbaceous parklands or woodlands with ponderosa pine or Douglas-fir under warmer scenarios (Halofsky and Peterson 2017). Remnant populations may persist in the highest of elevations within the Blue Mountains (such as the Wallowa Mountains). Increased wildfire may constrain tree reestablishment in these slow-growing systems, particularly for sites without serotinous lodgepole pine as a common, pre-fire component. Increased insect and disease activity with climate change may also increase stress and mortality in these cold upland forests (Halofsky and Peterson 2017).

Grasslands

Grasslands are composed of upland herbaceous vegetation dominated by grasses. Grasslands provide forage for wildlife, permitted livestock, and wild horses, as well as habitat for a wide variety of animal and plant species, including rare or unique plant species and communities. Grasslands and associated plant communities also provide important watershed values, including soil protection and maintenance, high quality water storage and slow release, and biodiversity. Other intrinsic values associated with rangelands include maintenance of open space, visual beauty, and areas for recreational activities.

In the Blue Mountains, upland herblands have been greatly affected by ungulate grazing, non-native species, and agriculture, beginning in the mid-1800s. Settlers also introduced non-native grasses, including cheatgrass, most of which were less palatable for cattle forage, leading to heavily grazed native vegetation and increased nonnatives. Large areas formerly dominated by grasslands were converted to annual crops (Kerns et al 2017).

Within the Blue Mountains, grasslands are classified as the cold, moist and dry upland herbland potential vegetation groups (Powell et al 2007). Dry upland herbland is generally more common than moist upland herbland in the Blue Mountains. Climate is arid to semi-arid with low precipitation, hot summers, and cold winters. Most precipitation occurs as rain and snow in winter and spring. Consisting of grasslands and herbaceous vegetation, species composition varies depending primarily on temperature, precipitation, soil texture, and soil depth (Kerns et al 2017).

Vegetation in moist and dry upland herbland is generally well-adapted to cold winter temperatures and summer drought, with grasses avoiding drought stress by concentrating growth in the spring and early summer. In a warmer climate, grasslands at lower elevation may have increasing dominance by the most drought tolerant species. Little information is available for individual grassland species, although Reeves et al. (2014) project that net primary productivity will increase in eastern Oregon grasslands in a warmer climate (Halofsky and Peterson 2017). C3 plants are adapted to cool season establishment and growth in either wet or dry environments. C4 plants are more adapted to warm or hot seasonal conditions under moist or dry environments. A feature of C3 grasses is their greater tolerance of frost compared to C4 grasses. Distribution of cold season (C3) grasslands are predicted to decrease, and warm season (C4) grasslands will increase. A potential shift from C3 to C4 grassland species is uncertain, whereas a shift to drought tolerant species is likely (Kerns et al 2017).

Grasslands are a key component of the plan area and account for 428,000 acres, approximately 10 percent of the 4.9 million acres of National Forest System lands within the Blue Mountains national forests (Table 14) (USDA FS FEIS 2018).

Table 14. Summary of Grasslands

National Forest	Extent, acres	Proportion of plan area
Malheur	34,000	2%
Umatilla	196,000	14%
Wallowa-Whitman	198,000	11%

Wildfire occurrence is limited by lack of ignitions in summer or by lack of continuous fuels, although cold-season bunchgrass communities often have sufficient fuels to propagate fire. Many bunchgrass species resprout following wildfire and can recover to pre-fire productivity within five years; fire return intervals of less than five years are rare. In some places, introductions of non-native cheatgrass, medusahead, and North Africa grass (*Ventenata dubia*) produce fine fuels that support burning at frequencies greater than can be tolerated by native perennial grasses (Kerns et al 2017).

Status and Trends

Findings from 50 years of photographic and vegetation sampling within subalpine grassland ecosystems in the Blue Mountains followed the ecological recovery of sites that had been degraded by early 20th century unregulated grazing (USDA FS FEIS 2018). They found that in general there had been substantial improvement in ecological status with increases in native grass species and ground cover that should prevent accelerated soil erosion. While substantial improvement has occurred, there is still a need for restoration of the grassland ecosystem.

Change detection using repeat photography by Skovlin and Thomas (1995) documents long-term changes that occurred on a variety of Blue Mountains vegetation types (USDA FS FEIS 2018). Original photo series were taken prior to 1925 and repeat photos were taken in 1992. Shifts from grassland to shrub steppe-juniper woodland were observed. Canyon lands were in fair condition and appeared stable. The valley grasslands had improved in general and appeared stable. Foothills surrounding the Blue Mountains were found to be in poor to good condition with an upward trend in forage values and watershed stability, with an increase in juniper encroachment (USDA FS FEIS 2018). Mountain grasslands showed increases in conifer encroachment but remained in fair condition and stable. Mountain meadows in general showed improvements in native species composition, though there were some that had not improved in 75 years (USDA FS FEIS 2018). Subalpine grasslands showed increased conifer encroachment. Another photographic comparison shows increase in conifer encroachment onto grasslands (Skovlin et al. 2001).

Countryman et al (2012) evaluated continuous vegetation survey plot data and calculated the relative amount of the dry and moist upland grassland potential vegetation groups to phases A, B, C or D. Transitions between states are generally described by biotic thresholds based on vegetation composition. Phases A and B are used to describe the distinctive plant communities in a state close to reference, which represents the historic range of vegetation dynamics of a site. Phase A is the most resilient plant community within that state and depicts reference conditions. Phase B shows moderate departure from reference conditions. Phases A and B presumed to be capable of ensuring long-term sustainability and resiliency. Phase C is strongly departed from reference conditions. This is the at-risk phase, which is the least resilient and most vulnerable to transition to an alternate state. Phase C is assumed to be of concern but is still likely to allow grazing land to operate within the range of natural variability. Sites with vegetation conditions completely departed from the reference condition are classified as Phase D. This phase represents various alternate states possible for a site. Refer to the Rangelands report for an additional description of the rangeland condition state and transition modeling and phases. Tables 15 and 16 show existing conditions for phases for each of the Blue Mountains national forests (USDA FS FEIS 2018).

Table 15: Dry upland grassland potential vegetation group phase existing conditions

National Forest	Phase A or B	Phase C	Phase D
Malheur	21%	43%	36%
Umatilla	42%	35.5%	22.5%
Wallowa-Whitman	46.5%	32%	21.5%

Table 16: Moist upland grassland potential vegetation group phase existing conditions

National Forest	Phase A or B	Phase C	Phase D
Malheur	91%	9%	0%
Umatilla	50%	37.5%	12.5%
Wallowa-Whitman	67%	17%	16%

Grazing, unnaturally high fire frequency, and invasion by exotic plants are the biggest threats to the sensitive species occupying grassland habitat. Higher fire frequencies are to be expected in phases C and D grasslands, which have a higher proportion of nonnative invasive species at the expense of native bunchgrasses. Therefore, actions to promote the transition of phase C grasslands to phase A or B would best address the threats from invasive plants and high fire frequencies.

The ability of a grassland ecosystem to adjust to change depends upon the system's capacity to positively respond to disturbance events (or at least to respond in a minimally negative manner with the ability to recover in a reasonable timeframe). Response indicators include moving native vegetative cover and species composition toward a potential vegetation, age class distribution that indicates adequate reproduction is occurring, and other plant community attributes that indicate the maintenance or improvement of soil stability, nutrient storage, and cycling.

Fire Exclusion - Throughout the Forest Service and the plan area, the exclusion or rapid suppression of fire has been a common practice. This action has many unintentional effects to grassland vegetation such as:

- Increasing coniferous tree cover, which decreases forage production.
- Increasing the height, cover, and density of sagebrush, primarily for mountain big sagebrush, which decreases native herbaceous cover and alters hydrology (Quigley et al. 1997). Where sagebrush density and size has progressed to a major extent, it has made it more difficult to reintroduce fire into the disturbance process.
- Increasing the population, abundance, and range of western juniper (*Juniperus occidentalis*), a species known for its ability to capture precipitation while creating monocultures of trees with very little forage production.

Livestock grazing, which began in the mid-1800s, reduced the abundance and continuity of herbaceous fine fuels that had previously carried surface fires across the landscape (Juran 2017). Overgrazing of livestock was common, which disturbed vegetative cover and exposed bare mineral soil, converting sites from native plant cover to invasive annual grasses. Livestock management actions, such as permitting allotments and improved monitoring, have led to a gradual improvement of grasslands. See Rangelands Report for more information and discussion about rangeland conditions.

Expected recovery potential is a function of fire severity. Johnson (1998) reported that in lightly burned grassland areas (low severity fires) the expected recovery is fairly quick, and a natural recovery of one to two years would be expected. Moderately burned areas (medium severity fires) have a modest recovery rate of two to five years. Heavily burned (high severity fires) have a slow natural recovery and may require five or more years to recover.

Most grassland communities are adapted to periodic vegetative material removal and regeneration and tend to be most healthy in the presence of periodic fire and disturbance (Johnson 1998). Until about the mid-1900s, natural fire played its natural role in ecosystems. This included indigenous burning practices used to manage food resources and manipulate food-producing environments and improve grazing forage for horses. In general, this periodic natural fire-maintained grassland canopy covers within natural ranges, allowed for mosaics of plant communities, seral stages, and age classes, and helped stimulate new growth of grasses that kept them healthy and thriving (Johnson 1998).

Since the mid-1900s, humans restricted the occurrence and spread of natural fire. This has had the effect of allowing an increase in conifer canopy and the encroachment of conifers, juniper, or sagebrush into open grasslands or shrublands, thereby decreasing herbaceous cover and impacting those species which required open sunny conditions (Juran 2017). As canopies closed, the understory herbaceous and shrubby vegetation was reduced or lost. This impacted forage quantity, quality, and availability for native ungulates, as well as for permitted livestock. With this loss, forage harvest was concentrated even more on the open grasslands, shrublands or on riparian areas and wetlands.

Fire exclusion has had a significant effect on rangeland vegetation, especially grasslands, and this effect is expected to continue in areas where increased urbanization has made the use of fire and the potential for natural fire more difficult due to smoke exposure and risks of fire spread into communities.

Conversely, the use of prescribed fire has also had effects on rangelands, including grasslands. In some instances, fire was used to control shrub vegetation (e.g., sagebrush or juniper) without a clear understanding of how natural fire would have affected plant communities. In other instances, fire was overused and impacted plant community health and sustainability. Additionally, fire use inadvertently favored the spread of invasive species, such as cheatgrass. For the most part, prescribed fire has had minimal and mostly short-term effects to rangeland resources, such as soils, grassland and shrub vegetation, wildlife habitat, carbon stocks (See Carbon Report), and recreational or visual quality (Johnson 1998).

Lower intensity or mosaic prescribed fire tends to stimulate vegetative growth and is normally considered to have a positive effect on grassland vegetation.

The response of individual plant species to fire varies between and within species. Moreover, this response is influenced by a variety of fire parameters, including intensity, severity (e.g., amount of organic matter consumed), residence time, soil heating, season of burn, and time since last fire. These parameters can vary significantly among fires and within a fire. These variations can and will cause differences in the response of individual species and the community. In addition, numerous physical and climatic factors (e.g., fuel condition, weather, slope, and aspect), as well as biological factors (plant morphology and physiology) will influence post-fire effects on plant communities. This includes direct effects, such as the ability of individual species to recover from the effects of fire.

Ecological Integrity

Grasslands are experiencing moderate but declining ecological integrity. If the system remains on the current trajectory, it is expected to deliver major functions and services at a reduced level relative to expectations.

Climate Change Context

Cold upland herblands, typically called subalpine and alpine meadows, are found at high elevations where temperatures are too cold or snow is too persistent for tree growth. Plant communities are grasslands with greenleaf fescue (*Festuca viridula*), Idaho fescue (*Festuca idahoensis)*, elk sedge (*Carex geyeri*), and Hood's sedge (*Carex hoodii*). Continued warming in future decades could cause the geographic range of grass and forbs to contract, expand, or remain the same (See Climate Change Report). However, multiple lines of evidence suggest that contraction may be more likely than expansion, and that meadows may continue to experience tree encroachment with a reduction of cold-adapted high elevation plant species (GLORIA 2024, Gottfried 2012, Halofsky and Peterson 2017, Halloy and Mark 2003). Trends will probably depend on the rates at which meadow species colonize exposed soil following disturbance (Kerns et al 2017).

Dry upland herbland is generally more common than moist upland herbland in the Blue Mountains. Climate is arid to semi-arid with low precipitation, hot summers, and cold winters. Most precipitation occurs as rain and snow in winter and spring. Dry upland herbland are dominated by bluebunch wheatgrass and Sandberg bluegrass, and moist upland herblands are characterized by Idaho fescue and bluebunch wheatgrass. Vegetation in moist and dry upland herblands is generally well-adapted to cold winter temperatures and summer drought, with grasses avoiding drought stress by concentrating growth in the spring and early summer. In a warmer climate, grasslands at lower elevation may have increasing dominance by the most drought tolerant species (Kerns et al. 2017, Halofsky and Peterson 2017).

Moist and dry upland herblands may be increasingly dominated by drought tolerant species, particularly at lower elevations and arid sites. Non-native annual grasses are also expected to increase. Increased temperatures and wildfire will probably facilitate a shift from forested areas to grasslands, particularly where woody species cannot survive (Kerns et al 2017).

Rare or Unique Type Ecosystems

Rare and unique terrestrial ecosystems, although occupying a small percentage of the planning area, often provide a disproportionately large amount of important ecological services and wildlife habitat. Therefore, maintenance and restoration of rare and unique ecosystem ecological integrity is essential to maintaining overall species diversity and integrity on a larger scale.

A developed or revised plan must provide for the diversity of plant and animal communities, within Forest Service authority. The plan must include components, including standards or guidelines, to maintain or restore the diversity of ecosystems and habitat types throughout the plan area, including rare aquatic and terrestrial plant and animal communities (36 CFR 219.9(a)(2)(ii)). The rare and unique type ecosystems presented in this report for the Blue mountains national forests include whitebark pine, aspen, and sagebrush steppe.

Whitebark Pine

Whitebark pine (*Pinus albicaulis*) has a limited distribution within the Blue Mountains and is strongly associated with higher elevation areas within the cold upland forest potential vegetation group and within wilderness areas. Based on Forest Service vegetation databases, the Wallowa-Whitman National Forest contains the largest acreage of whitebark pine, with the Umatilla and Malheur National Forests containing smaller extents.

Table 17: Summary of Whitebark pine

National Forest	Potential Whitebark Pine Habitat
Malheur	118,000 acres
Umatilla	78,000 acres
Wallowa-Whitman	620,000 acres

Whitebark pine seedlings survive on harsh, arid sites and may act as nurse trees to less hardy vegetation. At high elevations, the species helps regulate snow melt and reduce soil erosion. For these collective functions, whitebark pine is considered both a keystone species for promoting community diversity and a foundation species for promoting community stability (Goeking and Izlar 2018) USDA FS FEIS 2018). The substantial seeds are important for an array of wildlife species. As an important ecosystem component that influences the success of other organisms, it plays a vital role in being one of the first species to colonize areas disturbed by fire or landslides, stabilizing the soil, moderating snow melt, and providing the cover that allows regeneration of other tree species (USDA FS FEIS 2018). Seed dissemination by whitebark pine is unique among American pines. The seeds are mostly released from cones and disseminated by a bird species, the Clark's nutcracker (*Nucifraga columbiana*). Many other wildlife species of high-elevation ecosystems depend to varying degrees on whitebark pine seeds as food resources.

Status and Trends

Whitebark pine has been declining in both the United States and Canada from the combined effects of the exotic disease white pine blister rust (caused by the fungal pathogen *Cronartium ribicola*), mountain pine beetle (*Dendroctonus ponderosae*) outbreaks, altered disturbance regimes in stands where whitebark pine is a seral species, and climate change (USDA FS FEIS 2018). These combined threats led the U.S. Fish and Wildlife Service to list whitebark pine as Threatened under the Endangered Species Act, effective January 17, 2023.

Monitoring transects within the Blue Mountains analysis area indicate white pine blister rust infection within most of the checked sites, with higher levels of infection in the Elkhorn Mountains compared to the Wallowa Mountains (USDA FS FEIS 2018). Increased levels of whitebark pine mortality may alter high elevation community composition and ecosystem processes similarly to what has been seen in other areas of the western United States (Keane et al. 2012).

Current Ecological Integrity

Whitebark pine terrestrial ecosystems currently exhibit low ecological integrity. If the system remains on current trajectory it is expected to deliver some major functions and services including supporting a portion of the biodiversity and productivity at a reduced level relative to expectations for this ecosystem without restoration.

Climate Change Context

During the past two decades, warmer temperatures have allowed mountain pine beetle to shift upward and persist in high elevation forests (Halofsky and Peterson 2017). Whitebark pine mortality from mountain pine beetle may have been facilitated by an increasing late summer dry season (Halofsky and Peterson 2017). Longer, high elevation growing seasons could enhance the growth of subalpine tree species. However, whitebark pine grows so slowly that it may be at a competitive disadvantage compared to other species (Halofsky and Peterson 2017).

Whitebark pine is threatened by white pine blister rust, a nonnative fungal pathogen, *Cronartium ribicola,* that forms cankers of necrotic tissue that girdle tree stems. Alternate hosts for the fungus are currant, (*Ribes spp.)*, or the herbs paintbrush (*Castilleja spp.)*, and lousewort, (*Pedicularis spp.)* (Halofsky and Peterson 2017). Indirect pathogen related effects could occur if climatic changes increasingly favor blister rust. Higher variability in weather conditions may create conditions conducive to infection, although drier summers could inhibit the formation and spread of rust spores and fruiting body development (Halofsky and Peterson 2017).

Fire effects on whitebark pine are difficult to generalize. Mixed-severity and stand-replacing fires are beneficial to whitebark pine communities because the pine is better adapted to recolonize burned sites compared to more shade-tolerant subalpine fir (Halofsky and Peterson 2017). However, recovery following wildfire requires nearby seed sources. Seed is dispersed by the Clark's nutcracker. Probability of seed dispersal by the bird declines with diminishing cone production (Halofsky and Peterson 2017). Wildfire events may be more common as the summer dry period grows longer, adding an additional threat to cone presence throughout the whitebark pine landscape.

With declining populations, loss of cone-bearing trees with potential resistance to blister rust will limit future natural distribution of the tree (Halofsky and Peterson 2017).

Aspen

Although quaking aspen (*Populus tremuloides*) occurs in a wide variety of habitats throughout northern and western North America, stands of quaking aspen are uncommon and considered a unique habitat type in the Blue Mountains. Wildfires or other disturbances normally revitalized aspen clones under historic conditions (Seager et al 2013, Shinneman et al. 2013). As one of the few broadleaf deciduous trees in a region dominated by conifers and semi-desert grassland and scrub, aspen brings important diversity to the landscape. Aspen's palatable twigs and foliage, leaf litter that promotes understory diversity, and tendency to develop decay (which facilitates cavity excavation), make it valuable habitat for wildlife such as deer, elk, woodpeckers, beaver, songbirds, and small mammals (USDA FS FEIS 2018). Aspen is also widely appreciated for its scenic value including its fall foliage.

Figure 10: Quaking aspen stand at Elk Flat on the Walla Walla Ranger District, Umatilla National Forest

Status and Trends

Within the Blue Mountains, aspen stands have declined over the past century due to fire suppression that has enabled conifer encroachment and browsing pressure from large ungulates (Shirley and Erickson 2001). Aspen is an early seral component of forest communities, and stands have been declining in number, area, and stocking density. Although succession is a natural event, the alteration of fire regimes and a lack of successful aspen recruitment have promoted a more consistent landscape level succession to conifers or grass/shrubland. Aspen populations within the Blue Mountains generally now exist as small, scattered, remnant stands of rapidly declining trees.

Detailed aspen inventories conducted on the Malheur National Forest have revealed 1,327 stands, with a median stand area of less than 1 acre, and only 5 percent of the stands are greater than 10 acres in size (Swanson et al. 2010). Within the Umatilla National Forest, an inventory of 514 stands also show a median area of less than 1 acre and only 1 percent of the stands larger than 10 acres (Swanson et al. 2010). The total basal area of aspen stands tend to be quite low across the Blue Mountain national forests, making it even more vulnerable to loss from herbivory, fire suppression, and competition from other conifer species. Although little is known about the historic distribution of aspen in Oregon, it is believed that stands were once larger and more widely distributed (Shirley and Erickson 2001).

Ecological Integrity

Aspen ecosystems currently exhibit low ecological integrity. Aspen populations within the Blue Mountains generally now exist as small (< 1 acre), scattered, remnant stands of rapidly declining trees.

Climate Change Context

Increasing air temperature, through its influence on soil moisture, is expected to cause gradual changes in the abundance and distribution of tree, shrub, and grass species throughout the Blue Mountains, with drought-tolerant species becoming more competitive (Halofsky and Peterson 2017). Ecological disturbance, including wildfire and insect outbreaks, will be the primary facilitator of vegetation change, and future forest landscapes may be dominated by younger age classes and smaller trees. High elevation forest types will be especially vulnerable to disturbance. Increased abundance and distribution of nonnative plant species will create additional competition for regeneration of native plant species (Halofsky and Peterson 2017). A warmer climate and drier growing season could increase susceptibility to sudden aspen death (SAD) in the Blue Mountains, because aspen requires mesic soil moisture conditions, and moisture stress is an underlying factor for SAD (Halofsky and Peterson 2017). SAD is characterized by rapid, synchronous branch dieback, crown thinning, and mortality of stems, without the involvement of primary insect and disease pathogens. Aspen stands in the dry upland forest potential vegetation group are already near their soil moisture limit for survival, and increased loss of aspen in the Malheur National Forest might be expected at lower elevations (Halofsky and Peterson 2017). Rare, disjunct terrestrial communities such as aspen require adaptation strategies and tactics focused on encouraging regeneration, preventing damage from disturbance, and establishing refugia.

Sagebrush Steppe

Sagebrush steppe shrublands are sagebrush communities with at least five percent crown cover of sagebrush (*Artemisia tridentata* or *A. arbuscula*). These terrestrial ecosystems make up a small portion of the plan area but contribute to the biological diversity of the forests, including providing habitat for rare species such as sage grouse, *Centrocercus urophasianus*. Sagebrush is an important ecosystem for the greater sage grouse, a Species of Conservation Concern found primarily in the Malheur National Forest. Sagebrush ecosystems are rare on national forest lands administered by the Forest Service within the Blue Mountains, comprising only 6 percent of the Malheur National Forest and less than 1 percent of both the Umatilla and Wallowa-Whitman National Forests.

Sagebrush communities occur at high elevation in the cold shrubland potential vegetation group. At lower elevations, big sagebrush, *Artemisia tridentata,* are found in the moist shrubland potential vegetation group and low sagebrush, *Artemisia arbuscula,* and stiff sagebrush, *Artemisia rigida*, are in the dry shrubland potential vegetation group. Both the cold and moist shrubland potential vegetation groups include mountain big sagebrush, *A. tridentata var. vaseyana*. However, the understory changes from western needlegrass, *Stipa occidentalis,* or elk sedge, *Carex garberi,* in the cold shrubland potential vegetation group, to Idaho fescue, *Festuca idahoensis,* in the moist shrubland potential vegetation group (USDA FS FEIS 2018). Low sagebrush-Idaho fescue communities are also a component of the moist shrubland potential vegetation group.

Upland shrublands are uncommon in the Blue Mountains, occupying the transition zone between woodlands and grasslands, in some forest openings, and near high elevation ridgetops. Characteristic species in moist upland shrublands include mountain big sagebrush, antelope bitterbrush (*Purshia tridentata*), snowberry (*Symphoricarpos spp*.), bitter cherry (*Prunus emarginata*), curl-leaf mountain-mahogany (*Cercocarpus ledifolius*), and cool season bunchgrasses. Dry upland shrublands are dominated by sagebrush species. Climate is arid to semi-arid with low precipitation, hot summers, and cold winters (Kerns et al 2017).

Status and Trends

Sagebrush habitats have been reduced by more than 21 percent in Oregon from the late 1850s to present (Hagen 2011). Much of the loss is due to conversion by agriculture and the conversion of lands to other uses, exotic forbs, and annual grasses (USDA FS FEIS 2018). More than 90 percent of the sagebrush steppe community currently occurs within Bureau of Land Management and private lands, while only 8 percent occurs within National Forest System lands, U.S. Fish and Wildlife Service administered lands, and Oregon Department of State Lands.

The Ecostate Summarization Tool generates information about rangeland vegetation condition and trends using threat-based ecological state time series maps for each Blue Mountains national forest. Each map depicts vegetation condition averaged over 3 years.

The condition of sagebrush steppe terrestrial ecosystems can be described by ecological states (ecostates) that express current vegetation composition and level of threat from invasive annual grasses, wildfire, and juniper encroachment (Creutzburg 2021). Ecostate ruleset assignments are determined as follows: Areas with less than 5 percent juniper cover are divided into shrubland (ecostate groups A, A-C, C, Juniper: low-mid cover). Herbaceous condition is determined by the ratio of annuals to perennials (AFG:PFG), with sites considered in good condition where there are greater than 3 times more perennials than annuals (A), sites in poor condition where annuals are dominant over perennials (C), and intermediate condition where perennials are slightly dominant (A-C). The “Juniper: low-mid cover” ecostate group is shrubland with a juniper encroachment threat.

Table 18 displays the amount of sagebrush shrubland in each ecostate condition, by national forest. Less than 1 percent of sagebrush steppe ecosystems on the Umatilla are in good condition, and 14 percent and 15 percent of sagebrush steppe ecosystems are in good condition on the Malheur and Wallowa-Whitman, respectively.

Table 18: Sagebrush Condition by Blue Mountains National Forest

	Malheur		**Umatilla**		**Wallowa-Whitman**	
Ecostate Group	Acres	Percent	Acres	Percent	Acres	Percent
A: Good condition shrubland	28,000	14%	240	<1%	34,000	15%
A-C: Intermediate condition shrubland	14,000	7%	1,400	4%	7,400	3%
C: Poor condition shrubland	400	<1%	380	1%	3,400	2%
Juniper: low-mid cover	154,000	78%	34,000	94%	176,000	80%

The extent and condition of sagebrush communities broadly are threatened by juniper encroachment, renewable energy development (both wind and geothermal), energy transmission, roads, off-highway vehicle recreation, mining development, and residential development. Wildfires, invasive species, and grazing also present threats to sagebrush.

Ecological Integrity

Sagebrush steppe ecosystems in the Blue Mountains currently exhibit moderate but declining ecological integrity.

Climate Change Context –

Cold upland shrublands occur on exposed sites, rocky substrates, and cold air drainages at mid-high elevations. Typical species include Sitka alder (*Alnus viridis ssp. sinuata*), mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*), and shrubby cinquefoil (*Dasiphora fruticosa*).

In the future, wildfires in subalpine systems may be more common, and shrub species may be able to regenerate faster than subalpine trees. However, mountain big sagebrush is readily killed by fire and requires at least 15 years to recover (Halofsky and Peterson 2017).

Deep rooted shrubs like sagebrush species in dry upland shrubland communities are well adapted to cold winters and summer drought, conducting photosynthesis during periods of extreme moisture and heat stress (Halofsky and Peterson 2017). High temperature does not appear to directly affect big sagebrush regeneration due to the broad temperature range that is optimum for regeneration (Halofsky and Peterson 2017). Moist upland shrublands may be vulnerable to increasing drought, particularly at the lower ecotone.

Palaeoecological evidence for the Blue Mountains indicates that sagebrush has increased with warming, with the shrub-steppe boundary at higher elevations during the warmer early-mid Holocene, providing a context for interpretation of modeling studies (Kerns et al 2017). A warmer climate would result in a greater extent of ecosystems adapted to arid conditions. However, as wildfires increase, conversion to non-native annual grasslands may occur in some areas (Kerns et al 2017).

Key Benefits to People

Terrestrial ecosystems contribute to social and economic sustainability, biodiversity and occurrence of rare type ecosystems like whitebark pine, carbon storage, recreation and scenic values, forest products, grazing opportunity, and overall quality of life. Residents of local communities, recreationists, and visitors benefit from the intact and functional ecosystems of the Blue Mountains. There are broad uninterrupted expanses of native forests, shrublands, and grasslands that provide diverse landscapes, habitat for wildlife, solitude for hikers, and fuelwood products. Marketed and non-marketed goods and services from terrestrial ecosystems provide key benefits to people.

Marketed Goods and Services: The national forests provide a stable amount of raw material for timber industries within and adjacent to the national forest's zone of influence (See Forest Management Report). The supply maintains local industries currently in place to remain a cornerstone of a stable and predictable local economy. A sustained yield of wood fiber to meet projected production levels is provided insofar as possible while meeting resource objectives, forest plan standards and guidelines, and cost efficiency. Slightly declining range outputs still assist in maintaining the ranching industry which contributes to the social stability of the area.

Non-marketed Goods and Services: Non-commodity resources maintain the rural, forested setting important to local lifestyles and provide a strong foundation for diversifying the economic base of the affected communities. Native Americans have long used various forest products for ceremonial and subsistence needs. Much of the areas not managed for timber harvest provide a recreation setting relatively free of human intrusions. Visitors also value scenic travel corridors and big game habitat.

Ecosystem services that terrestrial vegetation provide benefit people and include:

- **Supporting services:** terrestrial ecosystem services create photosynthesis that produces oxygen and accumulates solar energy, nutrient cycling that maintain appropriate levels of many nutrients essential for life, genetic diversity that supports plant adaptation, and soil fertility that sustain many of the products that people value.
- **Regulating services:** terrestrial ecosystem services regulate processes for vegetation by contributing and extracting chemicals from the atmosphere, sequester or emit greenhouse gasses, and storing carbon (See Carbon Report), effect timing and quantity of runoff and groundwater recharge to both regulate flooding and maintain water storage, and purify water by filtering out and decomposing organic wastes. They also stabilize soils to reduce erosion and prevent landslides.

- **Provisioning services:** terrestrial ecosystem services include food derived from plants or animals that directly or indirectly depend on plants, wood fiber materials, fuelwood for home heating, plants used for landscaping or ornaments, natural medicines, fresh water, and clean air.
- **Cultural values:** terrestrial ecosystem services are nonmaterial benefits such as scenic beauty and aesthetic value, spiritual or religious uses, formal and informal educational and research opportunities, cultural heritage in the form of cultural landscapes or culturally significant species, specific types of recreational experiences, tourist attractions, a sense of place, and a source of inspiration for art, folklore, and symbolism.

Risks and Stressors

Stressors are defined as factors that may directly or indirectly degrade ecosystem composition, structure, or processes in a manner that may impair its ecological integrity (36 CFR 219.19). Degraded ecological integrity creates risks to systems, as impaired ecosystems function at reduced productivity and capacity to provide biodiversity and ecosystem services.

Drivers and stressors of terrestrial ecosystems in the Blue Mountains include agents such as succession, wildfire, insects and disease, invasive species, drought, and climate change. Management influences include vegetation management, grazing, roads and trails, recreation use, and development.

Succession - Succession is the natural change in the composition, structure, and function of an ecosystem over time during long periods without major disturbance and is an ecosystem driver. Disturbances like fire, drought, and grazing can interrupt or reverse succession.

Wildfire – Wildfire is a natural part of ecosystems of the Blue Mountains. Past management actions have resulted in fewer fires in some ecosystem types in the plan area since the late 1800s. This reduced amount of fire has led to an accumulation of fuels, altered fuel arrangements, and changed species compositions in these ecosystems, creating the potential for larger and more severe, uncharacteristic fires (Holsinger et al. 2016, Hessburg et al 2015, Peterson 2005). Uncharacteristic fires, those that differ in frequency, severity, and intensity from an ecosystem's historic fire regime*, can be a stressor and may permanently convert an ecosystem to a different cover type. Tree mortality from drought or insect and disease outbreaks changes fuel structures and can affect fire behavior (Agee and Skinner 2005, Lehmkuhl 1994, Parsons and DeBenedetti 1979, Skinner 1995). In the future, changing climate is expected to lengthen the fire season and lead to higher severity fires than historic conditions in dry and moist upland forest types.

*Fire regimes describe historical fire conditions that influenced how vegetation communities evolved and were maintained over time (Schmidt et al. 2002; Hardy et al 2001). These conditions are generally characterized by fire frequency (the average number of years between fires) and fire severity (the effect fire has on the dominant overstory vegetation). The historical fire regime varies widely across different ecosystems, from a regime of short return intervals and low severity to long return intervals of fires that consume all vegetation (stand-replacing). For example, cold upland forest generally experienced infrequent, stand-replacing fires while the dry upland forests are associated with more frequent, low-severity fire.

Insect and Disease - Insect and disease dynamics play a major ecological role in maintaining forests in a healthy, functioning condition. Tree mortality and other impacts of insects and disease regulate forest vegetation composition, influence stand density and structure, provide wildlife habitat in dead and dying trees, and contribute nutrients to soils. Without the influence of widespread, natural disturbances in the forest (fire, insects, and disease), the composition and structure of the forest landscape becomes less diverse, and therefore less resilient to future disturbance. These change agents are an integral part of forest ecosystem processes. These processes are likely to be altered and compounded by the stressor of climate change.

Invasive Species - Invasive species are defined by Executive Order 13112 (1999) as those species that are non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm, or harm to human health. As such, they are an ecological stressor. They often pose a competitive advantage at a site and can outcompete and displace native plant species. They are capable of dominating and converting a site from native species to non-native cover.

Areas where vegetative cover is disturbed and exposing bare soil are most susceptible to invasions. These lands may be disturbed from human land uses and management (such as roads, trails, ditches, agriculture, grazing, timber harvest, prescribed burning, wildfire response, and land clearance), or by natural disturbances (such as wildfires, wildlife concentration areas). Invasive plant species can be spread or introduced into unoccupied areas by vehicles, humans, wind, water, and animals along travel routes and waterways.

Natural plant community composition can be altered by nonnative invasive plants, greatly reducing biodiversity, eliminating habitat and forage for wildlife and livestock, and potentially altering fire regimes. Ecosystem functions such as nutrient cycling and energy flow can be altered. Invasive plants can affect soil characteristics by altering soil chemistry, changing soil moisture levels and evapotranspiration rates, and by lowering water tables.

Climate change is expected to increase the impacts of invasive plant species. Many invasive plant species will either increase in abundance, if established, or expand into the lower elevation grassland, shrubland, and open woodland communities, regardless of level of disturbance, as these communities become warmer and drier. In addition, the rate and magnitude of infestation will likely increase with greater disturbance levels that are expected to be concomitant with a changing climate.

Climate Change - All aspects of vegetation potential and expression are anticipated to be influenced by climate change. Temperature and precipitation patterns that determine dominant species and productivity of vegetation, nutrient availability, and cycling in soils are expected to change in the coming decades (See Climate Change Report). These changes are expected to influence the frequency, extent, and severity of disturbance from drought, insects and disease, and fire. Current ecosystems have evolved under a specific climate with a within a particular level of variability. Climate is inherently an ecosystem driver but becomes a stressor when its mean, variability, or rate of change shifts outside of its contemporary natural range of variability.

Vegetation Management - includes a variety of management activities, such as timber harvest, broadcast burning, fuels treatments, insect and disease management, planting, seeding, and treatment of invasive species. Current management actions in the Blue Mountains national forests are often intended to mitigate impacts of ecosystem stressors but can also be stressors themselves. For example, timber harvesting alters stand structure and function, but its impact varies by the size, intensity, and type of harvest, pre-existing harvest conditions (past management activities), biotic and abiotic factors (soil type, slope, aspect, and vegetation type), and the distribution of harvesting practices across the landscape.

Vegetation management activities can be designed to improve wildlife habitat and mitigate the impacts of past management policies (i.e. the legacy of fire suppression). Timber harvest activities can be used to modify stand structure, influence and change the representation of vegetative species, reduce stand density and ladder fuels and may be used prior to the reintroduction of fire. Vegetation management can be an ecosystem stressor and can have undesirable side effects. For example, heavy equipment used in timber management has the potential to disrupt soil hydrologic function, stability, and nutrient cycling, which can affect revegetation on disturbed areas.

Livestock Grazing - While grazing practices and rangeland condition have improved substantially over the past several decades, the legacy of high historical livestock levels and associated activities still impacts the current ecological integrity of some ecosystems in the Blue Mountains. For example, past grazing reduced fine fuels and contributed (along with active fire suppression) to low levels of fire in some ecosystems, particularly the dry upland forests.

Roads - Roads have a large impact on landscape patterns and processes. They create barriers to species mobility, acting as corridors for non-native and edge-adapted species, and increase human access to interior habitats. Higher road densities can significantly affect the presence of large mammals and can also alter natural disturbance processes and biotic interactions with communities. Roads also impact natural sediment and hydrologic regimes, contributing more sediment to streams than any other land management activity.

Recreation - Recreation uses are an ecosystem stressor and are increasing. Impacts to terrestrial ecosystems from recreation include trampling of vegetation, soil compaction, erosion, disturbance of wildlife, pollution and littering, nutrient loading, and the introduction of invasive species.

Trends and Drivers

System drivers are the ecological processes or factors that determine how ecosystems change or recover over time. Drivers affect ecosystem characteristics and contribute to the natural range of variation of vegetation and their trends within terrestrial ecosystems. Drivers include biotic and abiotic agents of change and management influences, which affect ecosystem trends, health, and function. Based on the trends of various ecosystem drivers, current and future conditions can be inferred and assessed against a desired condition.

Current resource conditions and trends are detailed in the Blue Mountains Forest Plan Revision Current Management Situation Report (USDA FS SR 2018) and summarized below.

Invasive Plant Species - A large portion of the Blue Mountains is characterized as being susceptible to exotic weed invasion. The susceptibility occurs in areas dominated by dry forest, dry grass, dry shrub, and cool shrub types, which are the sites that many invasive species evolved in and are adapted to. The current forest plans stated that invasive weed species would be present on the forests but the spread would be controlled. Invasive species are currently still present and increasing in distribution. In 2005, the Pacific Northwest Regional Forester amended all Region 6 forest plans, adding new management direction, including emphasis on early detection, and effective integrated treatment of invasive plants. To address invasive species on the landscape, the Umatilla and Wallowa-Whitman National Forests completed Environmental Impact Statements (EISs) in 2010, followed by the Malheur National Forest in 2015, and in 2016 a Supplemental EIS for the Wallowa-Whitman was completed. Site-specific treatments were analyzed and approved, however, there is a need to set priorities for individual treatments to be more successful at the landscape scale. There is also a concern whether the standards in the Invasive Species EISs will allow successful treatment and prevention of invasive weed species.

Insects and Disease – Several large-scale outbreaks of insects including western spruce budworm, *Choristoneura occidentalis*, spruce bark beetle, *Dendroctonus rufipennis*, and Douglas-fir tussock moth, *Orgyia Pseudotsugata,* that occurred in the 1980s and 1990s have collapsed after causing extensive defoliation and tree mortality (USDA FS SR 2018). Most plant diseases are increasing in occurrence and severity due to changes in species composition, stand structures, stocking levels, and disturbances (USDA FS SR 2018). The current condition is similar to the predicted desired future condition in the 1990 forest plans; large scale outbreaks have run their course, but much of the landscape would still be susceptible to infestations above historic levels (USDA FS SR 2018). The large-scale risk was expected to slowly decrease over time as the timber stands coming under management to meet species composition, structure, and density goals increased. However, current levels of acres of silvicultural treatment and volume of timber harvested have greatly decreased from projected levels in the current forest plans.

In recent years climate change impacts such as ongoing droughts and extreme weather events have increased forests susceptibility to opportunistic insect and disease agents, such as fir engraver bark beetle, *Scolytus ventralis*. As droughts persist, historic levels of tree mortality have been observed specifically in true firs, one of the least drought-tolerant conifers (USDA and ODF 2022). Drought stressed trees are less able to produce defenses against insect and disease, and often succumb to infestation that an otherwise healthy tree could have fought off. Fir engraver does not typically have the ability to kill healthy trees but can kill stressed trees due to the compounding effects of drought. Recent reports specific to the Blue Mountains have provided greater understanding of the long-term ecological implications of some past treatments which led to unanticipated large, landscape level changes (USDA FS SR 2018). There is a growing concern that past practices like fire suppression and timber harvest have created potential conditions, such as greater competition and moisture stress, for larger scale and more severe disturbances than those that have occurred historically. Climate change is expected to compound these stressors. In addition, threats from new introduced exotic pests and pathogens are ongoing. White pine blister rust has already been introduced, and continuing introductions across the western United States of a range of exotic biotic agents means that this possibility continues in these national forests.

Wildfire - The current forest plans state that large wildfire acres burned would be close to the acres burned during the last planning period or would decline as natural and activity related fuel reductions were implemented. Acres burned by wildfire in the Blue Mountains have increased over the last 20 years when compared to totals in the last 100-year time period, prior to 1980 (Hessburg et al 2016). There is an increased potential for high intensity, stand-replacing fires to occur in the dry upland forest potential vegetation group sites which was historically dominated by low intensity fire (Merschel et al 2021). Potential for high severity wildfire behavior within dry upland forest have increased when compared to estimated historic levels (USDA FS SR 2018). Objectives for reducing these severe and intense fires have not been met because landscape conditions have become susceptible to uncharacteristically severe wildfire at a rate faster than the ability to manage them. Due to fire suppression and other factors, there are higher and more contiguous fuel loads across the landscape. Because of the buildup of fuels, disturbance processes have been altered; fires are now more severe and intense than historic levels, especially in the warm, dry forest types (USDA FS SR 2018).

Climate and Climate Change - The current 1990 forest plans do not include any guidance related to climate and climate change.

Climate change is expected to profoundly alter vegetation structure and composition, terrestrial ecosystem processes, and the delivery of important ecosystem services over the next century. Climate is affected by multiple factors and will continue to change at an accelerated rate in the coming decades (See Climate Change Report). Climate models agree that average annual temperatures are likely to increase over the coming decades. Increased heat and evaporative pressure will likely further affect the carrying capacity of forested sites, resulting in altered composition, structure, or even ecosystem type (grass/shrub versus forest vegetation) especially on low elevation sites (Vose et al. 2016).

Succession – The average growth rates of trees exceed the removal and mortality rates of trees across the Blue Mountain national forests. The desired future condition in the current forest plans stated that the landscape would be dominated by productive stands of timber with growth rates matching yield tables based on well-timed treatments that would maximize production (USDA FS SR 2018). Current levels of mortality are higher than original assumptions. The amount of small diameter and dense stands continues to increase. If average growth rates of trees continue to exceed removal and mortality rates, it will lead to conditions susceptible to uncharacteristically large-scale, severe disturbances including insects, disease, and fire.

The current forest plans predicted that landscape diversity would be maintained by even-aged timber management practices that would create a mosaic of timber cutting patterns of varying sizes, shapes, and arrangements. The use of even-age methods of timber harvest has been reduced to less than 10 percent of what was projected in the current forest plans. Current levels of acres of silvicultural treatment and volume of timber harvested have greatly decreased from projected levels in the current forest plans.

Current data indicate a trend of decreasing acres of dry forest late and old structure among the Blue Mountains national forests. Many recent changes to timber stand structure have occurred due to changes in disturbance regimes (USDA FS 2018). There has been a loss in the abundance and distribution late-old structure and trees greater than 21 inches diameter at breast height due to wildfire and past timber harvest, especially in the dry and moist forest types (USDA FS 2018). Much of the management direction relevant to old forests and large trees has come from the "Eastside Screens" which amended the forest plans of the Blue Mountains national forests, and required levels of old forest to be maintained within the range of variability and has also prohibited the harvest of any live trees greater than 21-inch diameter when the amount of old forest in the landscape is below the range of variability.

Generally, average tree diameters have decreased, and the average stand density has increased. There has been an increase in the seedling stage and young multi-layered forests. Juniper and conifer encroachment onto grassland, shrubland, and woodland types has also increased.

The major changes over the last 10 to 15 years across the Blue Mountains may have reduced biodiversity and created a landscape condition dominated by dense, multi-layered stands, with tree species unsuited to the site. This contributes to the potential for uncharacteristically severe and large disturbances such as wildfire, insects, or disease. These conditions could create an unsustainable system.

Vegetation Management – Over a significant portion of the three national forests, outside of wilderness, the original Desired Future Conditions included a matrix of heavily managed lands, having an even-aged character with harvest rotations generally less than 100 years interspersed with small patches of unmanaged vegetation. This Desired Future Condition was modified in 1993 by the Eastside

Screens (USDA 1995c) to shift management towards conserving late/old structural conditions across the landscape. The original Desired Future Condition was never achieved, and current management continues to maintain multi-layered late and old structures by limiting activities that would significantly modify stand structure.

Current levels of acres of silvicultural treatment and volume of timber harvested have greatly decreased from projected levels in the current forest plans. Harvest methods have shifted from even-aged management to uneven-aged methods.

Implementation of the Eastside Screens and PACFISH/INFISH greatly reduced the number of acres that were available for stand treatment activities that would be accomplished using a timber sale. Riparian areas are considered special habitats across the Blue Mountains and are afforded protection through interim management direction referred to as PACFISH and INFISH. In addition to providing habitat for fish populations, riparian areas also serve as travel corridors between old growth units for big game species. This national policy direction to implement ecosystem management reduced the amount of clearcutting and increased the degree of retention of trees in harvest units.

There are concerns management practices have created a landscape condition dominated by dense, multi-layered stands, with tree species not well suited to the site. This contributes to the potential for uncharacteristically severe and large disturbances, eventually creating an unsustainable system.

Livestock Grazing – The desired condition in the current forest plans projected an improvement in the condition of vegetation in grazing allotments due to decreased utilization of grasses and shrubs, decreased utilization of riparian areas as a result of implementation of Riparian Management Objectives from PACFISH and INFISH, and updated allotment management plans.

Most of the southern end of the Blue Mountains (Malheur and southern Wallowa-Whitman National Forests) as well as the far north end (Wallowa Valley Ranger District), were characterized by the Interior Columbia Basin Ecosystem Management Project (ICBEMP) as having between 70 to 100 percent low range and ecological composite integrity (USDA FS SR 2018). Forage conditions have been reduced by woodland juniper encroachment and expansion of invasive weed species. A decline in herb lands and shrub lands was observed. Most of the Umatilla National Forest and the western portion of the Wallowa-Whitman National Forest (La Grande and Baker Ranger Districts) was modeled by ICBEMP as having 76 percent low range integrity and 58 percent low ecological integrity, with existing conditions that have been highly altered from historic conditions by grazing, timber harvest, and exclusion of fire. Historic high levels of grazing combined with possible climate shifts and fire suppression may have created conditions favorable to the establishment of large numbers of tree seedlings.

There is a concern that the forests should switch from the current range single pathway successional model to the concept of “state and transition” models which recognizes multiple successional pathways depending on the type of disturbance and environmental conditions present on the site. More specific desired conditions based on the different potentials for different shrub, forest, and grassland plant communities may be better than the current overall desired condition.

Roads - The transportation system on the Malheur, Umatilla, and Wallowa-Whitman National Forests serves a variety of resource management and access needs. Most roads on the three forests were originally constructed for commercial purposes including grazing, timber, and mineral extraction. The current forest plans describe an overall increase in the miles of road across the three national forests. Changes in logging methods, a moratorium directive on road building in roadless areas, land exchanges, and appropriations have influenced how roads are managed and maintained in the last decade. Recreational use of roads on the three national forests has increased. Roads are often associated with the introduction and spread of invasive species and can contribute to erosion. User-created, non-system roads cause fragmentation that modifies landscape pattern and damage to and loss of terrestrial vegetation. There is a concern that current funding levels are not adequate to maintain existing roads to applicable standards to minimize ecological impacts and allow efficient and safe use.

Trails – The trail system across the three national forests has not expanded to the scale anticipated in the current forest plans. New trail construction has been minimal throughout the planning area, although former roads have been converted to motorized or non-motorized trails. Decreased funds and limited partnerships have presented challenges to completing adequate "customer service-oriented" maintenance on many trails. Many trails have numerous maintenance needs, due to an aging infrastructure. Trails are used differently and more heavily than the level for which they were originally designed. Trail impacts to terrestrial vegetation include introduction and spread of invasive species, damage and loss to vegetation, and fragmentation that modifies landscape vegetation patterns.

Recreation - Dispersed recreation is a major niche that many visitors highly value. Big game hunting, relaxing in nature, gathering forest products (such as berries, mushrooms, and fuelwood), and most fishing take place in a variety of dispersed recreation settings. Because the budget focus is on more tangible, developed site activities and facilities, these areas of the forests receive little administrative presence. The result is increased user conflicts and potential for resource damage including damage and loss of terrestrial vegetation.

Information Needs

Continued updating of terrestrial ecosystems vegetation inventory and mapping to reflect current management action and disturbances to more accurately depict the most current conditions of terrestrial vegetation.

An ongoing evaluation of historic and desired conditions presented in the range of variation for each terrestrial ecosystem within the context of climate change.

FVS modeling to occur on the most updated vegetation data which includes effects of management activities, wildfire, insect and disease activity, and other known change agents including the projected impacts of climate change. Utilizing FVS modeling and/or other vegetation models to present an alternative metric than canopy cover to assess stand density at a stand and potential vegetation group level.

Vegetation change model improvements such as by incorporating biotic interactions and the phenotypic plasticities (the range of trains that can be expressed by their particular genotypes) for species (Halofsky and Peterson 2017).

Key Findings

While considering the compounding effects of climate change to terrestrial ecosystems, increasing vegetation density, shifts in forest species composition, and modified landscape patterns have created vegetation conditions in many locations that are characterized by:

- Creation of a simplified landscape vegetation mosaic dominated by a surplus of dense young and mid-aged forests and a lack of less dense and more open mature forests.
- Increased moisture stress and inter-tree competition for site resources due to overly dense stands, changes in moisture availability due to changing climatic conditions, and increased evaporative demand.
- A shifting of tree species composition away from a species mix that is well adapted and resilient to historical levels of disturbance agents like fire, drought, insects and diseases.
- An increased susceptibility to large and severe fires, insect outbreaks, and widespread disease.

All major and rare type terrestrial ecosystems of the Blue Mountain national forests are exhibiting degraded and impaired ecological integrity of varying degrees (Table 19). If systems remain on the current management trajectory as directed by the current 1990 forest plans, as amended, terrestrial ecosystems are expected to deliver functions and services at a reduced level.

Table 19. Summary of Ecological Ranking by Terrestrial Ecosystem Type

Terrestrial Ecosystem Type	Ecological Integrity Ranking
Dry Upland Forest	Moderate but Declining
Moist Upland Forest	Moderate but Declining
Cold Upland Forest	Low
Grasslands	Moderate but Declining
Whitebark pine	Low
Aspen	Low
Sagebrush Steppe	Moderate but Declining

Dry Upland Forests currently exhibit moderate but declining ecological integrity. If the system remains on the current trajectory, it is expected to deliver major functions and services at a reduced level relative to expectations. A large proportion of the dry upland forest is altered in density and structure and lacking its historical representation of fire-resistant species and older individual trees. The present condition of large areas of the dry upland forest now supports unusually severe wildfire behavior. The Malheur National Forest has the highest departure from the dry upland forests historical fire regime, followed by the Umatilla and the Wallowa-Whitman National Forests. Climate change is anticipated to compound stressors already existing due to the effects of past management like fire suppression.

Moist Upland Forests currently exhibit moderate but declining ecological integrity. If the system remains on the current trajectory, it is expected to deliver major functions and services at a reduced level relative to expectations. Potential for high severity fire behavior in the moist upland forests is close to natural levels; however, species composition has shifted away from fire and drought tolerant tree species and the proportion of low versus high density stands is not within the HRV. The Umatilla and Wallowa-Whitman National Forests currently have low (approaching moderate) RV departure scores, and the Malheur has a moderate RV departure score. Climate change is anticipated to compound stressors already existing due to the effects of past management like fire suppression.

Cold Upland Forests currently exhibits low ecological integrity. The Umatilla National Forest has a low RV departure score. The Wallowa-Whitman National Forest has a moderate RV departure score and although the Malheur's departure score is moderate, it is approaching high departure. Potential for high severity fire behavior exists in 50 to 60 percent of the cold upland forests in the Blue Mountains.

Climate change is anticipated to compound stressors already existing due to the effects of past management like fire suppression.

Grasslands currently exhibit moderate but declining ecological integrity. Grassland systems in general may be an early indicator of climate change due to the dominance of grasses and forbs and, hence, their relatively higher sensitivity to annual climate variability compared to forestlands. Increased disturbance will be facilitated by more frequent extreme droughts, amplifying conditions that favor wildfire of unnaturally high fire frequency, and invasive species invasion. Fire suppression and exclusion have altered the natural disturbance regimes of grassland ecosystems, leaving systems vulnerable to invasive species invasion and conifer encroachment. Climate change is anticipated to compound stressors already existing due to the effects of past management like fire suppression.

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Appendix

Map Index:

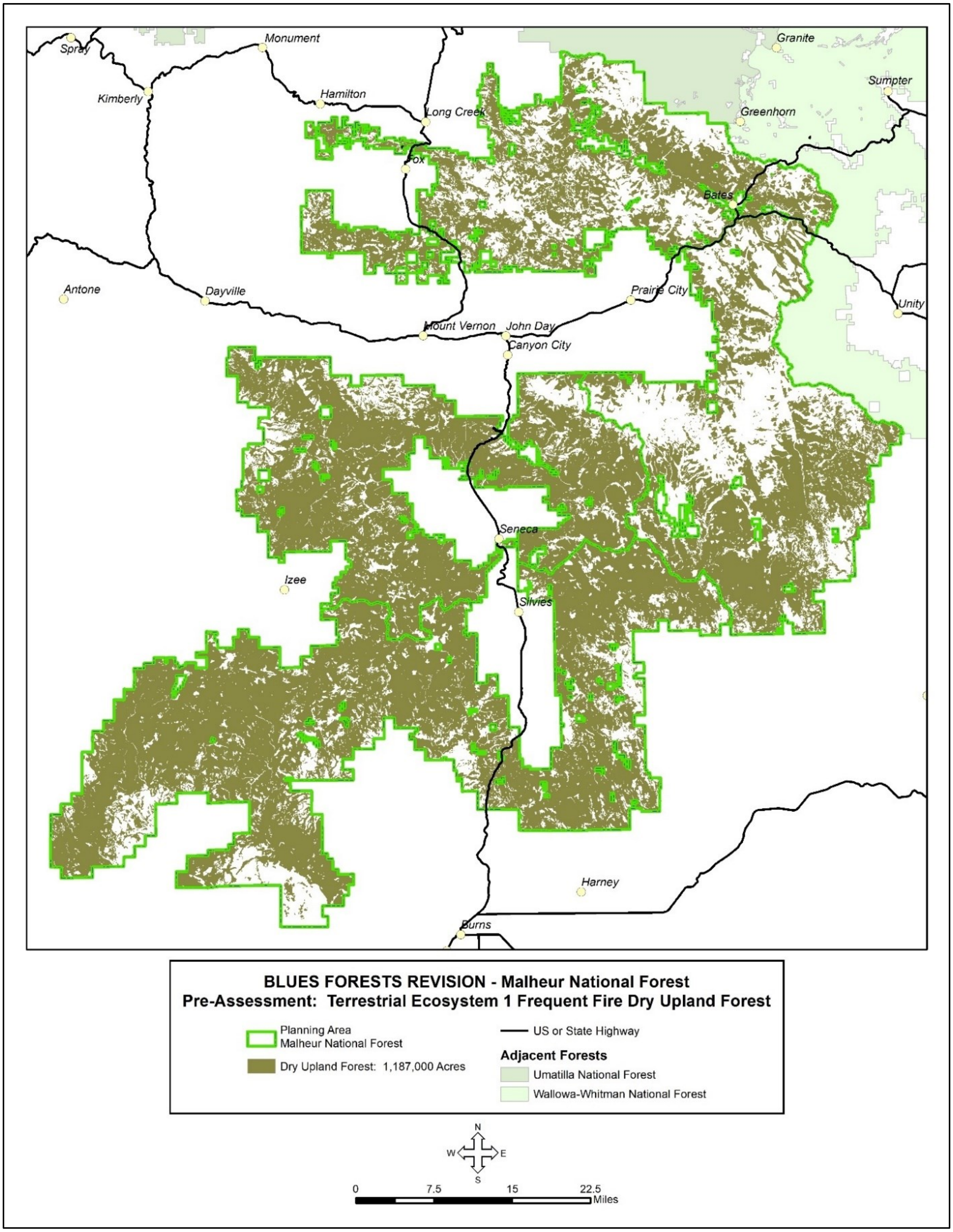

Figure 11- Dry Upland Forest on the Malheur National Forest

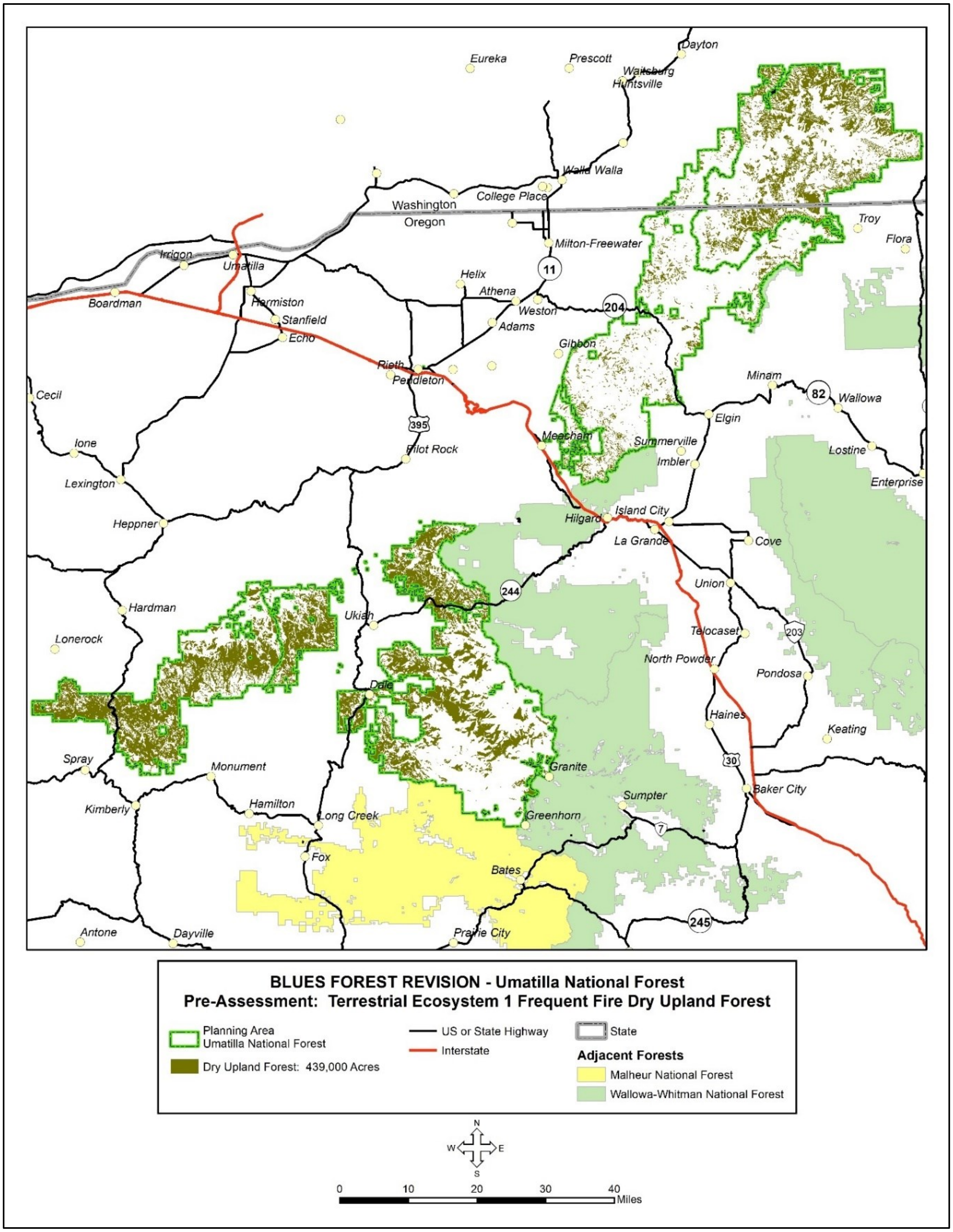

Figure 12- Dry Upland Forest on the Umatilla National Forest

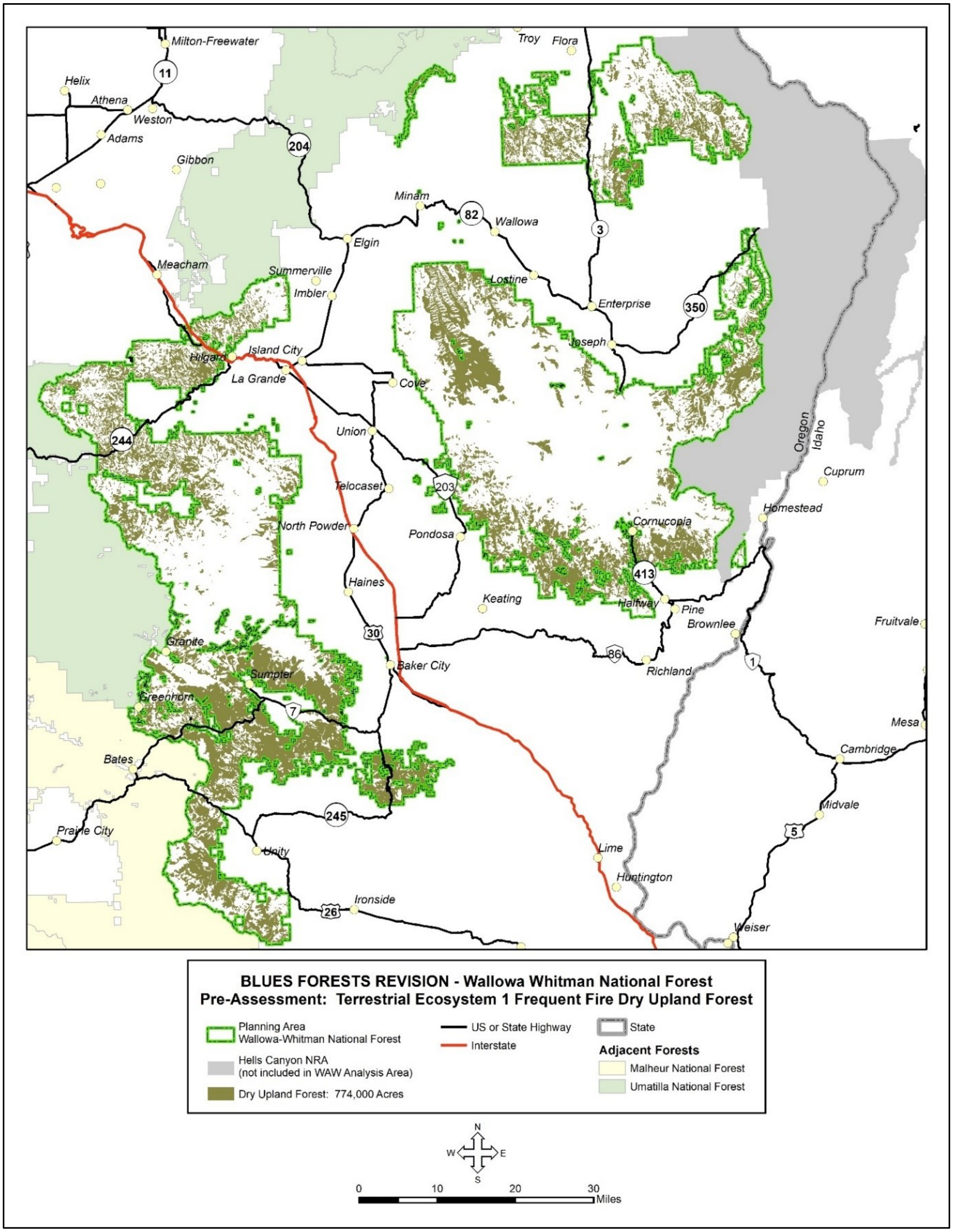

Figure 13- Dry Upland Forest on the Wallowa-Whitman National Forest

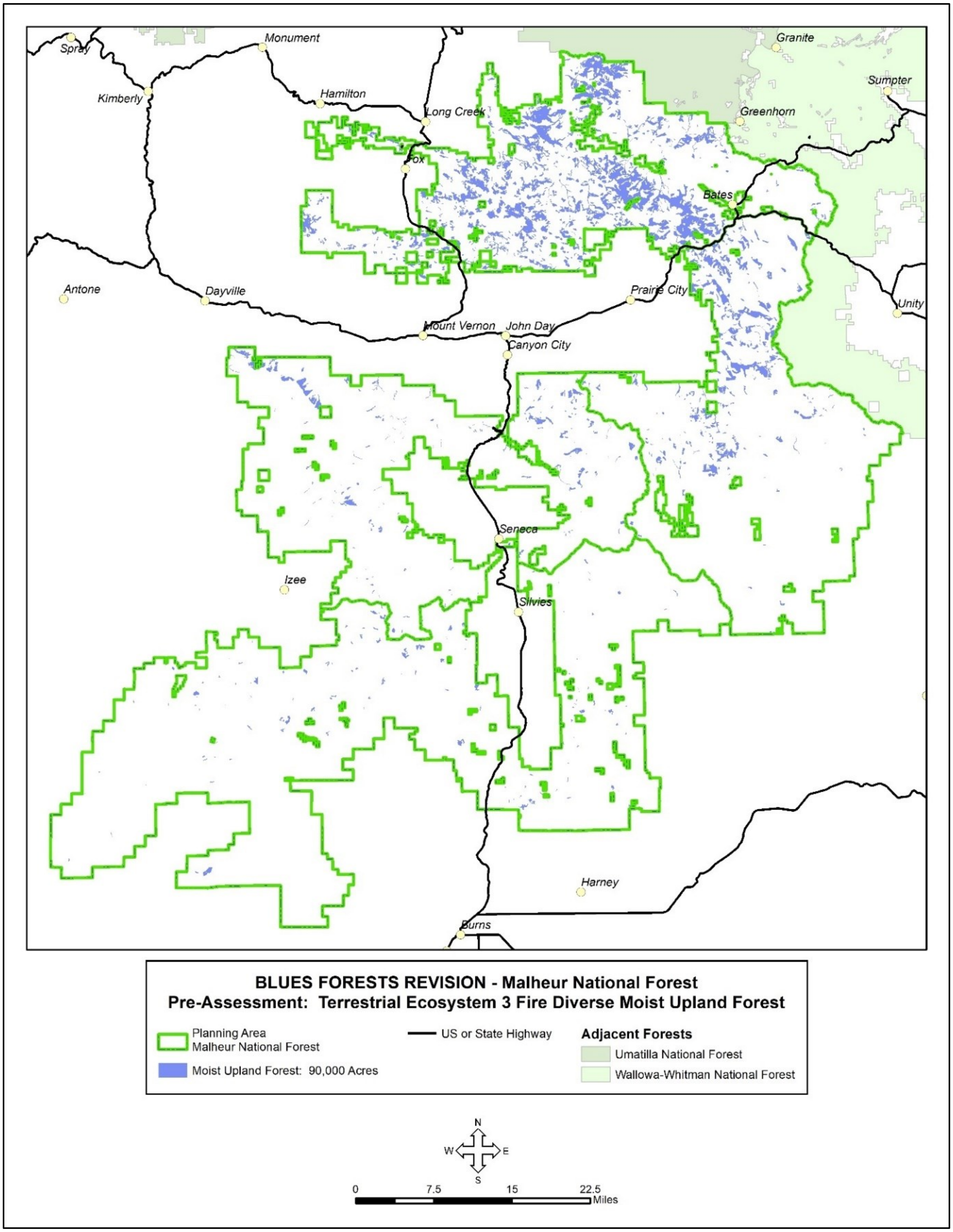

Figure 14- Moist Upland Forest on the Malheur National Forest

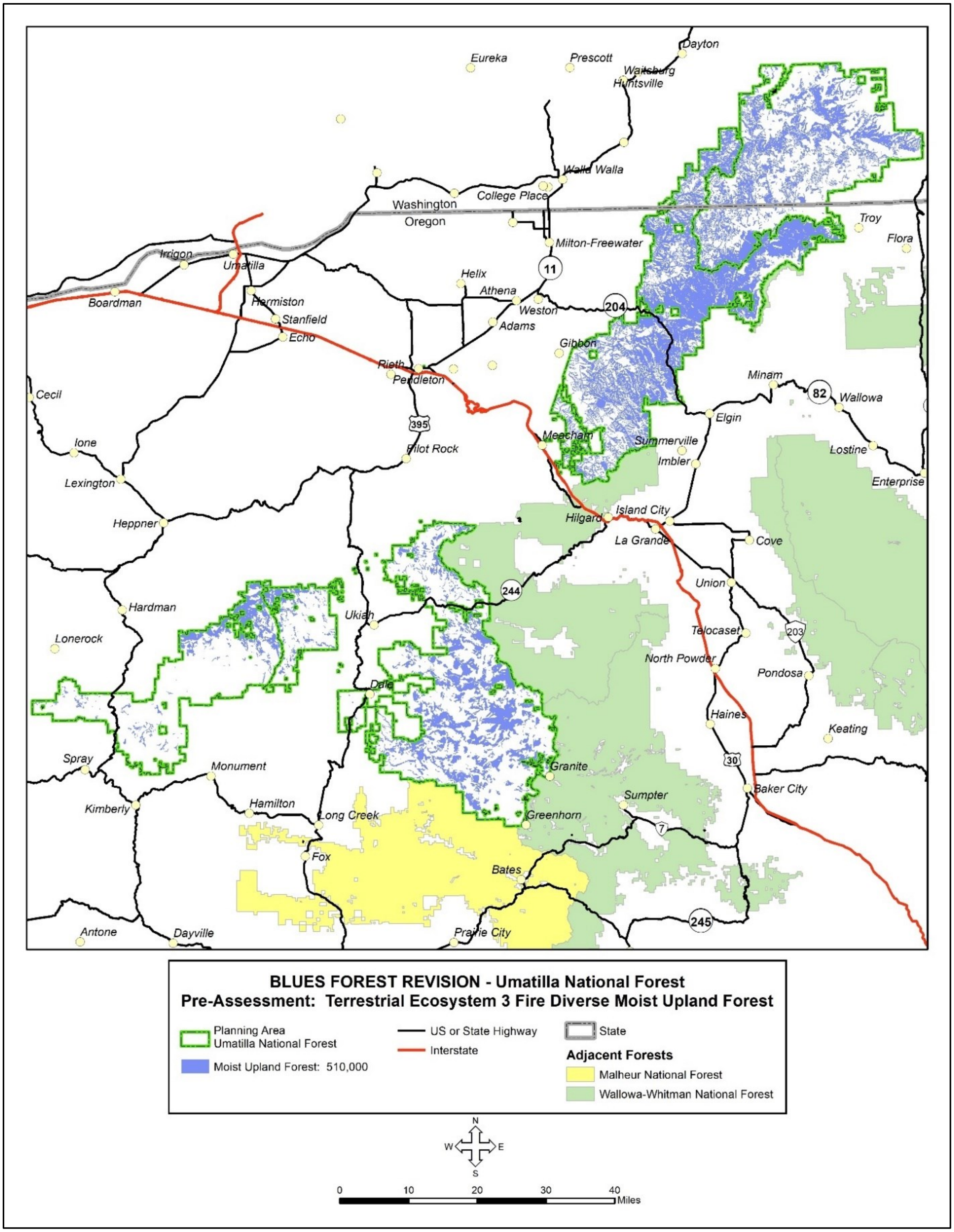

Figure 15- Moist Upland Forest on the Umatilla National Forest

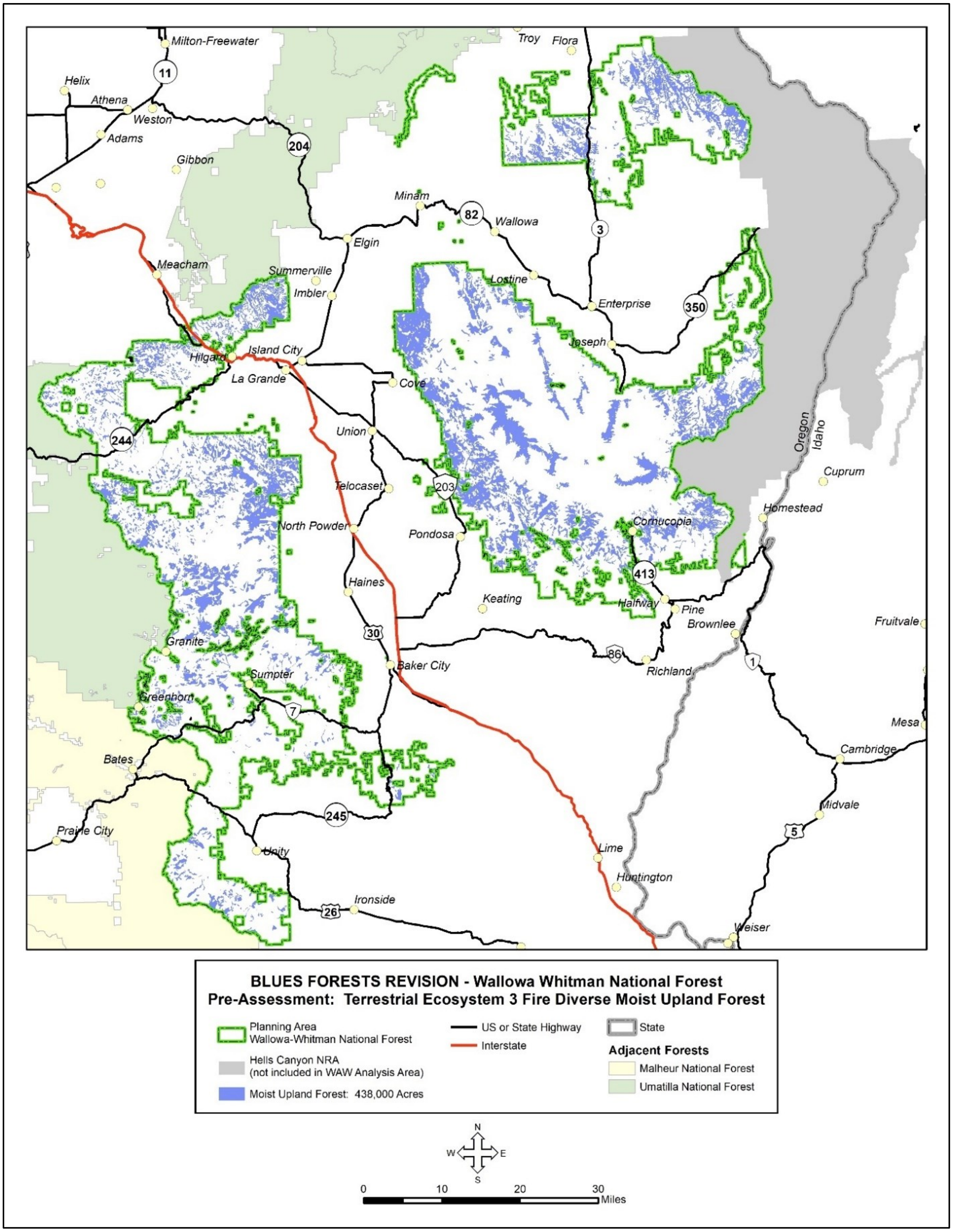

Figure 16- Moist Upland Forest on the Wallowa-Whitman National Forest

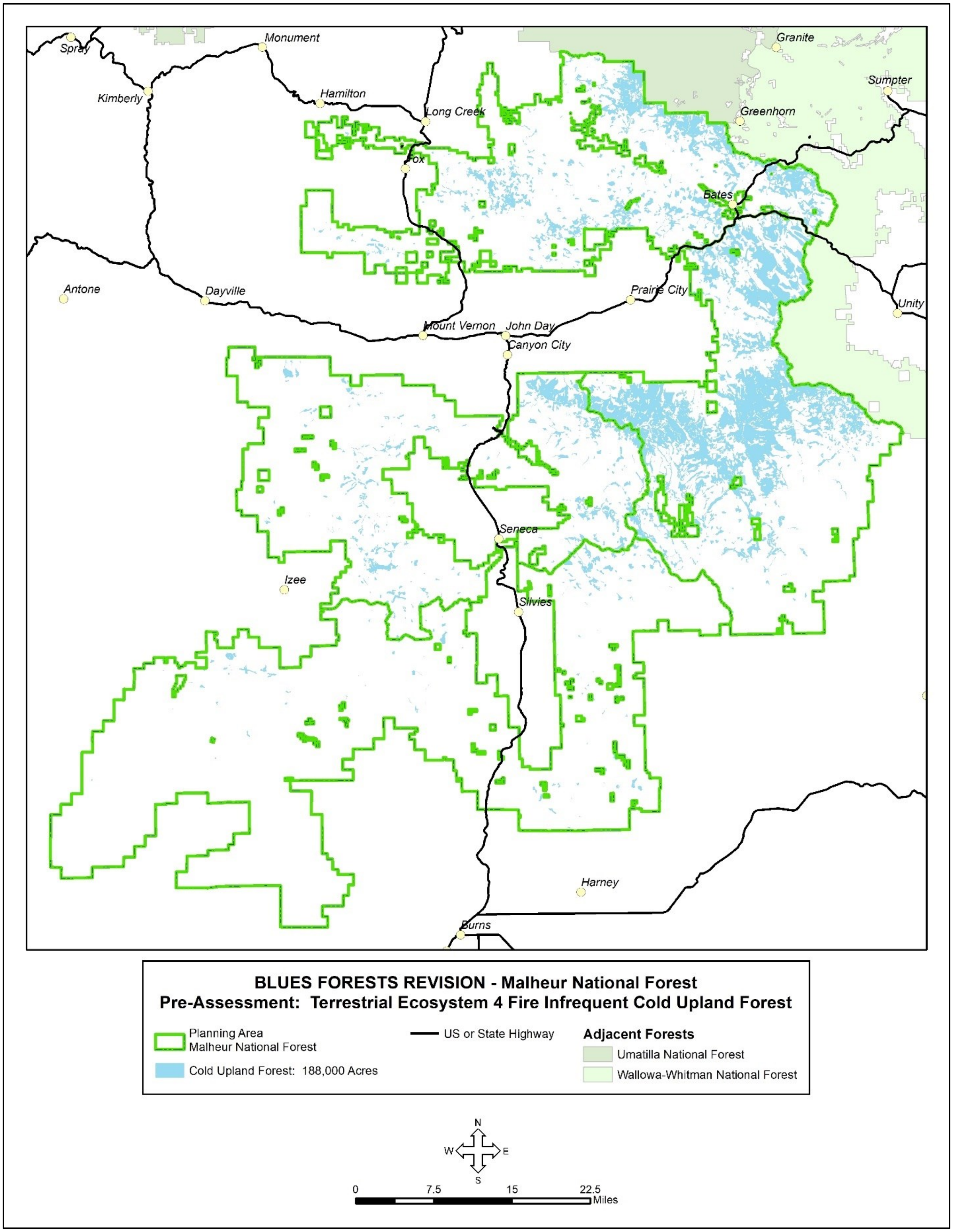

Figure 17- Cold Upland Forest on the Malheur National Forest

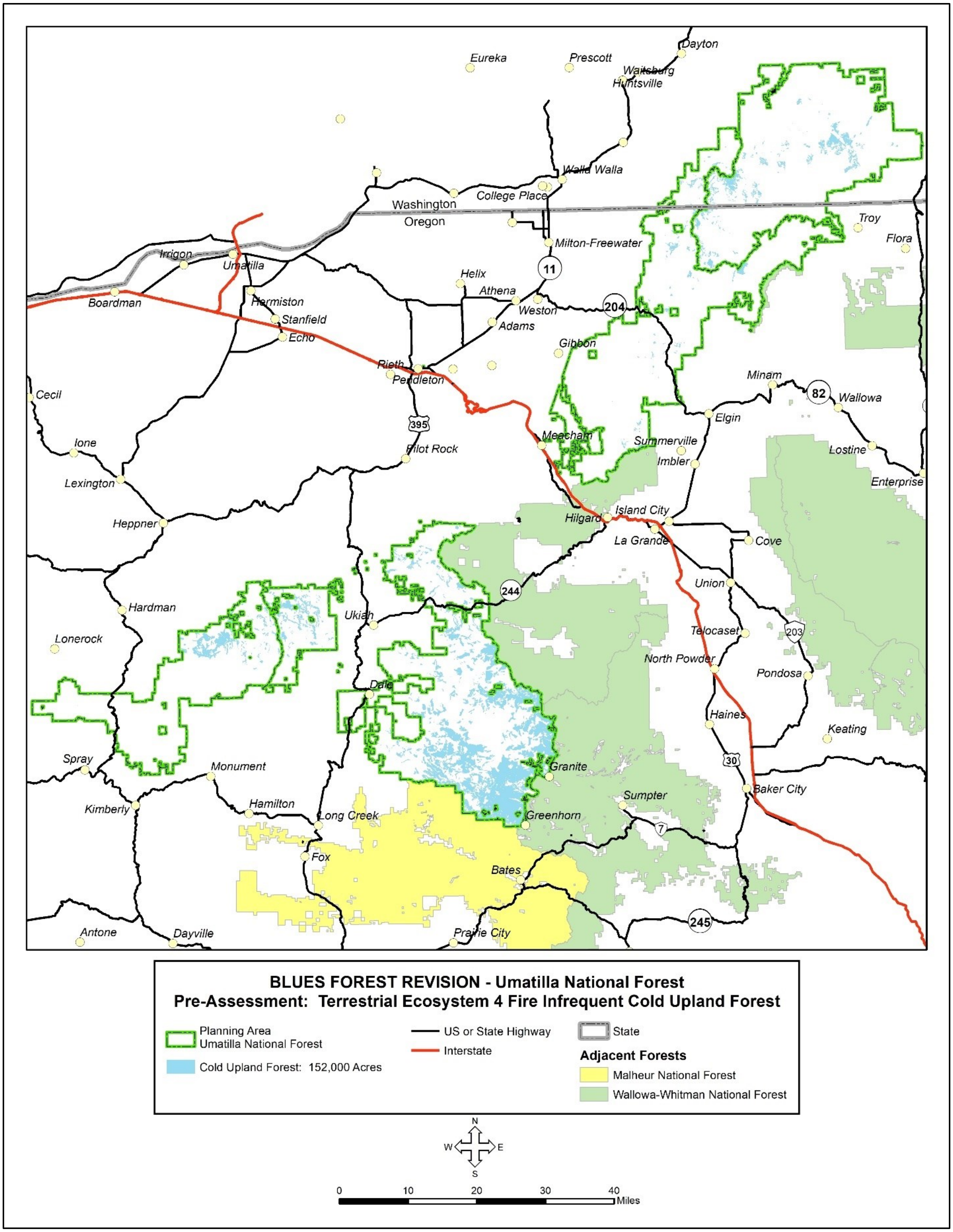

Figure 18- Cold Upland Forest on the Umatilla National Forest

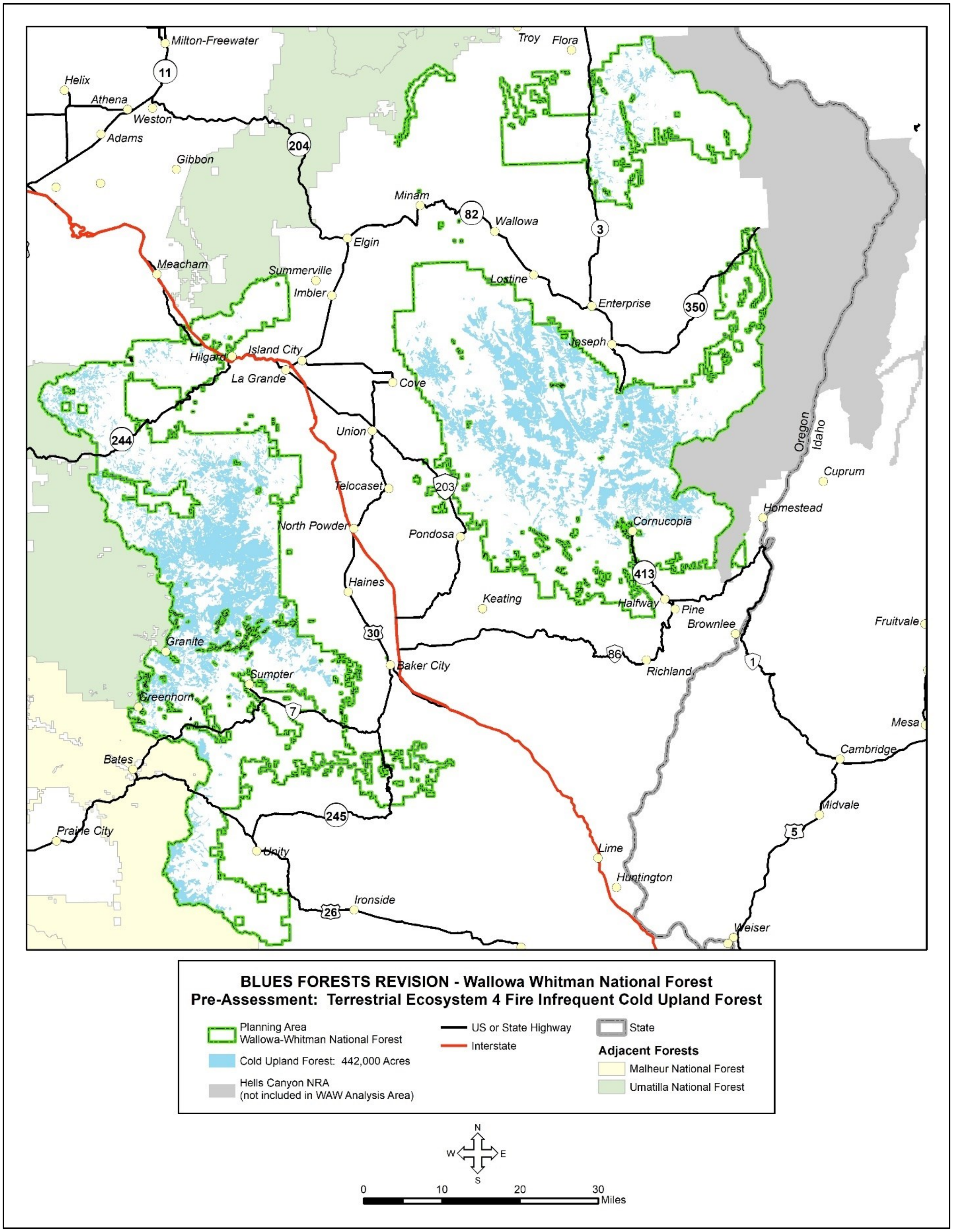

Figure 19- Cold Upland Forest on the Wallowa-Whitman National Forest

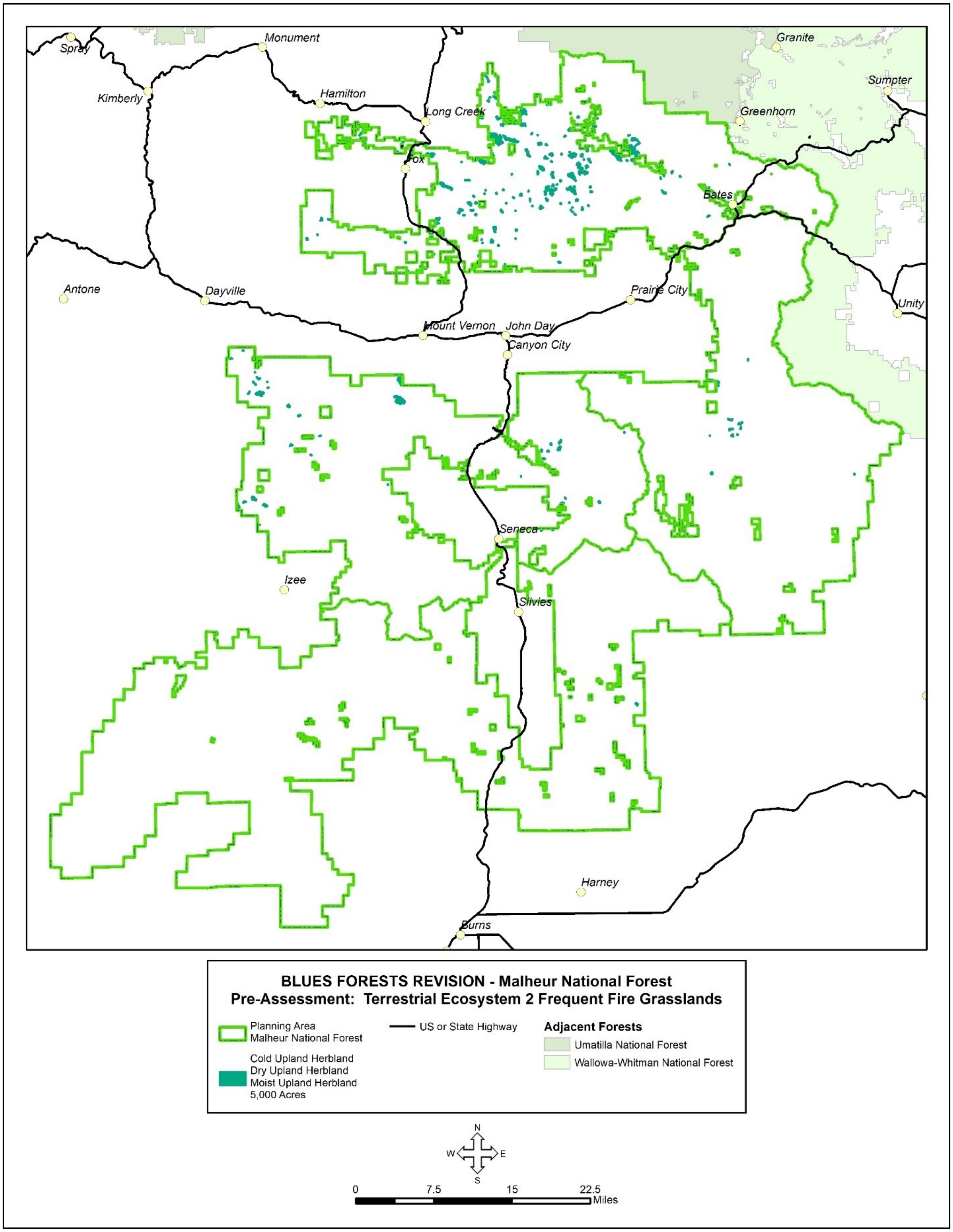

Figure 20- Grasslands on the Malheur National Forest

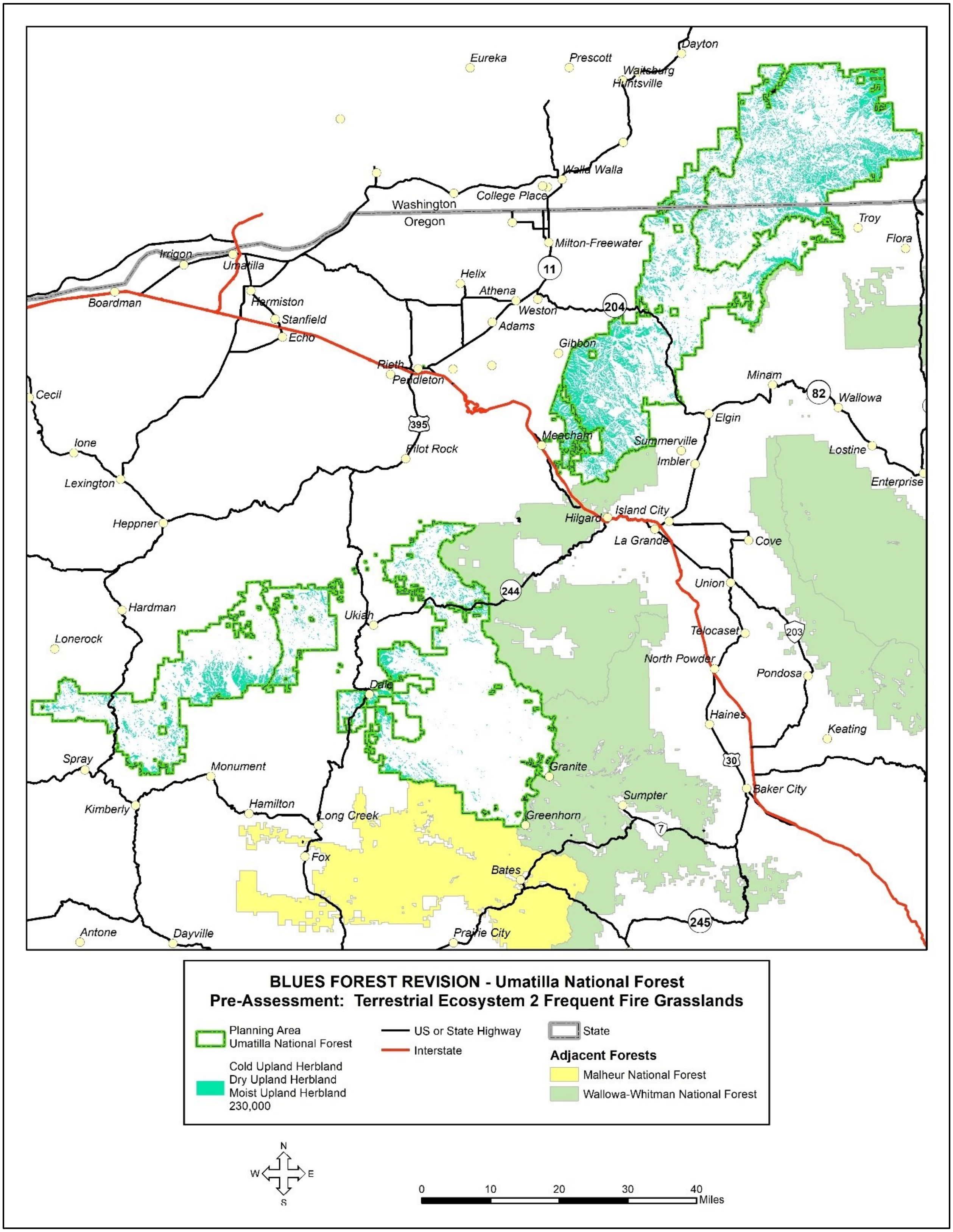

Figure 21- Grasslands on the Umatilla National Forest

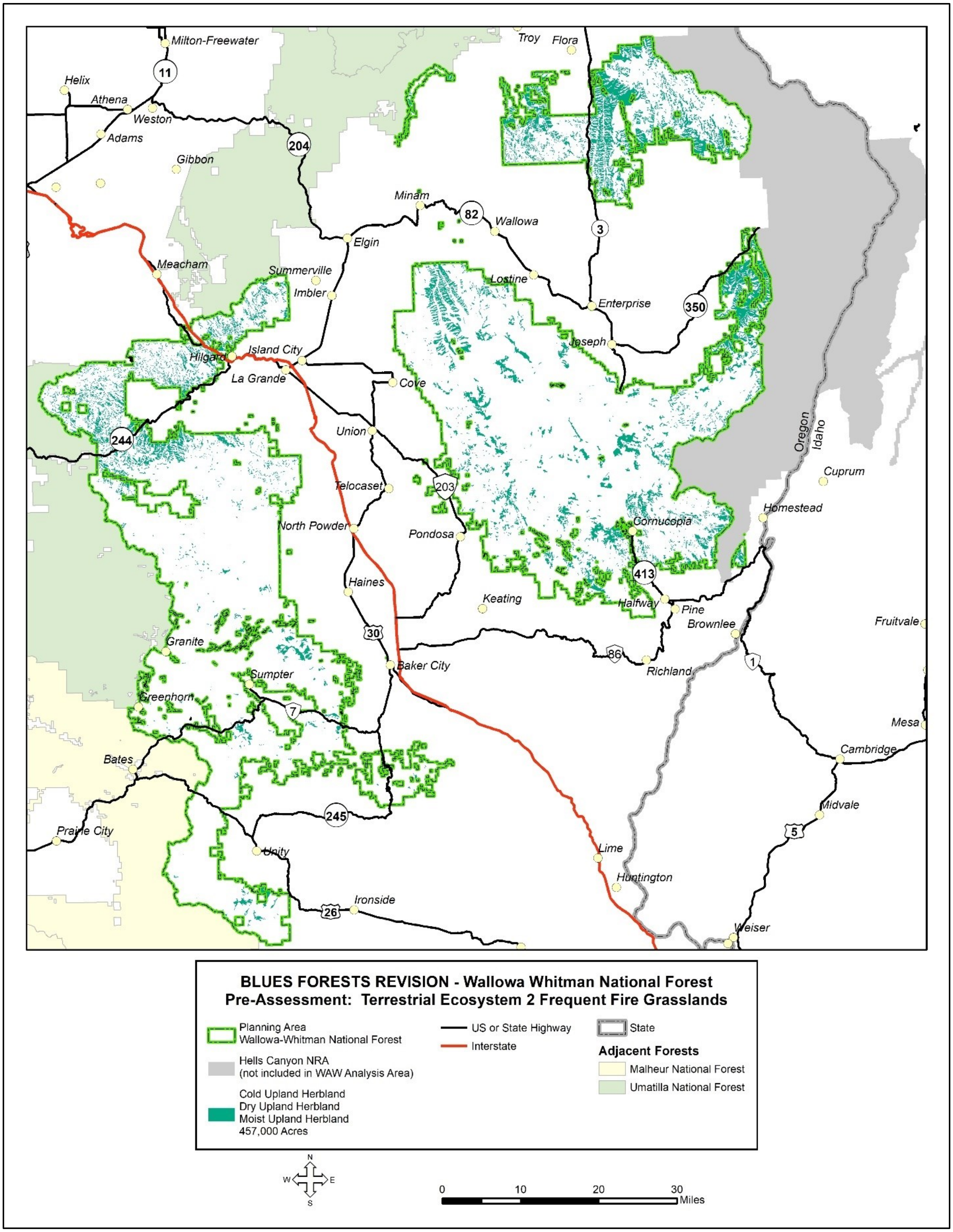

Figure 22- Grasslands on the Wallowa-Whitman National Forest

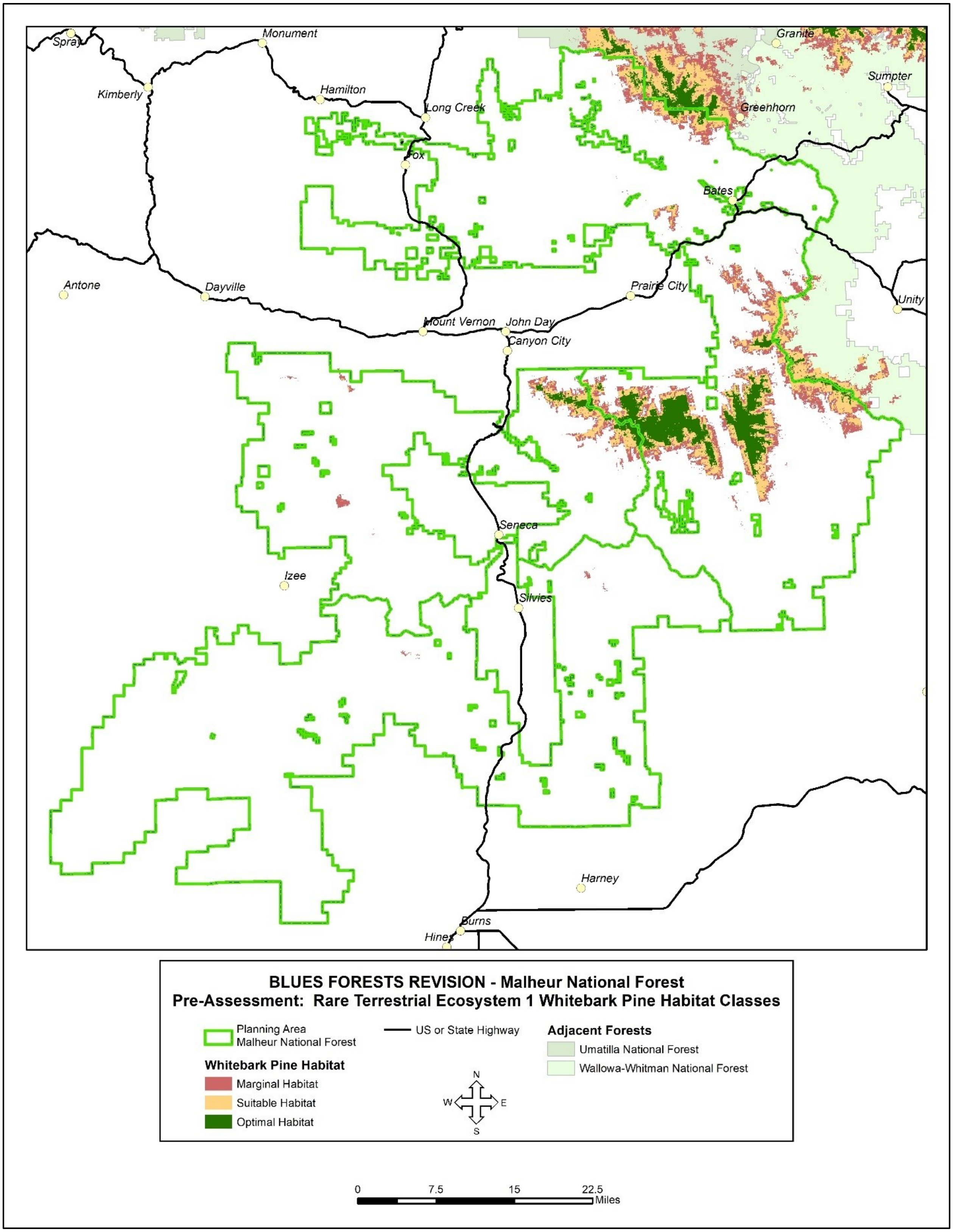

Figure 23- Whitebark pine on the Malheur National Forest

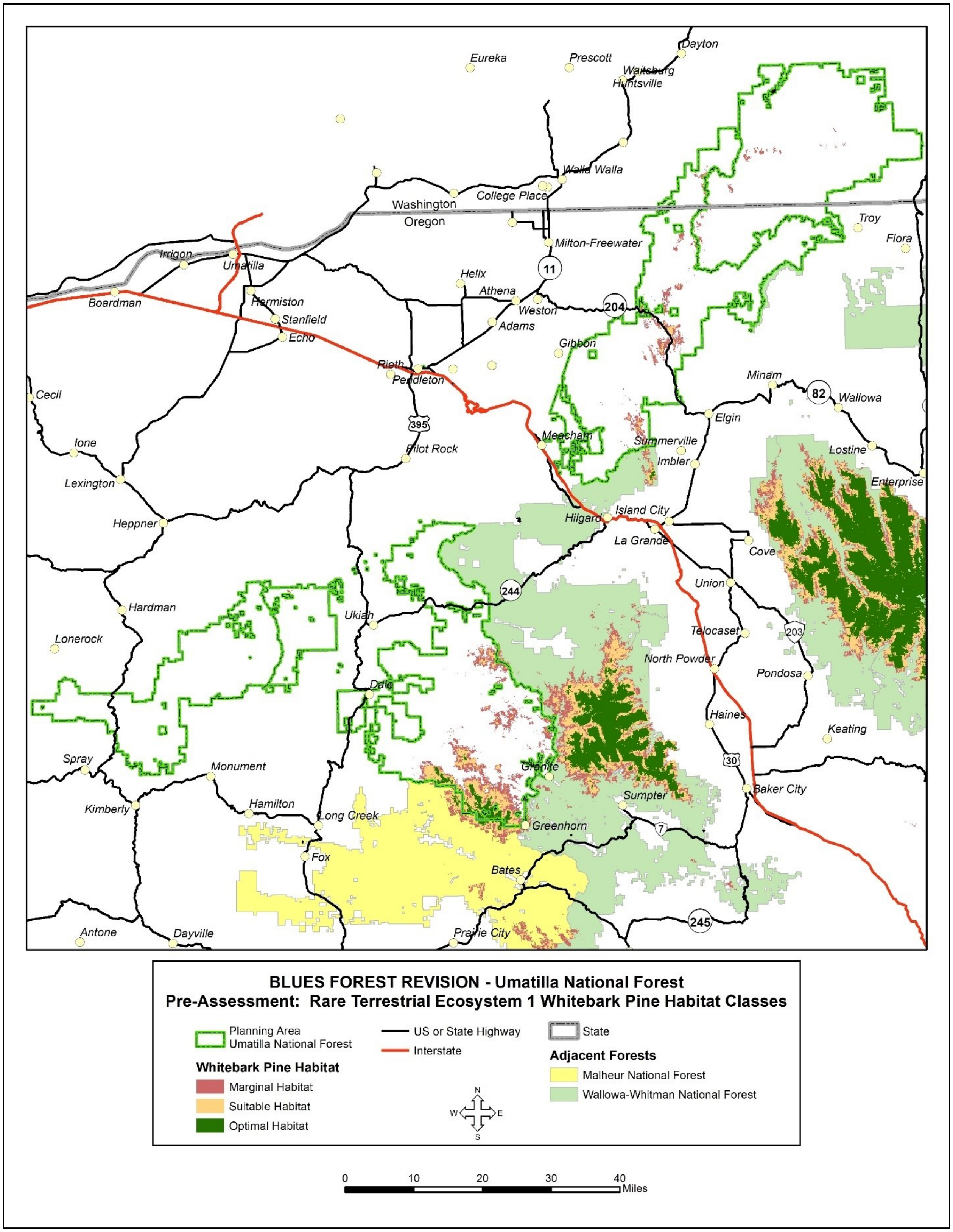

Figure 24- Whitebark pine on the Umatilla National Forest

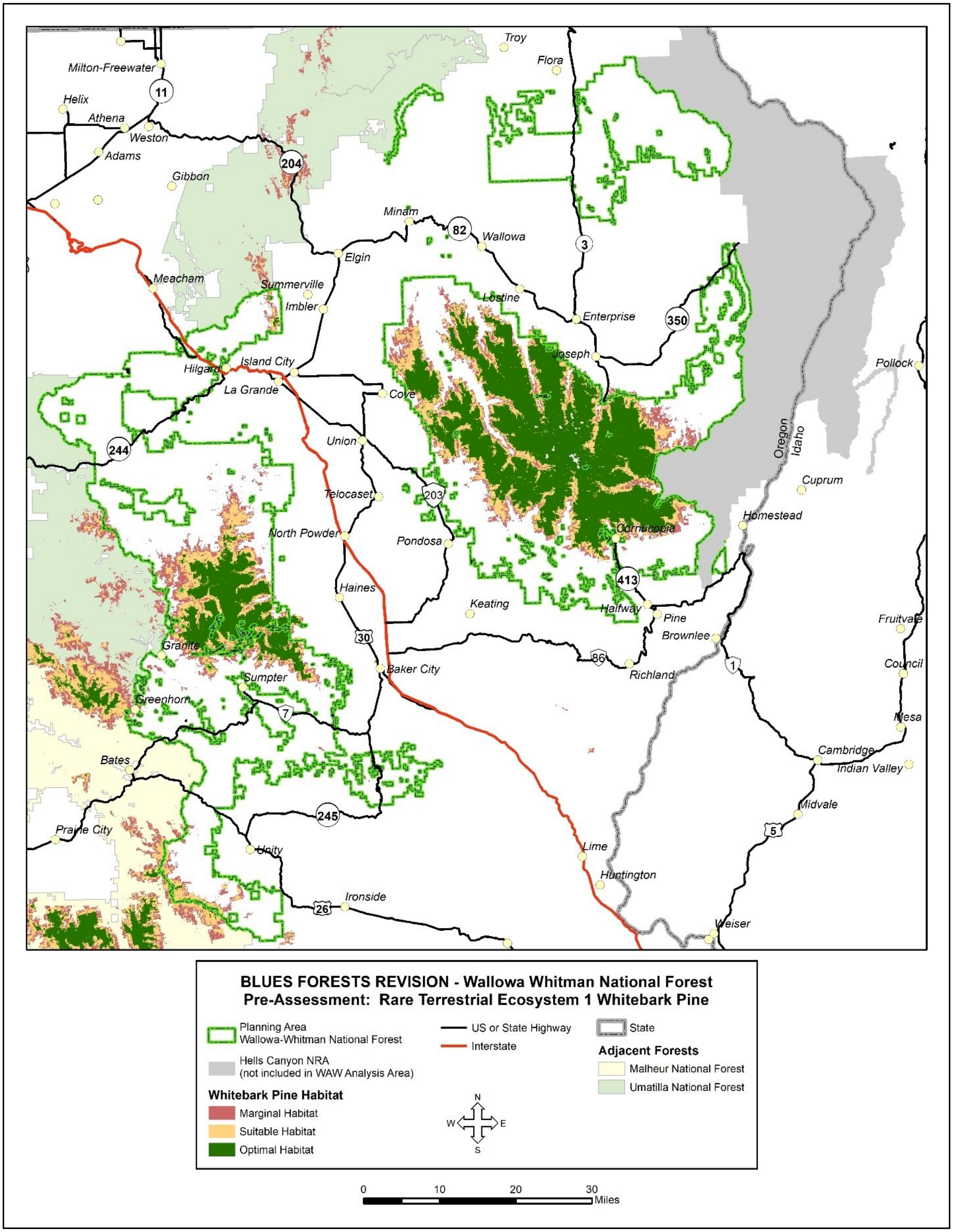

Figure 25- Whitebark pine on the Wallowa-Whitman National Forest

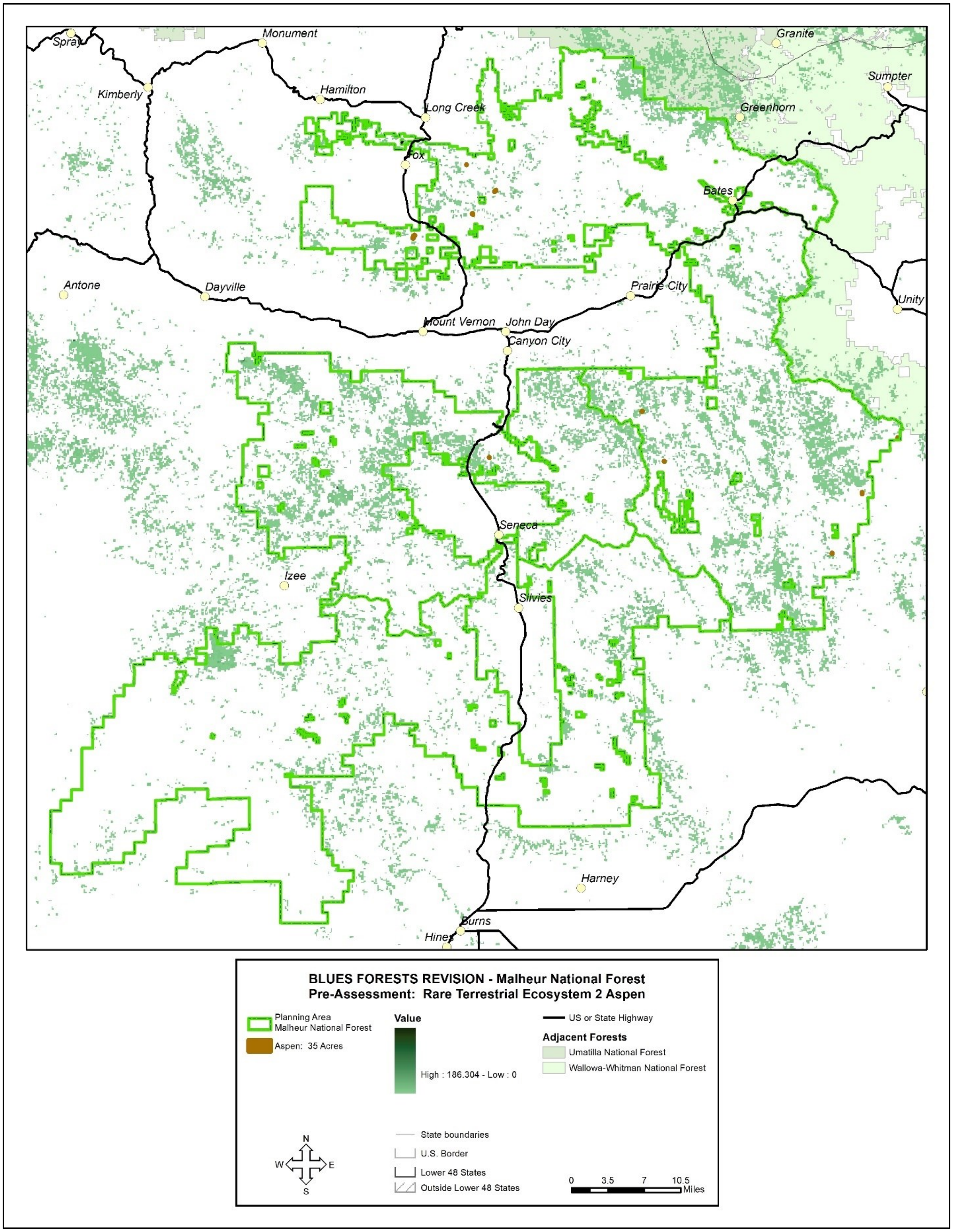

Figure 26- Aspen on the Malheur National Forest

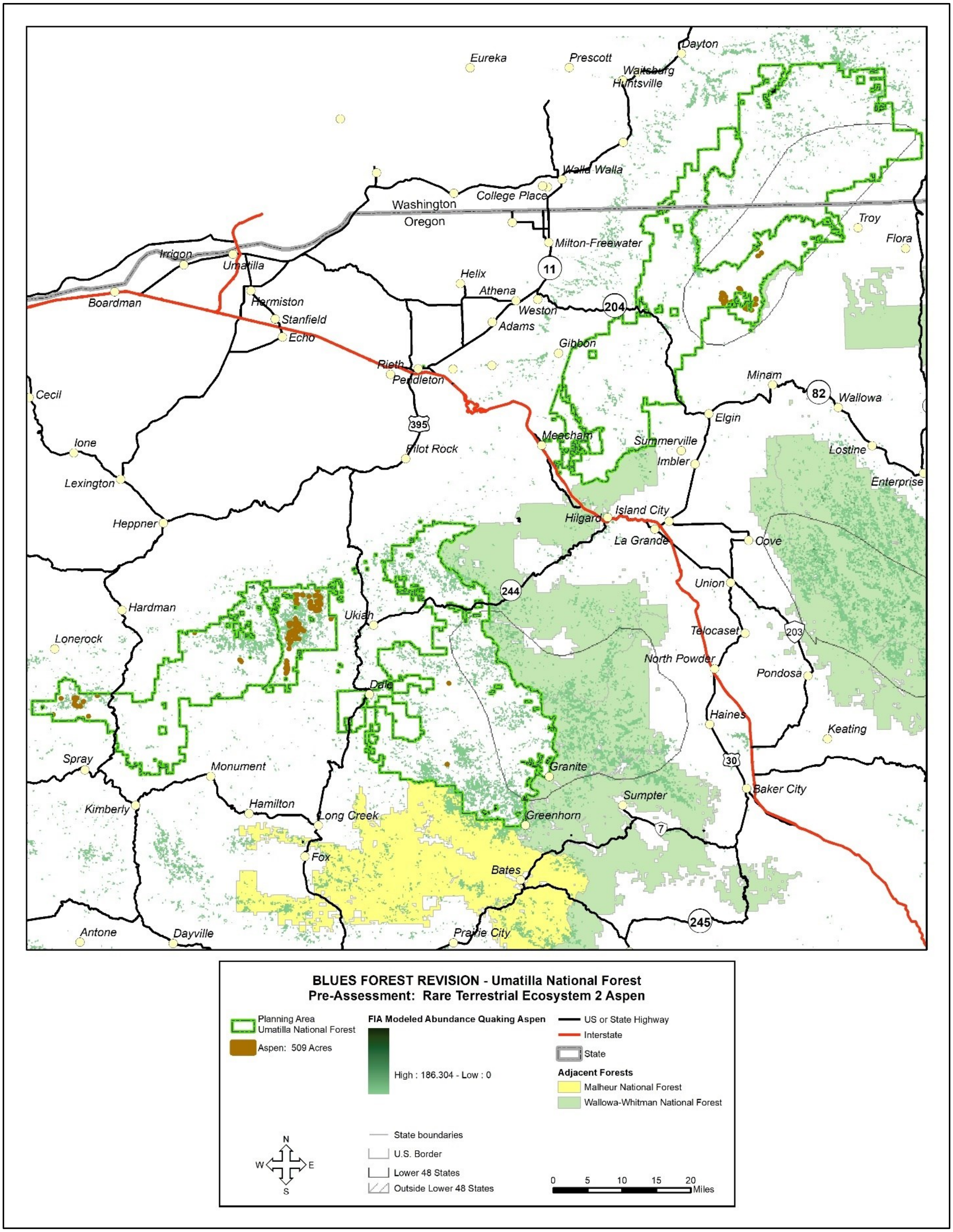

Figure 27- Aspen on the Umatilla National Forest

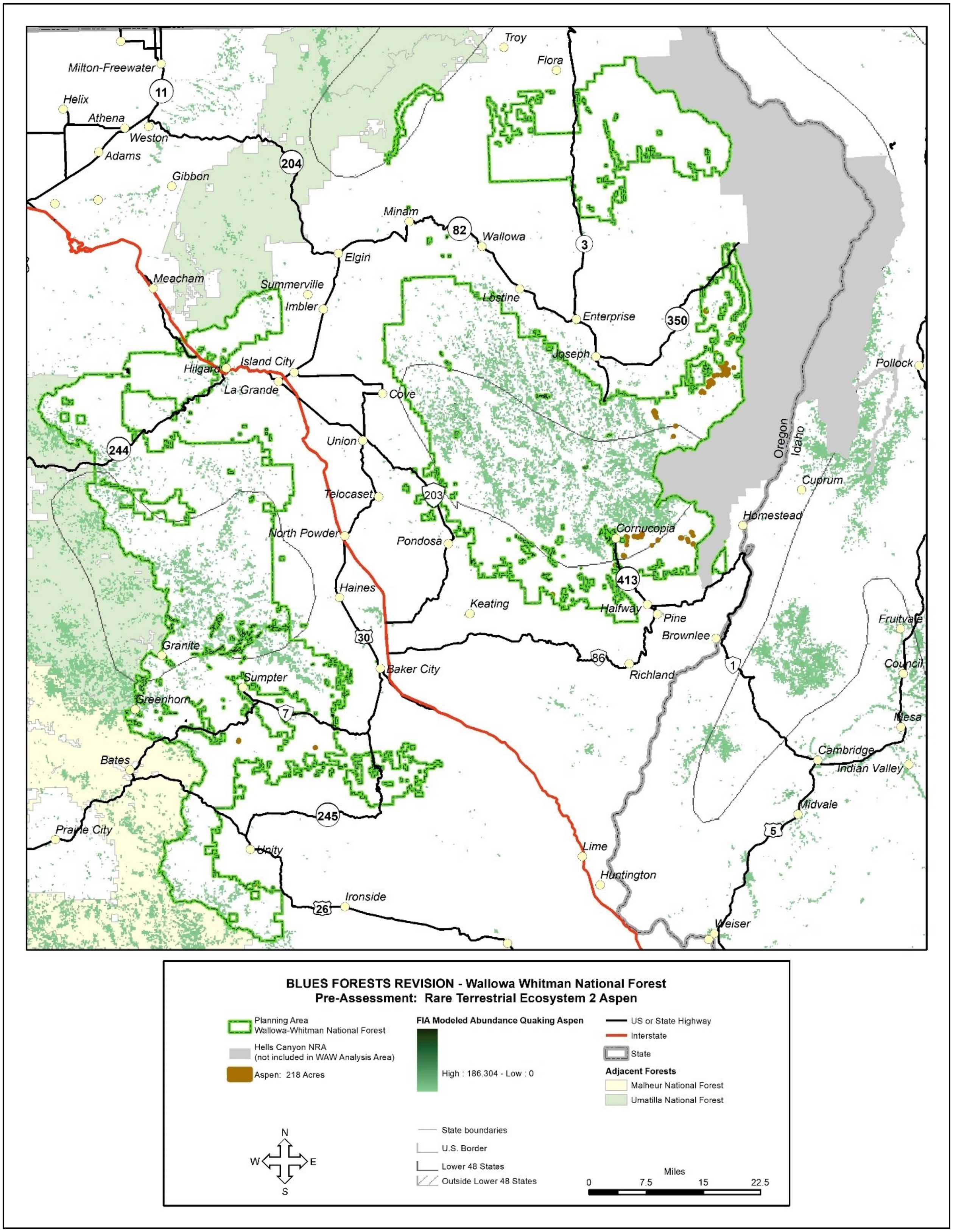

Figure 28- Aspen on the Wallowa-Whitman National Forest

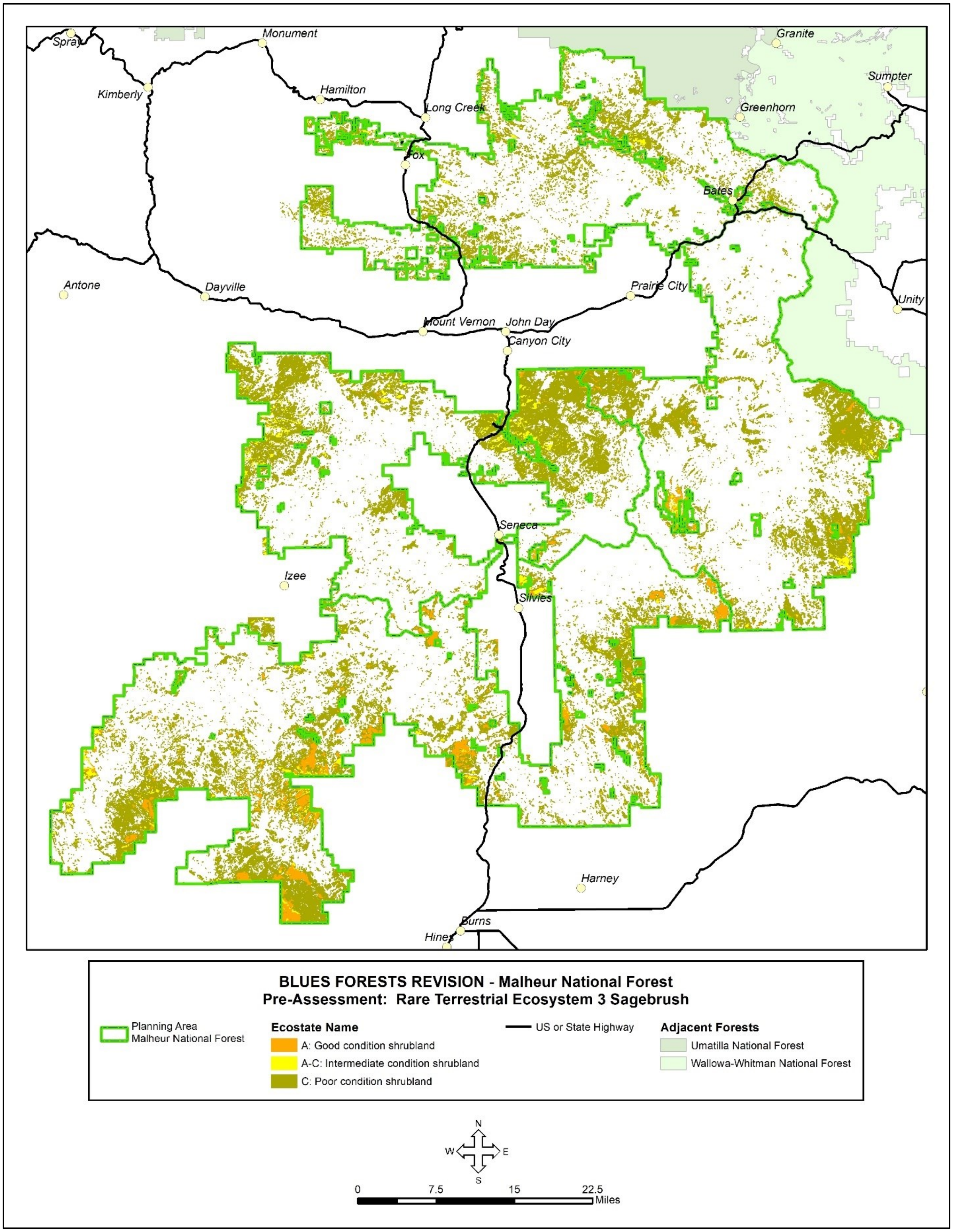

Figure 29- Sagebrush on the Malheur National Forest

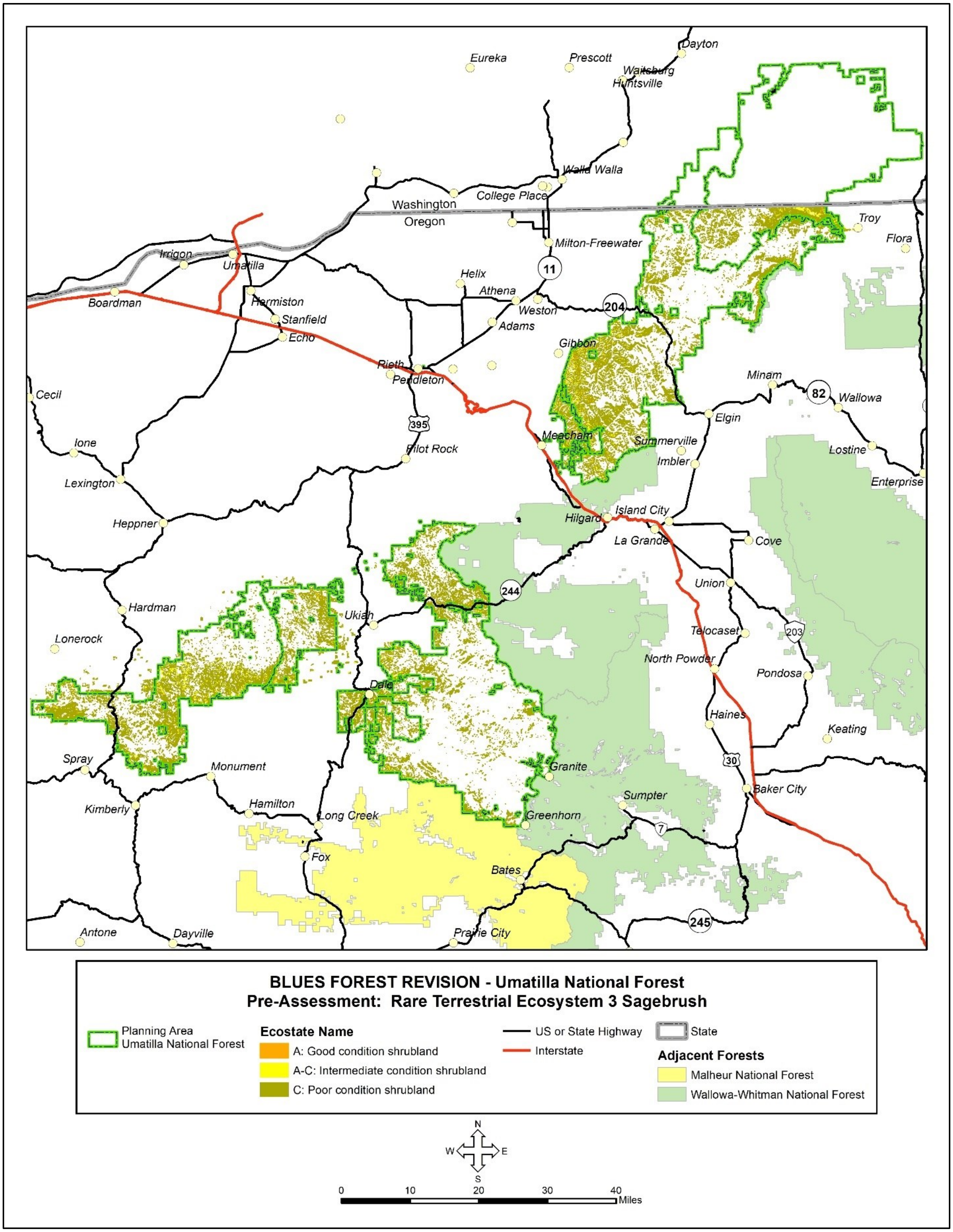

Figure 30- Sagebrush on the Umatilla National Forest

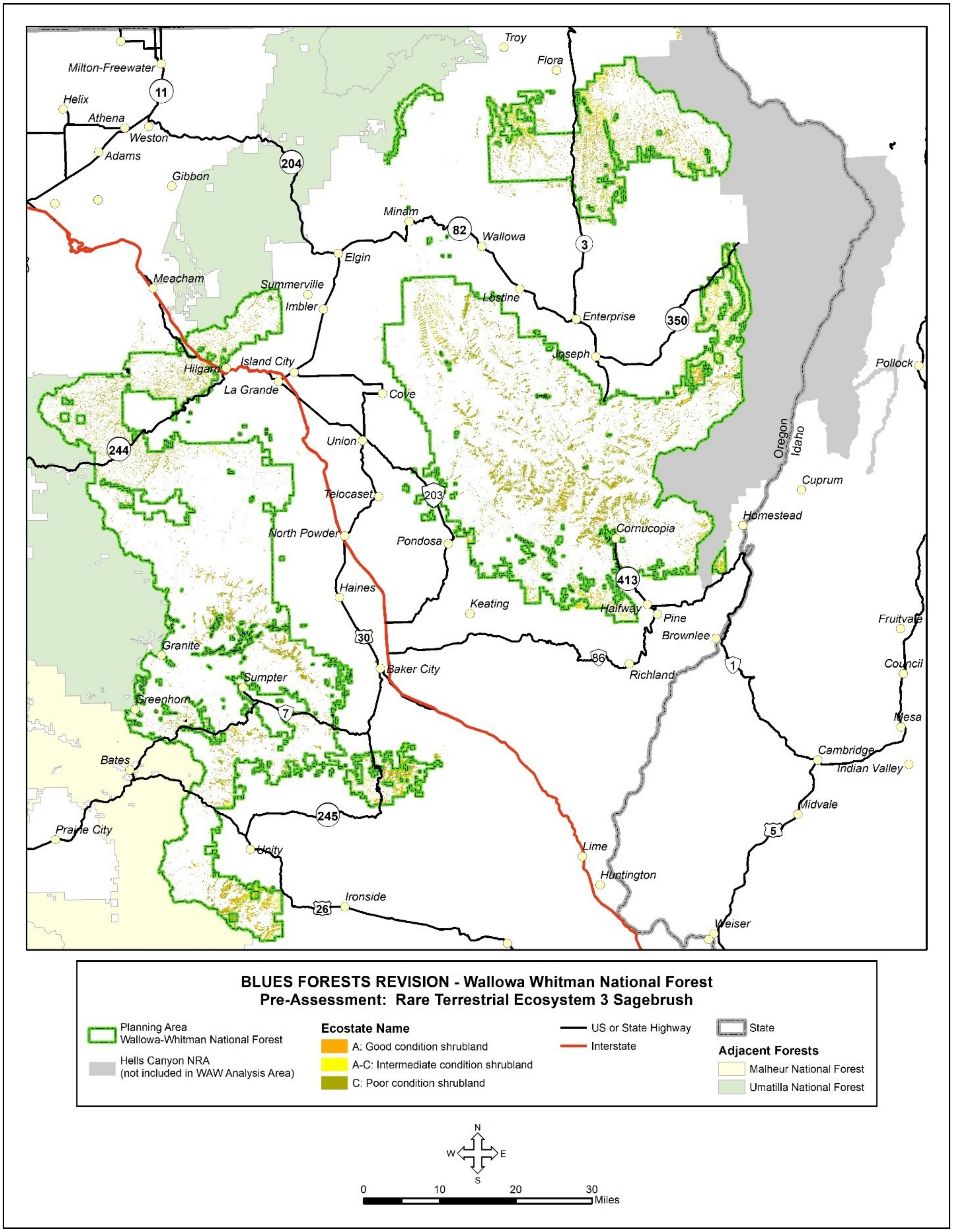

Figure 31- Sagebrush on the Wallowa-Whitman National Forest