WHITE PAPER

USDA Forest Service — Pacific Northwest Region — Umatilla National Forest

**WHITE PAPER F14-SO-WP-SILV-42**

# Life History Traits for Common Blue Mountains Conifer Trees[1]

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## INTRODUCTION

There are two basic philosophies with respect to plant succession – one is based on population or community dynamics, and the other is rooted in interactions between individual plants or species (Huston and Smith 1987).

A community-based model shares many similarities with a relay floristics pattern of plant succession; an individual-based model has much in common with initial floristics (Powell 2000, pages 26-30, provides a discussion about relay and initial floristics).

A community model was favored early in the 20th century, an era when mutualism and inter-species dependence were being emphasized in plant ecology. Beginning with the latter half of the 20th century, succession has been viewed primarily as a plant-by-plant or species-by-species replacement process, and dynamics of plant succession are understandable in those terms.

If we assume that succession, a species-by-species replacement process, is controlled by the life history characteristics of plants making up a community, then understanding these characteristics will help us grasp how succession might progress.

Forest succession, for example, is controlled largely by five traits (life history characteristics) influencing competition among trees: growth rate, size, longevity, rate of seedling establishment, and shade tolerance. These traits have an important bearing on a tree species' capability to compete for site resources collectively referred to as growing space.

[1] White papers are internal reports; they receive only limited review. Viewpoints expressed in this paper are those of the author – they may not represent positions of USDA Forest Service.

There is no such thing, however, as absolute competitive ability, nor any one life history trait that confers competitive superiority for every circumstance – what is important in one situation may have little or no influence in another setting (Huston and Smith 1987).

This white paper reports a wide array of life history characteristics (traits) with important implications for plant succession in forest ecosystems.

It is useful to examine a suite of life history traits because any individual one offers physiological or morphological trade-offs – and trade-offs prevent a species from being optimally adapted to every environment or setting.

An example is intertree competition for sunlight – the most important factor is a tree's position relative to a light source because tall plants have a great advantage over shorter competitors, regardless of their shade tolerances (Huston and Smith 1987).

Where can information about life history traits be found? In addition to a detailed autecological summary prepared by Minore (1979), useful life history information is provided by North America silvics manuals (Burns and Honkala 1990a, b), USDA Forest Service's Fire Effects Information System (Fischer et al. 1996; https://www.feis-crs.org/feis/), and many online database sources such as PLANTS (https://plants.usda.gov).

Table 1 provides common and scientific plant names, and life history traits, for 10 common conifer species found in the Blue Mountains section (e.g., Blue Mountains physiographic province or ecoregion). It reports a total of 34 life history traits for 10 trees, although information for every trait is not necessarily available for every species. When species-specific information is unavailable for a life history trait, then the corresponding species cell in table 1 is blank.

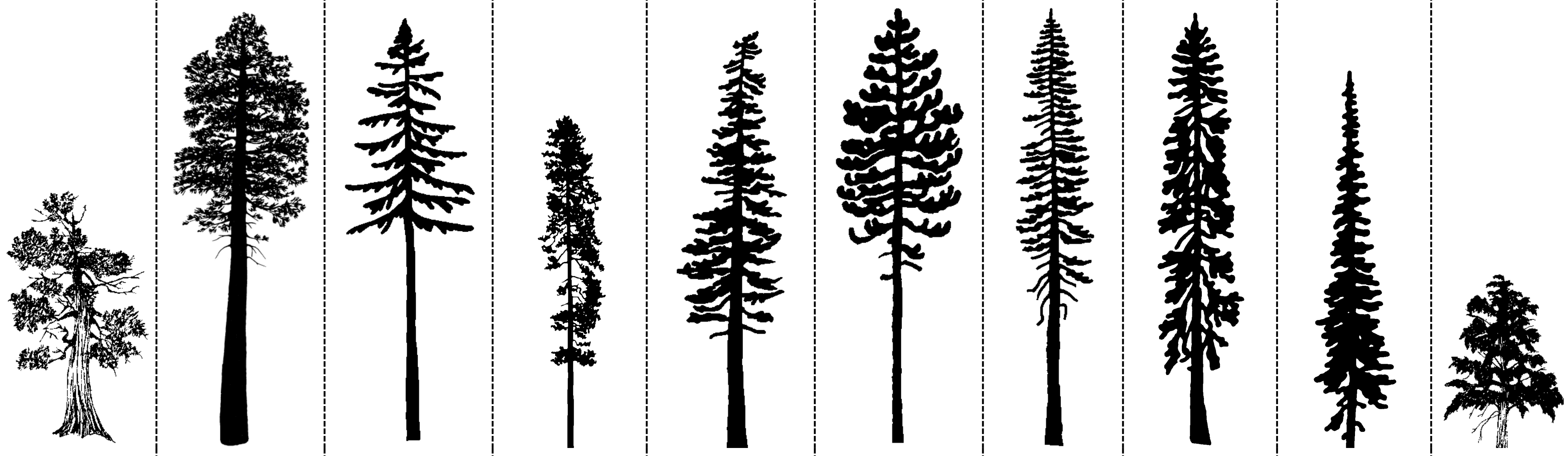
An important indicator of a species' competitive ability is its distribution (range) within a geographical area. For this reason, one life-history trait included in table 1 is geographical distribution of tree species in the Blue Mountains section.

To examine the geographical distribution trait more closely, tree-range maps prepared by USDA Forest Service chief dendrologist, Elbert L. Little, Jr., published in a series of tree atlases in the 1970s, and digitized by US Geological Survey, were 'clipped' to the boundary of the Blue Mountains section in a geographical information system process.

The 'clipped' maps depict ranges for 35 tree and tall shrub species of the Blue Mountains; 16 of the maps (excluding tall shrubs, but including broadleaf trees) are provided in this white paper, in a GIS layout format, as appendix 1.

Just because a tree species is widely distributed across the Blue Mountains does not ensure it is competitively superior in all or part of this range. A wide distribution does suggest, however, that a species may have more ecological amplitude than trees with a limited distribution in the Blues, or that its genetic fitness allows it to occupy a wider spectrum of ecological or environmental settings (niches).

**Table 1:** Life history traits for common conifer trees of the Blue Mountains; Species are ordered from warm dry (left) to cool moist (right) habitats, and drawings are in approximate scale to relative tree height.



| | Western Juniper | Ponderosa Pine | Western Larch | Lodgepole Pine | Interior Douglas-fir | Western White Pine | Grand Fir | Engelmann Spruce | Subalpine Fir | Pacific Yew |
|---|---|---|---|---|---|---|---|---|---|---|
| **Scientific Name** | *Juniperus occidentalis* | *Pinus ponderosa* | *Larix occidentalis* | *Pinus contorta* | *Pseudotsuga menziesii glauca* | *Pinus monticola* | *Abies grandis* | *Picea engelmannii* | *Abies lasiocarpa* | *Taxus brevifolia* |
| **Shade Tolerance[1]** | Intolerant | Intolerant | Very intolerant | Intolerant | Intermediate | Intermediate | Tolerant | Tolerant | Very tolerant | Very tolerant |
| **Seral Status[1]** | Early | Early | Early | Early | Mid | Mid | Mid/Late | Mid/Late | Late | Late |
| **Typical Longevity[1]** | 300 years | 300 years | 300 years | 100 years | 200 years | 400 years | 200 years | 250 years | 150 years | 250 years |
| **Maximum Longevity[1]** | 1000 years | 650 years | 450 years | 220 years | 400 years | 600 years | 350 years | 350 years | 230 years | 350+ years |
| **Maximum Height[2]** | 73 feet | 192 feet | 192 feet | 120 feet | 180 feet | 200 feet | 204 feet | 207 feet | 153 feet | 39 feet |

| | Western Juniper | Ponderosa Pine | Western Larch | Lodgepole Pine | Interior Douglas-fir | Western White Pine | Grand Fir | Engelmann Spruce | Subalpine Fir | Pacific Yew |
|---|---|---|---|---|---|---|---|---|---|---|
| **Maximum Diameter[2]** | 61 inches | 70 inches | 68 inches | 42 inches | 80 inches | 63 inches | 82 inches | 68 inches | 46 inches | 22 inches |
| **Geographic Distribution[7]** | Widespread (mostly south) | Widespread | Moderate (throughout) | Low to Mod. (throughout) | Widespread (throughout) | Sparse (throughout) | Low to Mod. (mostly north) | Low (mostly north) | Low (all north BM) | Very Low (all north) |
| **Root Disease Susceptibility[1]** | Low | Moderate | Low | Moderate | High | Moderate | High | Moderate | Moderate | Low |
| **Stem Decay Susceptibility[1]** | Low | Low | Low | Low | Moderate | Moderate | High | Moderate | High | Moderate |
| **Frost Tolerance[1]** | Low | Low | Moderate | High | Low | High | Moderate | High | Moderate | Moderate |
| **Drought Tolerance[1]** | High | High | Moderate | Moderate | Moderate | Moderate | Moderate | Low | Low | Low |
| **Snow Damage Susceptibility[1]** | Low | Low | Moderate | Moderate | Low | Moderate | Moderate | High | High | High |
| **Outer Bark Thickness[3]** | Thin to Moderate | Very thick (.574") | Thick (.466") | Thin (.188") | Moderate (.393") | Moderate (.378") | Very thin (.097") | Thin (.108") | Very thin | |
| **Rooting Habit[3]** | Shallow to Medium | Deep | Deep | Medium | Deep | Medium | Shallow | Shallow | Shallow | |
| **Bark Resin (Old Bark)[3]** | Very little | Abundant | Very little | Abundant | Moderate | Abundant | Very little | Moderate | Moderate | |
| **Branching Habit[3]** | Low & dense | Moderately high & open | High & very open | Moderately high & open | Moderately low & dense | High & dense | Low & dense | Low & dense | Very low & dense | |
| **Foliage Flammability[3]** | Low to Medium | Medium | Low | Medium | High | Medium | High | Medium | High | |
| **Overall Fire Resistance[3]** | Low to Medium | High | Very high | Low | Medium to High | Medium | Medium to Low | Low | Very low | Low |
| **Fire Survival Strategy[4]** | Avoider | Resister | Resister | Evader | Resister | Resister | Avoider | Avoider | Avoider | Avoider |

| | Western Juniper | Ponderosa Pine | Western Larch | Lodgepole Pine | Interior Douglas-fir | Western White Pine | Grand Fir | Engelmann Spruce | Subalpine Fir | Pacific Yew |
|---|---|---|---|---|---|---|---|---|---|---|
| **Min. Photosynthesis Temp.[1]** | | 30.2° F | 26.6° F | 23.0° F | 28.4° F | 30.2° F | 30.2° F | 24.8° F | 19.4° F | |
| **Maximum Leaf Area Index[1]** | | 8 | 6 | 7 | 10 | 8 | 12 | 12 | 12 | |
| **Leaf Retention Time (Years)[1]** | | 3 | 1 | 3 | 5 | 3 | 6 | 6 | 6 | |
| **Leaf Area to Sapwood Area Ratio[1]** | 180 | 250 | | 150 | 250 | | 480 | 350 | 750 | |
| **Relative Wood Density[1]** | | .51 | .55 | .41 | .43 | .34 | .45 | .34 | .40 | .55 |
| **Foliage Nitrogen Concentration[5]** | | .57 | .43 | .59 | .60 | .54 | .58 | .54 | .61 | |
| **Foliage Phosphorus Concentration[5]** | | .09 | .21 | .04 | .13 | .07 | .09 | .08 | .10 | |
| **Foliage Potassium Concentration[5]** | | .31 | .35 | .20 | .49 | .22 | .33 | .26 | .26 | |
| **Foliage Calcium Concentration[5]** | | .43 | .49 | .64 | 1.57 | .74 | 2.45 | 1.29 | 1.24 | |
| **Periodicity of Good Seed Crop[1]** | 1-2 years | 3-10 years | 3-5 years | 1-2 years | 3-10 years | 3-5 years | 3-5 years | 2-6 years | 2-3 years | |
| **Minimum Reproductive Age[1]** | | 20 years | 15 years | 15 years | 20 years | 15 years | 15 years | 25 years | 25 years | |
| **Seed Weight (Seeds/Pound)[1]** | 12,247 | 11,975 | 136,078 | 93,894 | 43,545 | 26,989 | 22,680 | 136,078 | 34,473 | |
| **Seed Dispersal Distance[1]** | | 100-120 feet | 120-150 feet | 200 feet | 300-330 feet | 400 feet | 200 feet | 100-120 feet | 50-100 feet | |
| **Seed Germination on Ash Surface[1]** | | Increased | No Effect | No Effect | Increased | Increased | Increased | Reduced | | |

| | Western Juniper | Ponderosa Pine | Western Larch | Lodgepole Pine | Interior Douglas-fir | Western White Pine | Grand Fir | Engelmann Spruce | Subalpine Fir | Pacific Yew |
|---|---|---|---|---|---|---|---|---|---|---|
| **Heat/Fuel Value[6]** | Moderate | Low/Moderate | Moderate/High | Low | Moderate | Low/Moderate | Low | Low | Low | Moderate |

Sources/Notes:

Information in table 1 was originally compiled in October 2004 by David C. Powell, and revised in May 2010. Sources, including literature citations, are provided by endnote references for each item.

[1] Taken from "Appendix 2: Life History Information" in Powell (2000). Refer to that document for additional literature citations relating to a trait's rating.

[2] Taken from Big-Tree Program for Umatilla National Forest; see white paper F14-SO-WP-Silv-01: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3794771.pdf

[3] Fire resistance ratings were adapted from Flint (1925), Klinka et al. (2000), Starker (1934), and Fire Effects Information System (Fischer et al. 1996); outer bark thickness values, in inches, were taken from Smith and Kozak (1971).

[4] Fire survival strategy is based on a classification by J.S. Rowe, a Canadian ecologist (Rowe 1983). Plants have specific functional adaptations to deal with fire, and Rowe distinguished five primary strategies after studying boreal forests:

**Invader:** these plant species are early arrivers, and they depend on copious amounts of light, wind-disseminated seed to invade a fire from areas outside of it (fireweed and Scouler willow are good examples of the invader group).

**Evader:** these plant species store seeds in the canopy, humus, or mineral soil to avoid high fire temperatures, and they respond to fire with rapid seed germination and establishment. Parent plants are generally killed by fire, so evader species persist by producing a new generation from an onsite seed bank. Common examples are snowbrush ceanothus (regenerates from a soil seed bank), and lodgepole pine (regenerates from a canopy seed bank stored in serotinous cones).

**Avoider:** these plant species arrive late in plant succession, and they prosper where fire cycles are relatively long (such as fire regimes 3 and 4). They essentially lack effective adaptations to either survive a fire, or to regenerate quickly after one. Avoiders generally include late-seral, shade-tolerant species found in old forests that haven't been disturbed for a long time. For the Blue Mountains, tree species that consistently function as avoiders are Engelmann spruce and subalpine fir. Grand fir is often an avoider, but when it grows on dry-forest sites in fire regime 1, it can function as a resister if it escapes or survives fire long enough to become large and thick-barked. [Note that some species – grand fir is a good example – have relatively wide ecological amplitude, which means they can function in an ecologically different way from one biophysical setting to another].

**Resister:** these plants tend to be early-seral, shade-intolerant species with effective adaptations for surviving low-severity fire (such as surface fire with a flame length of three feet or less). Good examples of resisters are thick-barked species with high crowns, such as ponderosa pine and western larch, because these life history traits protect a stem from damage (thick bark) and elevate an individual tree's flammable tissues (foliage) well above flames (high crown). Douglas-fir and western white pine are mid-seral species with relatively low fire tolerance when young (they are avoiders in this stage of their development), but older Dougs and white pines are reasonably good resisters because their bark is thick, and their crowns are well elevated.

**Endurer:** these plant species handle fire by resprouting after it occurs; fire consumes or kills the above-ground portion of the plant, but they promptly revegetate by sprouting from their root system, root collar, rhizomes, or other below-ground organs protected from heat damage. A good example for this group is quaking aspen: it is a clonal tree species with very low fire resistance (for existing stems), but it easily survives fire by sprouting prolifically from the root system (using vegetative shoots called suckers).

[5] Taken from Daubenmire (1953).

[6] Taken from: http://egov.oregon.gov/ODA/MSD/fuel_facts.shtml

[7] Ratings are based on digital representations of tree species range maps, as clipped to geographical extent of Blue Mountains section (US Geological Survey 1999). Appendix A provides these maps.

## APPENDIX 1: RANGE MAPS FOR TREE SPECIES OF BLUE MOUNTAINS

United States Geological Survey digitized range maps for tree species of the United States for use with climate modeling studies (US Geological Survey 1999).

United States Forest Service originally published tree range maps in a series of books authored by its chief dendrologist, Elbert L. Little, Jr. (Critchfield and Little 1966; Little 1971, 1976). Literature citations for tree-range books are included in a References section.

Digitized tree-range maps are available in an ArcGIS format (US Geological Survey 1999). For display purposes, range maps were ‘clipped’ to the boundary of the Blue Mountains section.

In this appendix, tree-range maps for the Blue Mountains section are formatted in a consistent GIS-generated layout for display purposes.

Note that ‘section’ is one level in an eight-level national hierarchy of terrestrial ecological units. The Blue Mountains are a section (M332G) in a large and wide-ranging province (M332) called “middle Rocky Mountain steppe – coniferous forest – alpine meadow.” Province M332 includes 7 sections; Blue Mountains is the westernmost of these sections.

Most, but not all, of the national forest lands in northeastern Oregon and southeastern Washington occur in the Blue Mountains section (note that a small portion of the Umatilla National Forest occurs in the lower Columbia River basin portion of province 342 – Intermountain Semi-Desert).

Blue Mountains section has a southwest to northeast orientation, ranging from Ochoco Mountains in central Oregon to Seven Devils Mountains in west-central Idaho. Bailey (1998), and McNab and Avers (1994), in a References section describe a national hierarchy of terrestrial ecological units in more detail.

# Tree Species of the Blue Mountains Section

**Bitter Cherry**

*Prunus emarginata**

Blue Mountains Ecoregion**

State Boundaries

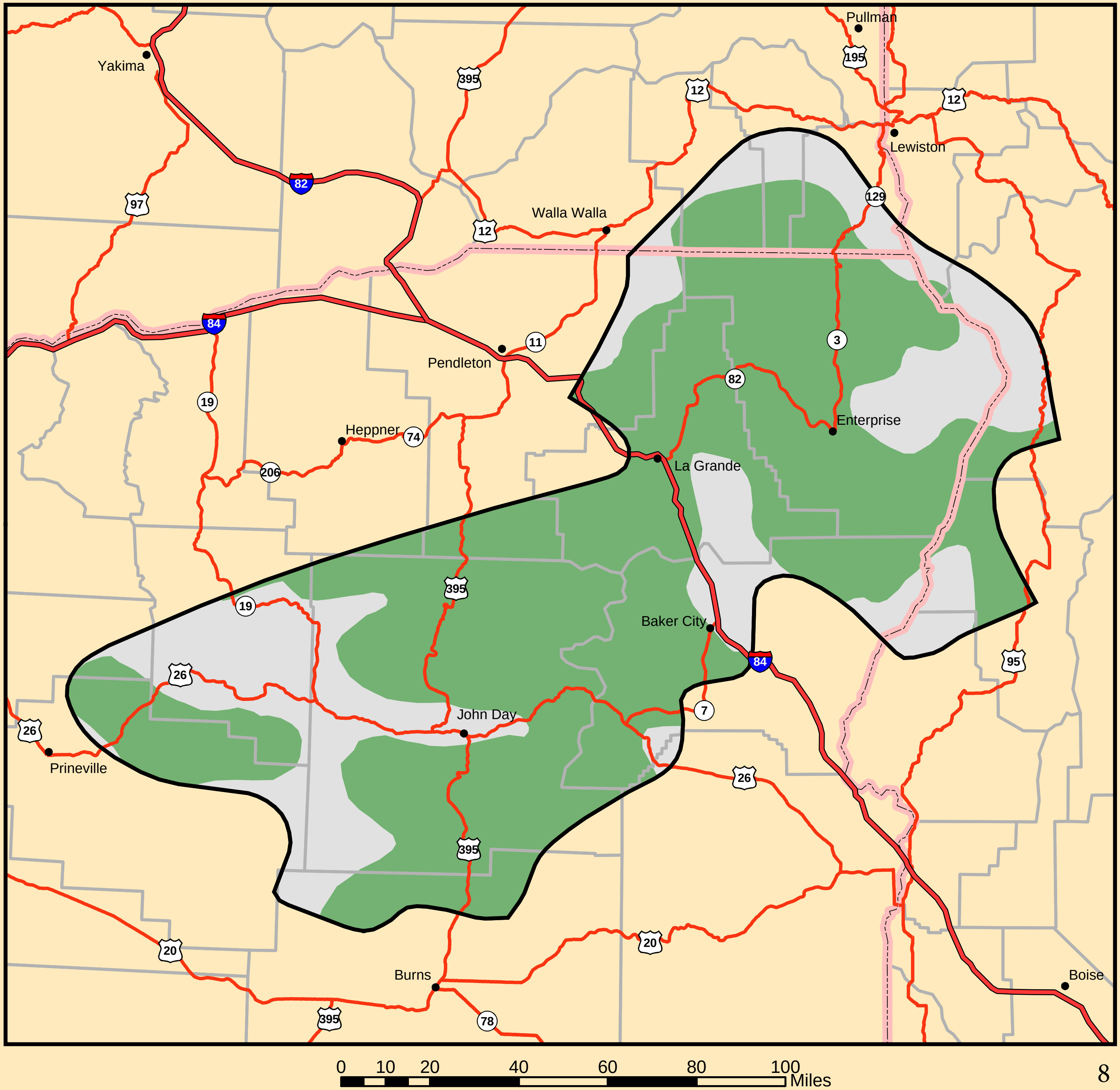
County Boundaries

Interstate Highways

US/State Routes

* Representations of Tree Species Range Maps from "Atlas of United States Trees" by Elbert L. Little, Jr. (1966-1977)

** Bailey's Ecoregion M332G




## Vicinity Map

# Tree Species of the Blue Mountains Section

**Black Cottonwood**

*Populus trichocarpa**

Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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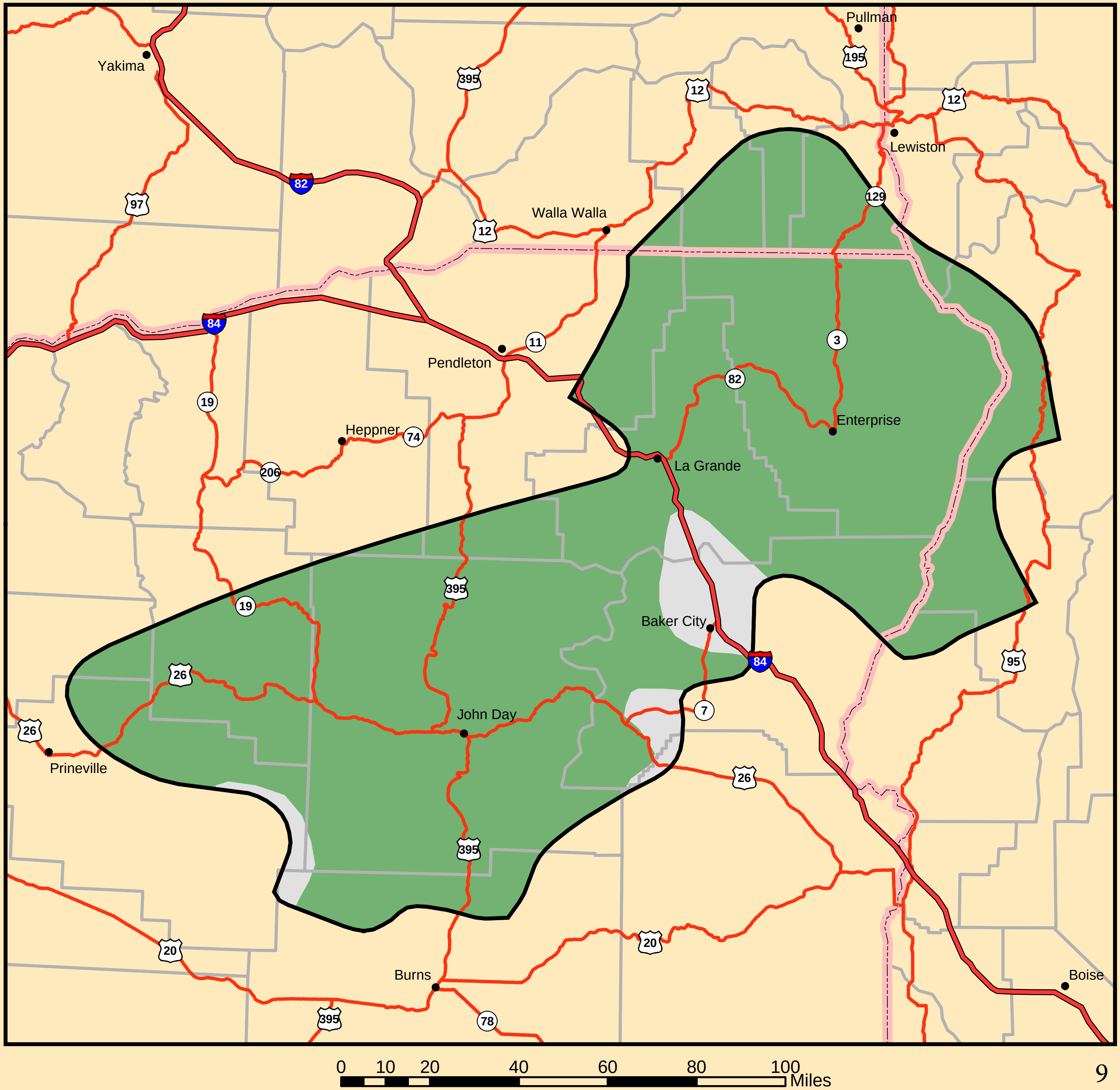
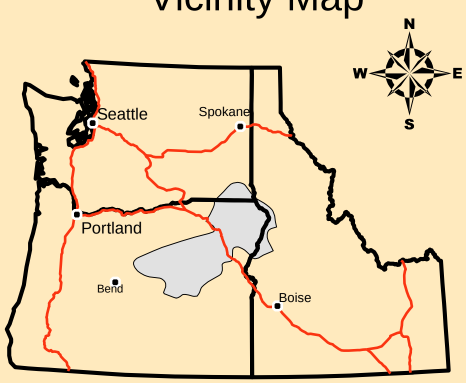
** Bailey's Ecoregion M332G




## Vicinity Map



# Tree Species of the Blue Mountains Section

**Douglas-fir**

*Pseudotsuga menziesii**

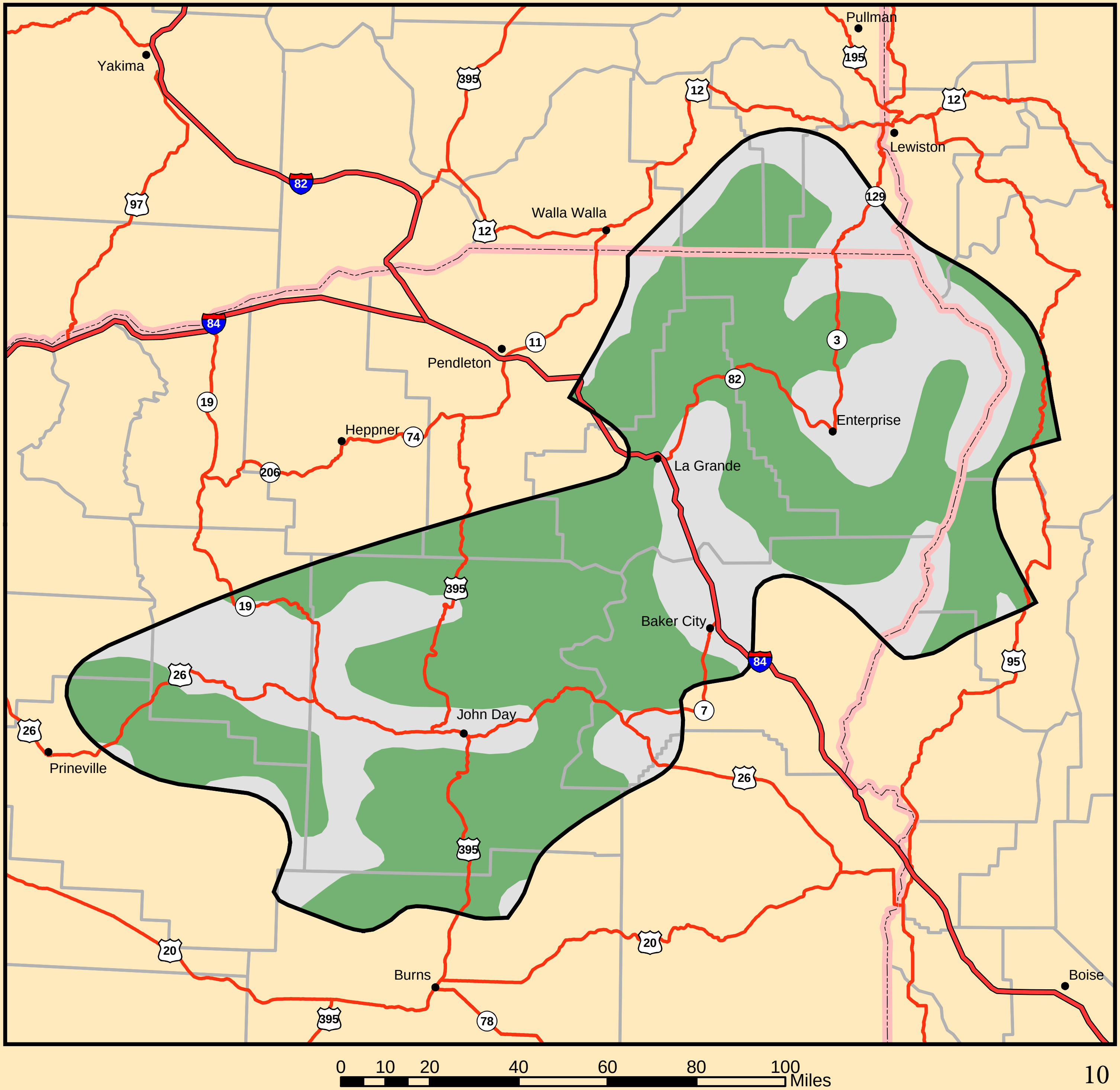
Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes




* Representations of Tree Species Range Maps from "Atlas of United States Trees" by Elbert L. Little, Jr. (1966-1977)

** Bailey's Ecoregion M332G

## Vicinity Map


The Forest Service cannot assure the reliability or suitability of this information for any particular purpose. Original data elements were compiled from a variety of sources and may not meet National Mapping Accuracy Standards. This information may be updated, corrected, or otherwise modified without notification.

# Tree Species of the Blue Mountains Section

**Engelmann Spruce**

*Picea engelmanni**

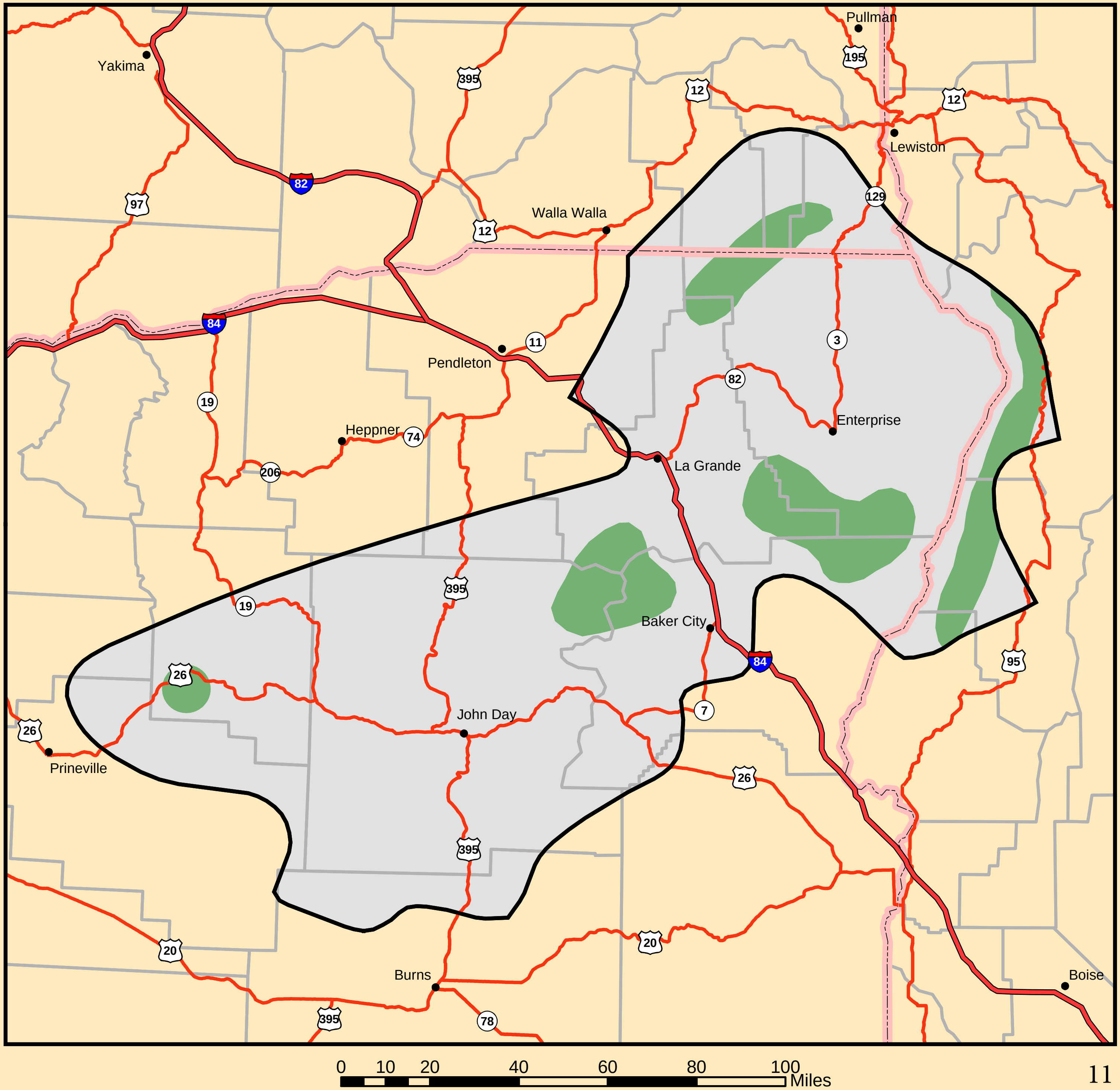
Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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# Tree Species of the Blue Mountains Section

**Grand Fir**

*Abies grandis**

Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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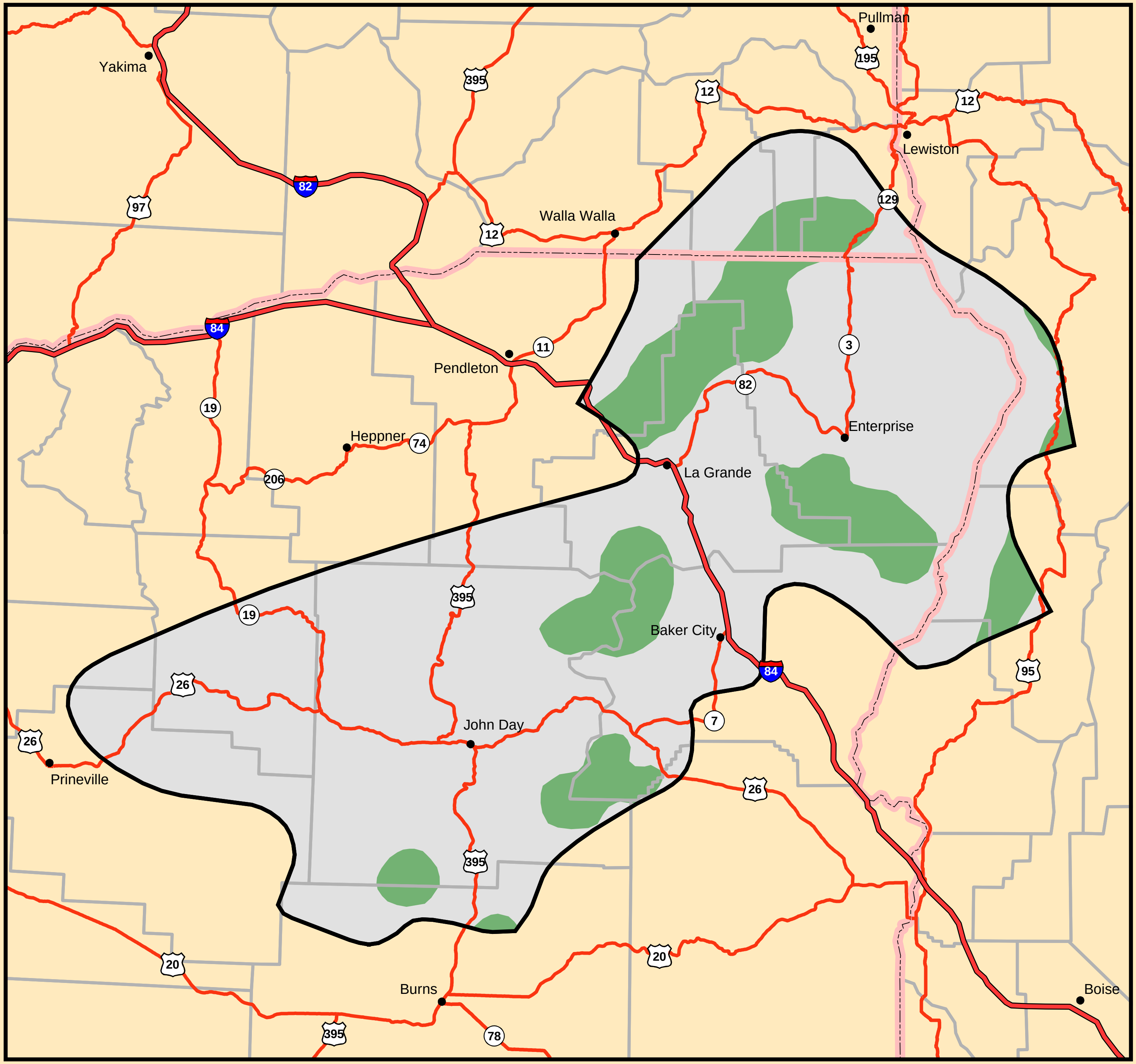


0 10 20 40 60 80 100 Miles

Vicinity Map


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# Tree Species of the Blue Mountains Section

**Lodgepole Pine**

*Pinus contorta**

Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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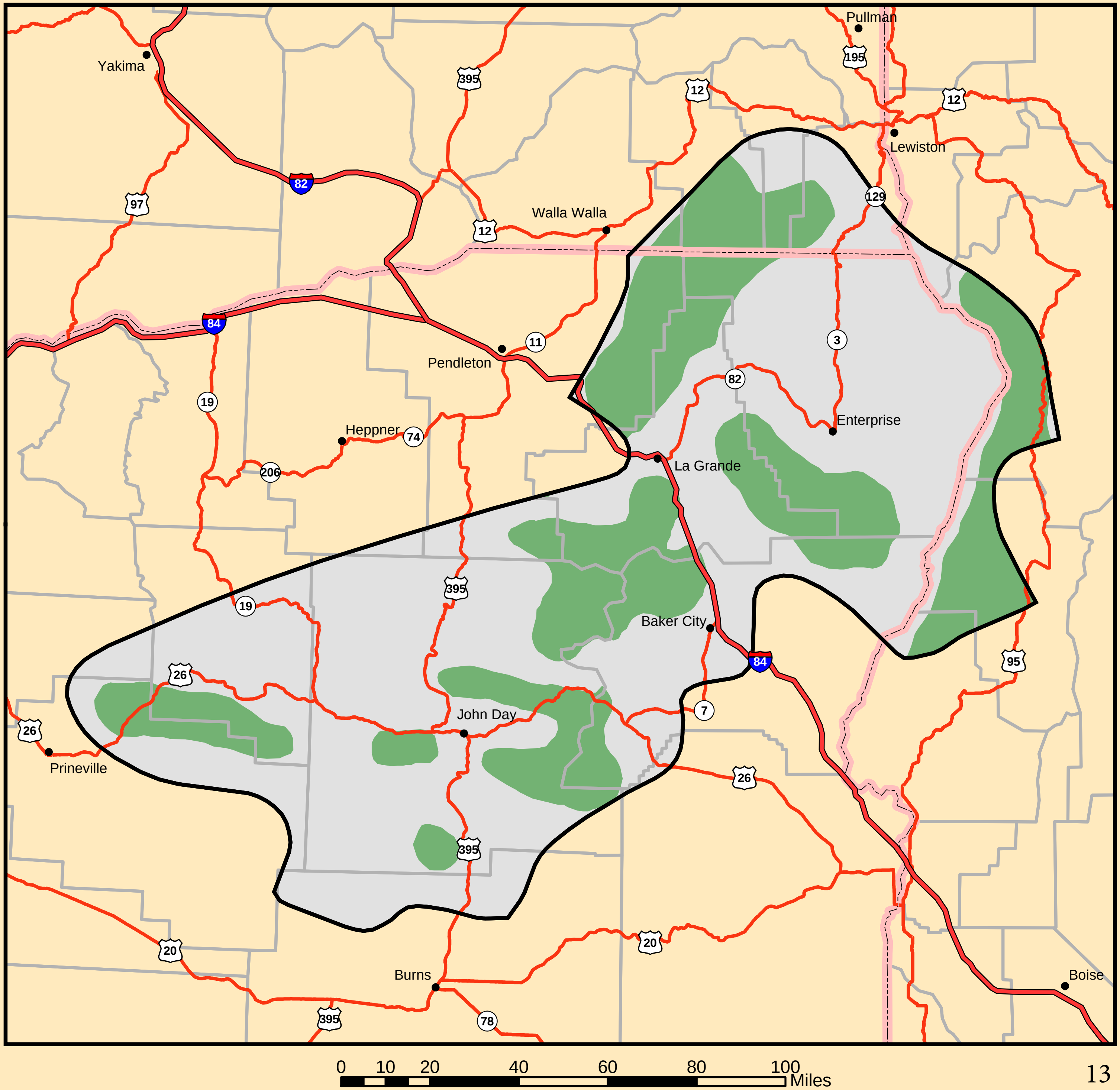


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# Tree Species of the Blue Mountains Section

**Pacific Yew**

*Taxus brevifolia**

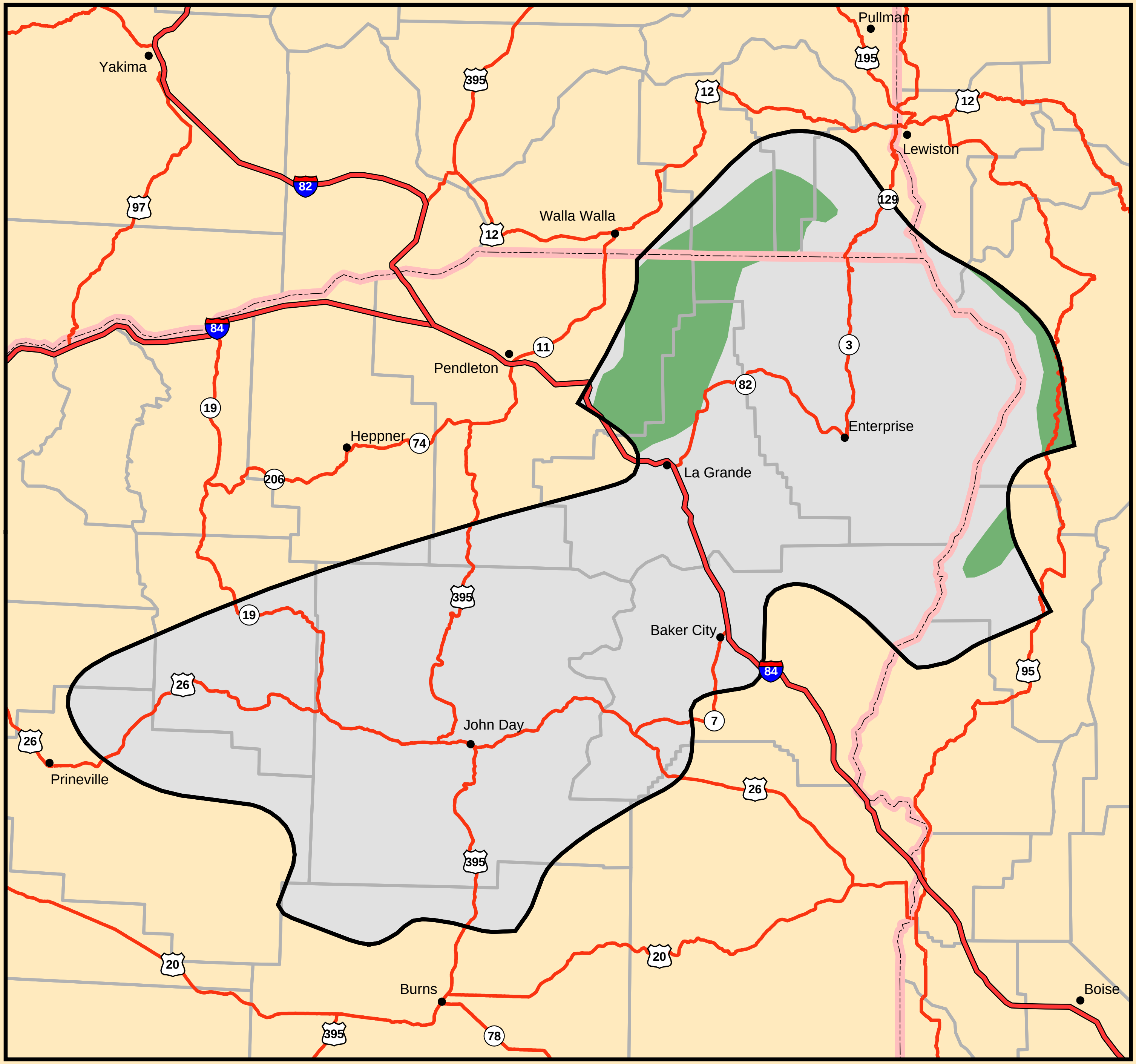
Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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** Bailey's Ecoregion M332G

## Vicinity Map


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# Tree Species of the Blue Mountains Section

**Ponderosa Pine**

*Pinus ponderosa**

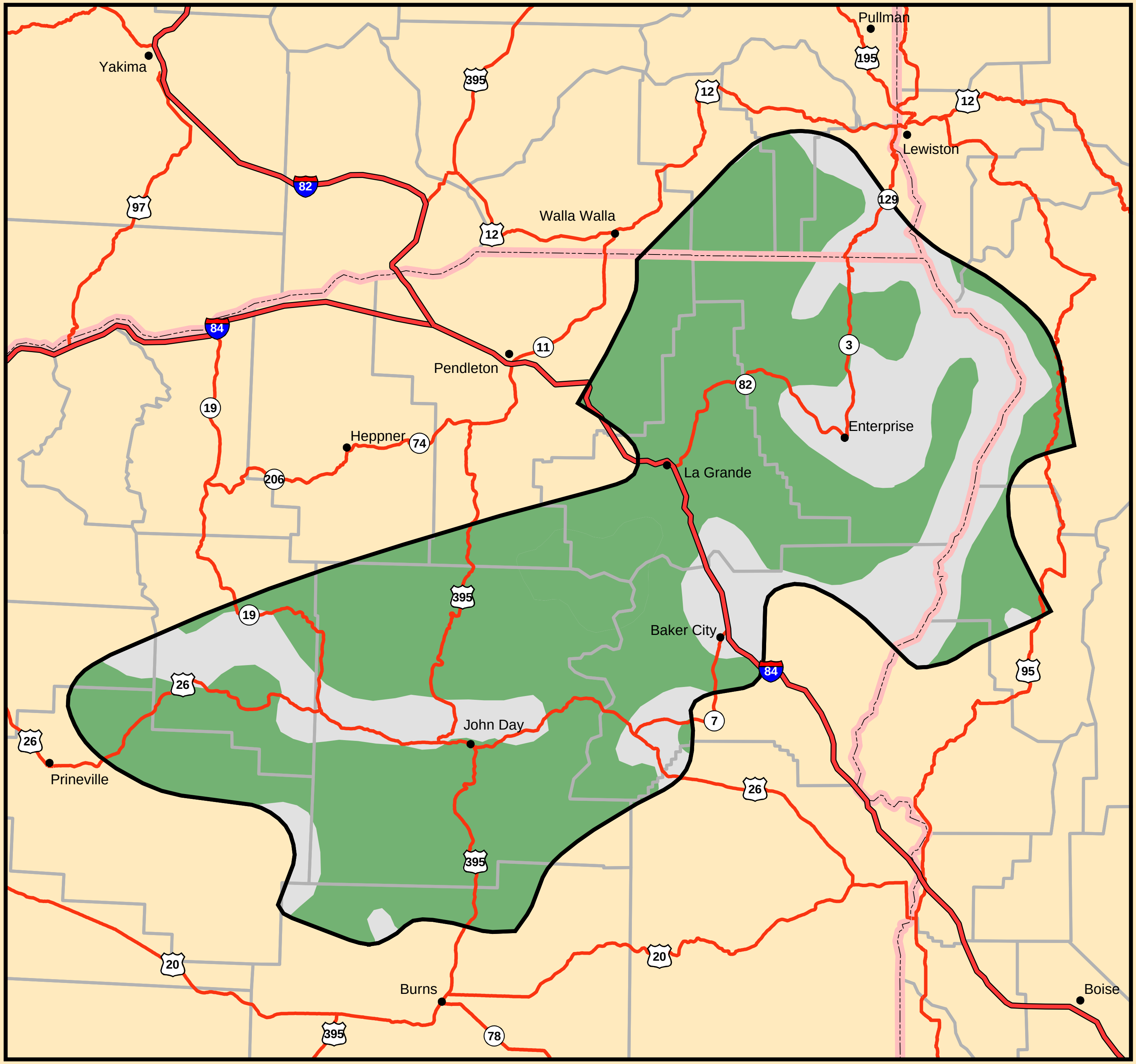
Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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** Bailey's Ecoregion M332G

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# Tree Species of the Blue Mountains Section

**Quaking Aspen**

*Populus tremuloides**

Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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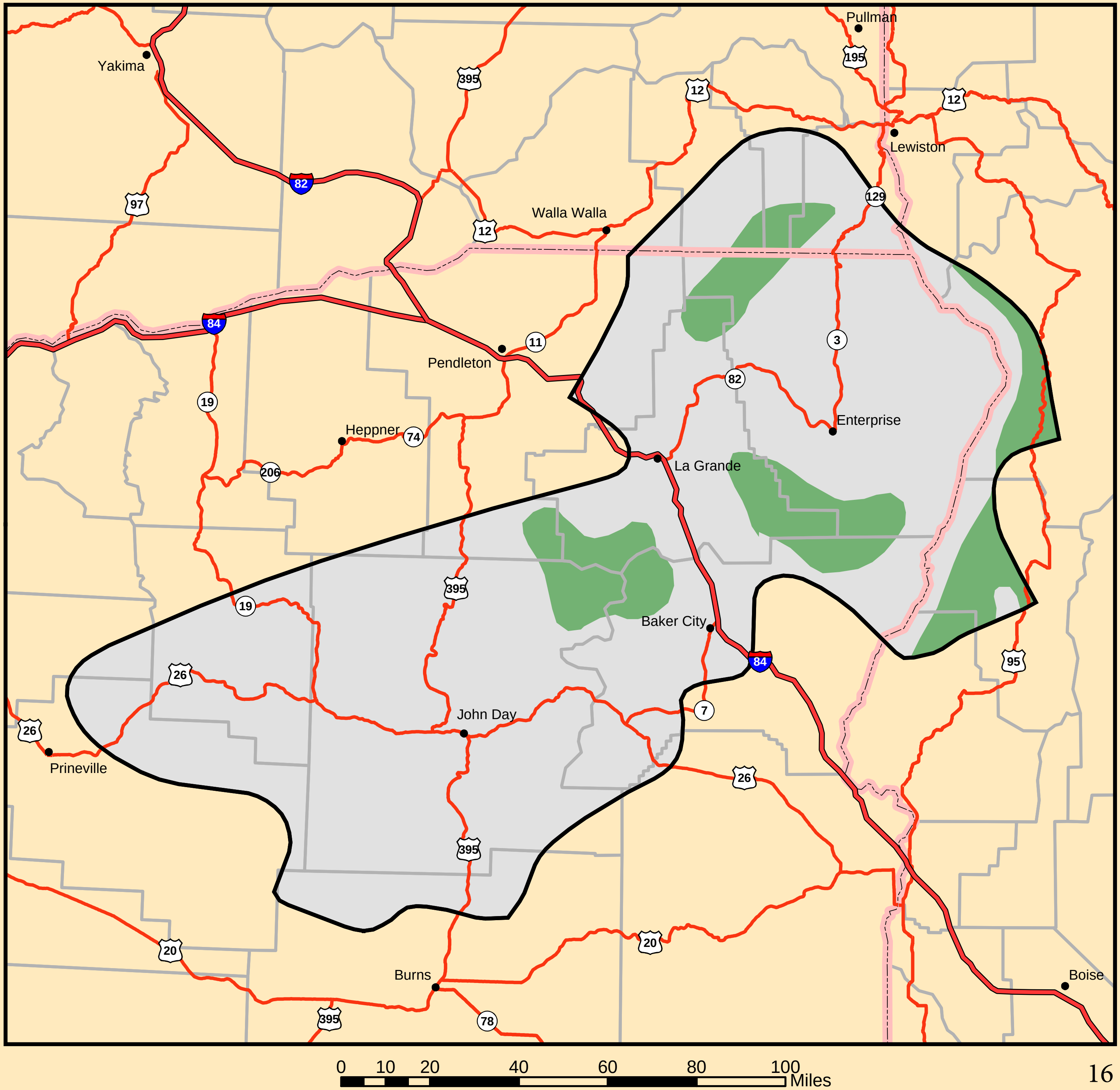
** Bailey's Ecoregion M332G

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# Tree Species of the Blue Mountains Section

**Subalpine Fir**

*Abies lasiocarpa**

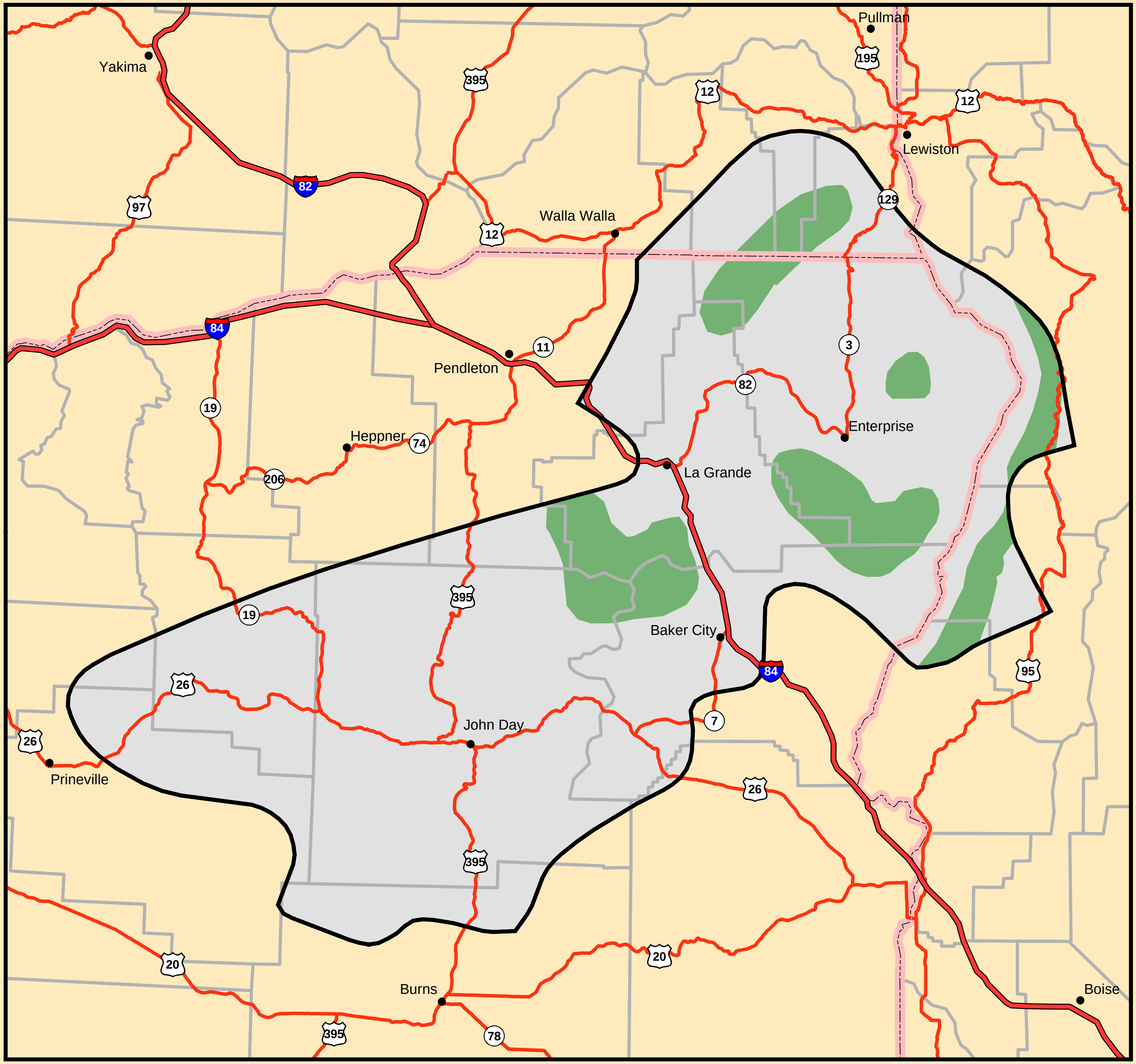
Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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# Tree Species of the Blue Mountains Section

**Thinleaf Alder**

*Alnus tenuifolia**

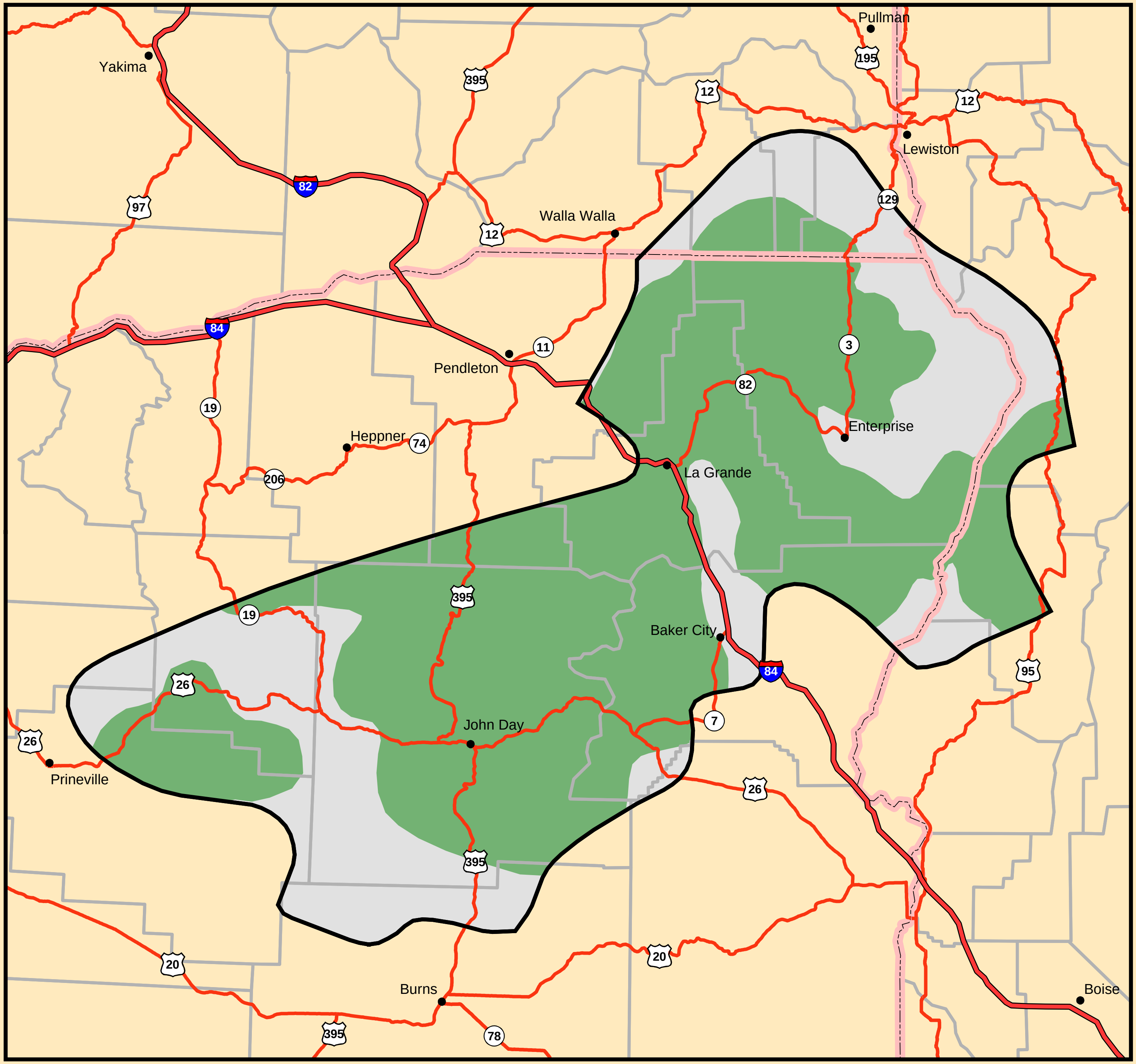
Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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# Tree Species of the Blue Mountains Section

**Water Birch**

*Betula occidentalis**

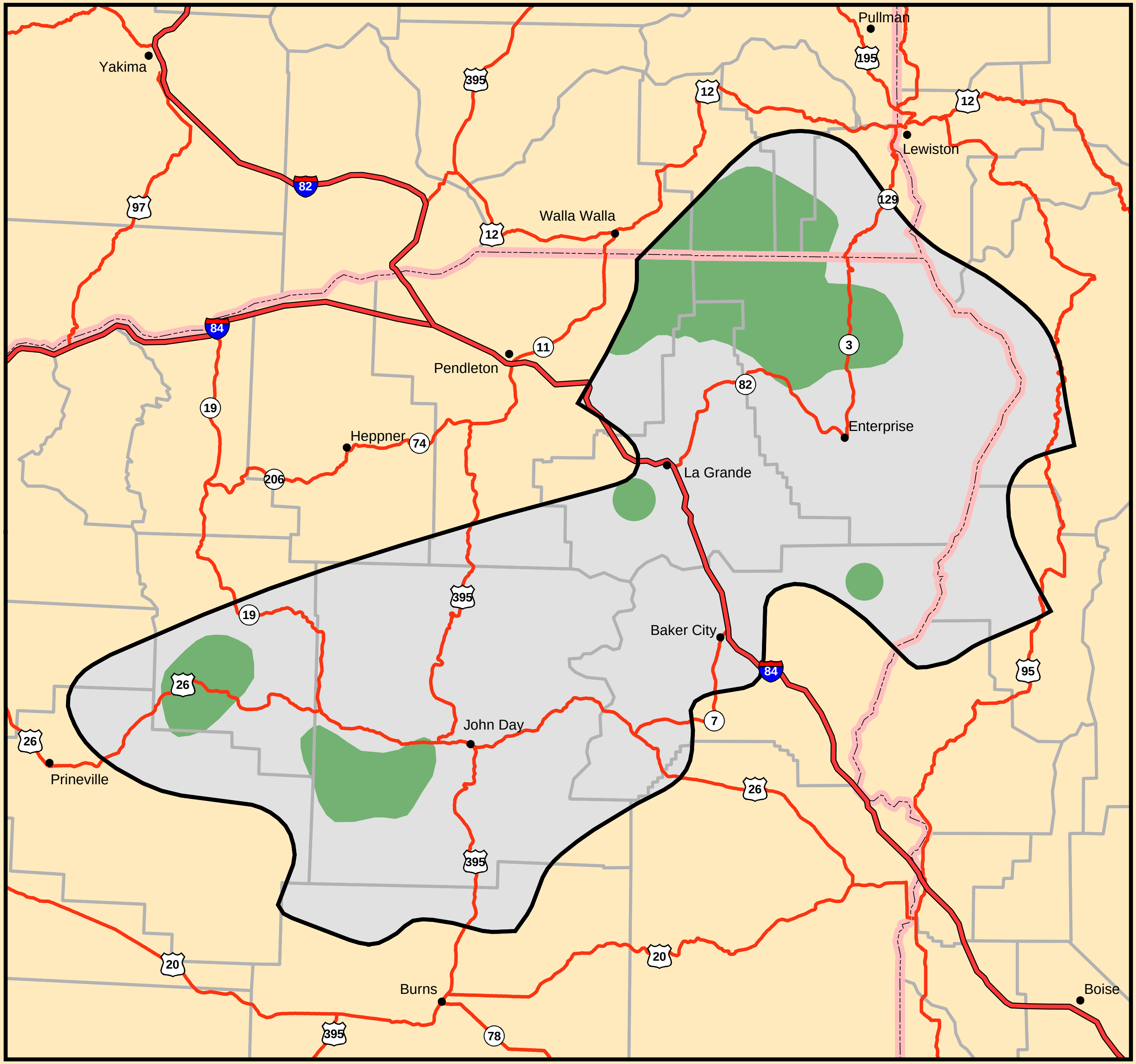
Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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** Bailey's Ecoregion M332G

## Vicinity Map

# Tree Species of the Blue Mountains Section

**Western Juniper**

*Juniperus occidentalis**

Blue Mountains Ecoregion**

State Boundaries

County Boundaries

Interstate Highways

US/State Routes

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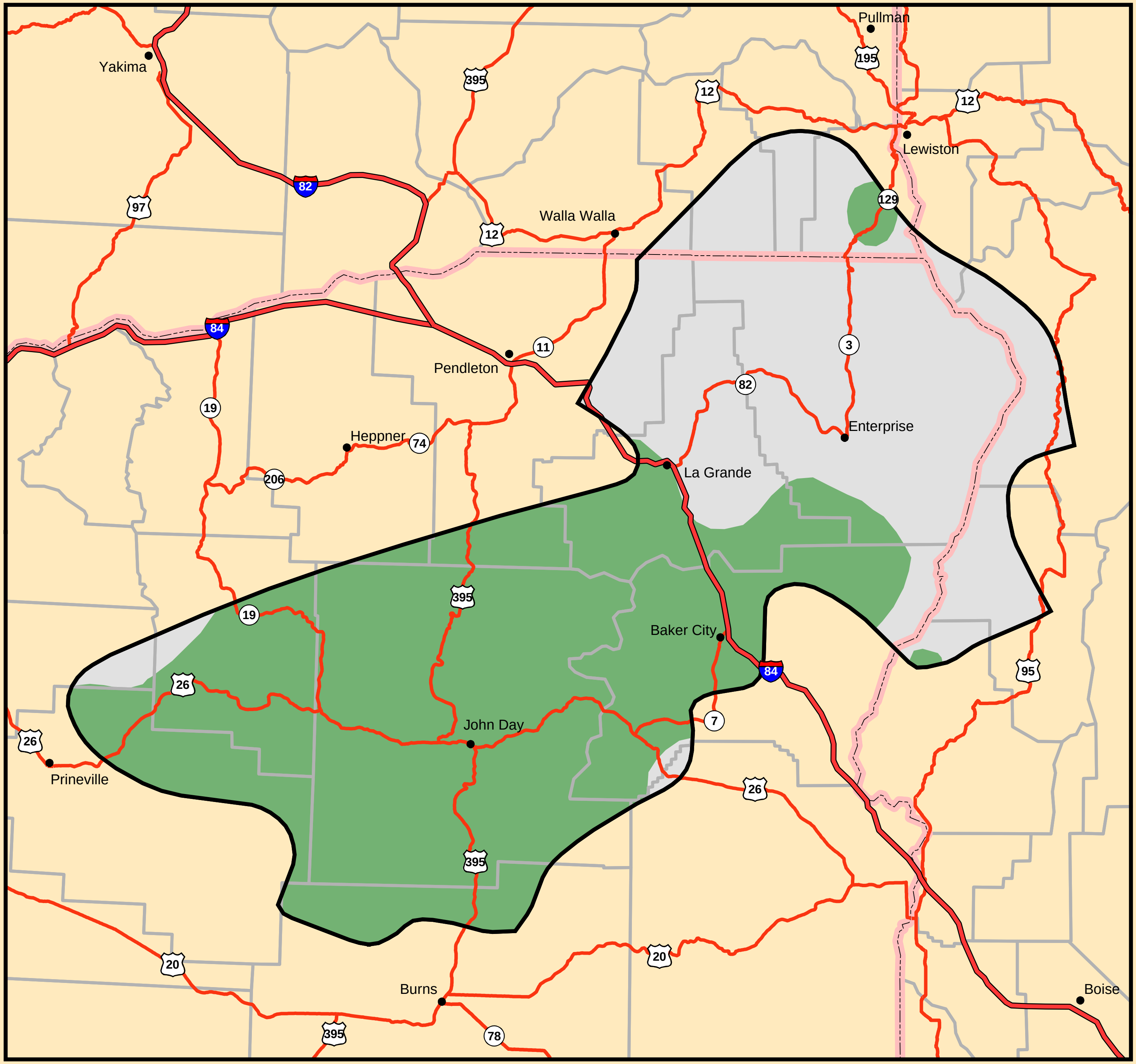


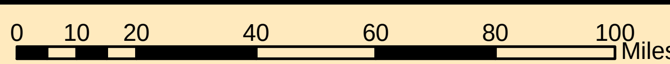


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# Tree Species of the Blue Mountains Section

**Western Larch**

*Larix occidentalis**

Blue Mountains Ecoregion**

State Boundaries

County Boundaries

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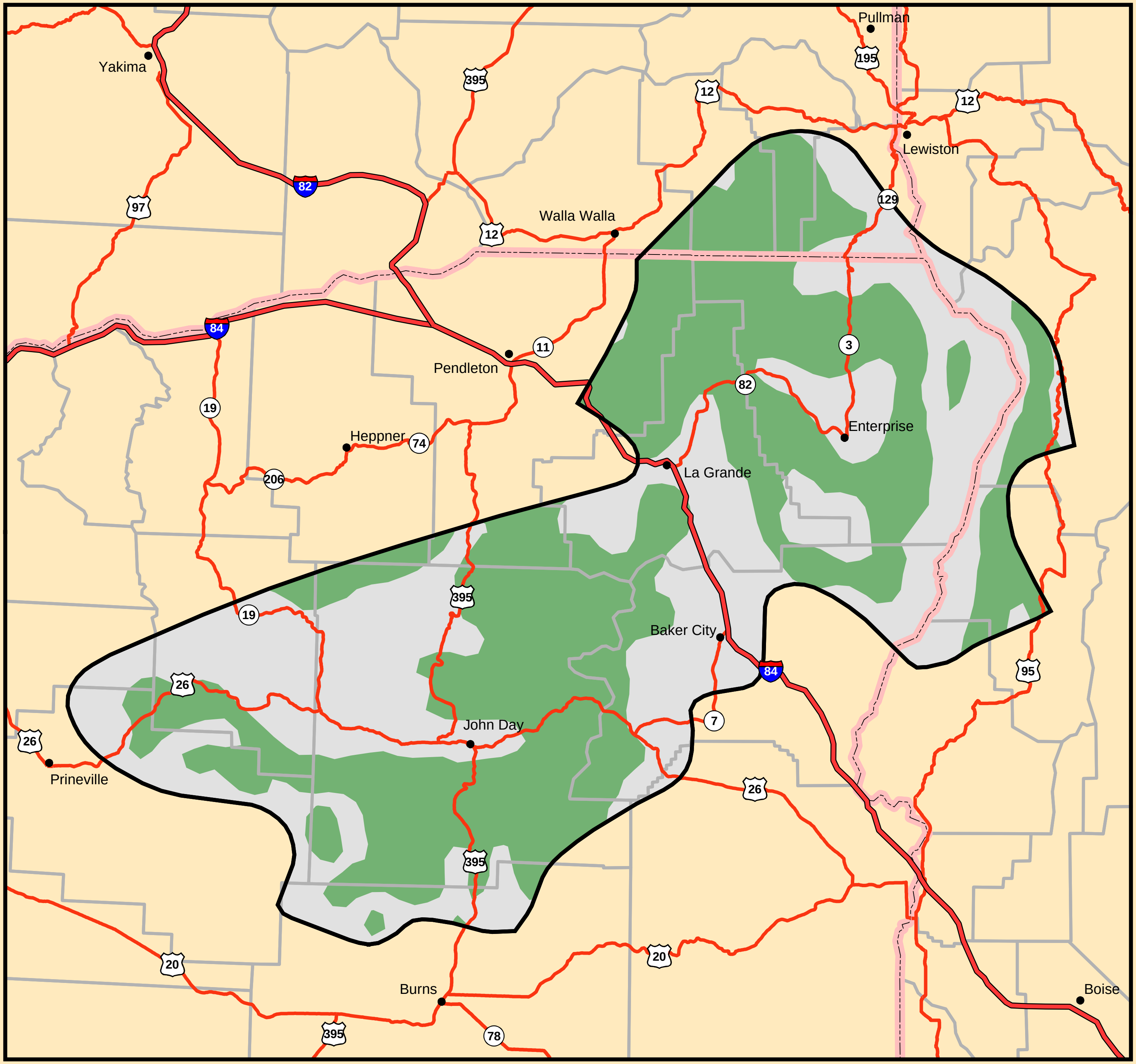
* Representations of Tree Species Range Maps from "Atlas of United States Trees" by Elbert L. Little, Jr. (1966-1977)

** Bailey's Ecoregion M332G




0 10 20 40 60 80 100 Miles

Vicinity Map


The Forest Service cannot assure the reliability or suitability of this information for any particular purpose. Original data elements were compiled from a variety of sources and may not meet National Mapping Accuracy Standards. This information my be updated, corrected, or otherwise modified without notification.

# Tree Species of the Blue Mountains Section

**Western White Pine**

*Pinus monticola**

Blue Mountains Ecoregion**

State Boundaries

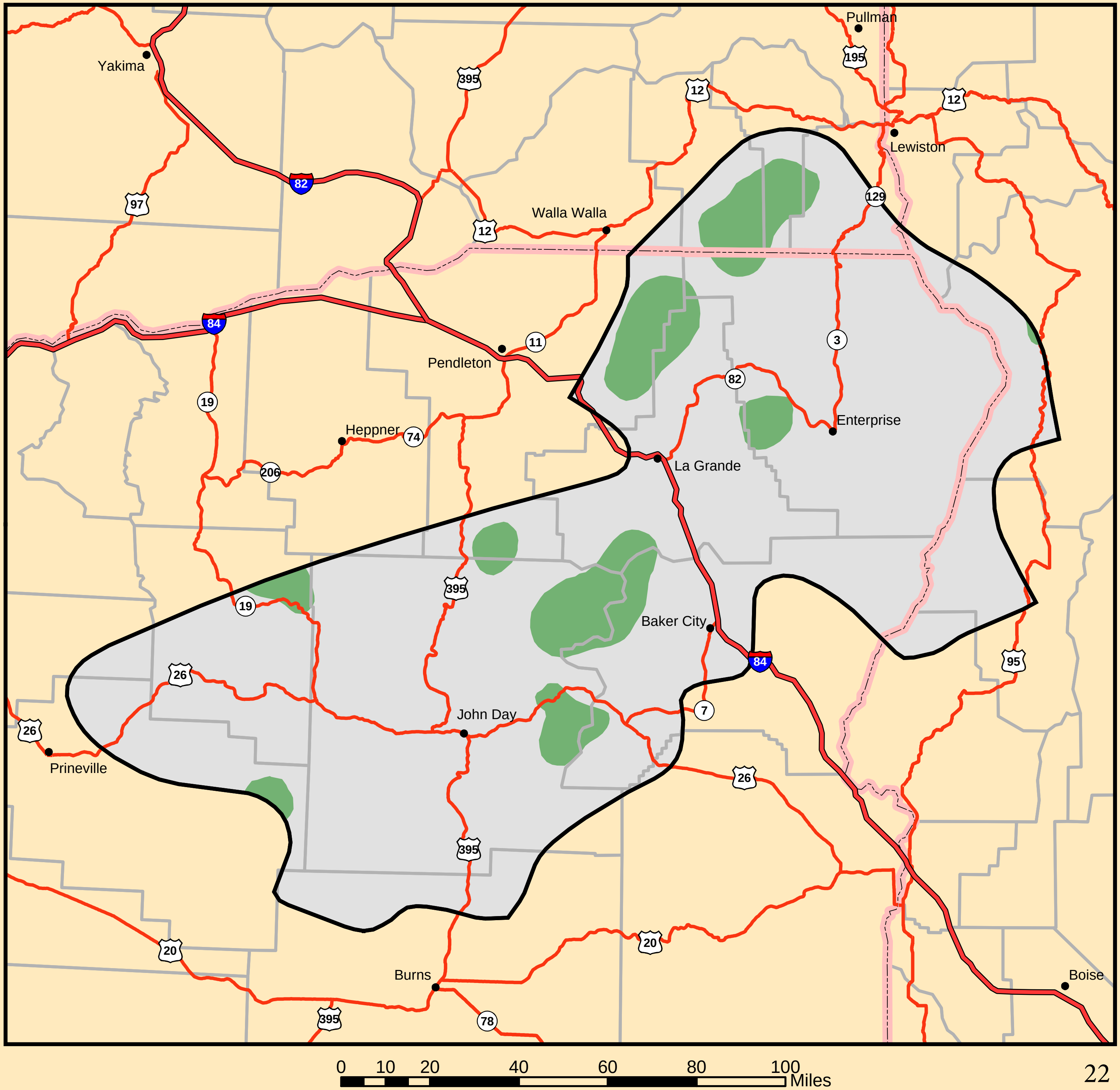
County Boundaries

Interstate Highways

US/State Routes

* Representations of Tree Species Range Maps from "Atlas of United States Trees" by Elbert L. Little, Jr. (1966-1977)

** Bailey's Ecoregion M332G




## Vicinity Map


The Forest Service cannot assure the reliability or suitability of this information for any particular purpose. Original data elements were compiled from a variety of sources and may not meet National Mapping Accuracy Standards. This information my be updated, corrected, or otherwise modified without notification.

# Tree Species of the Blue Mountains Section

**Whitebark Pine**

*Pinus albicaulis**

Blue Mountains Ecoregion**

State Boundaries

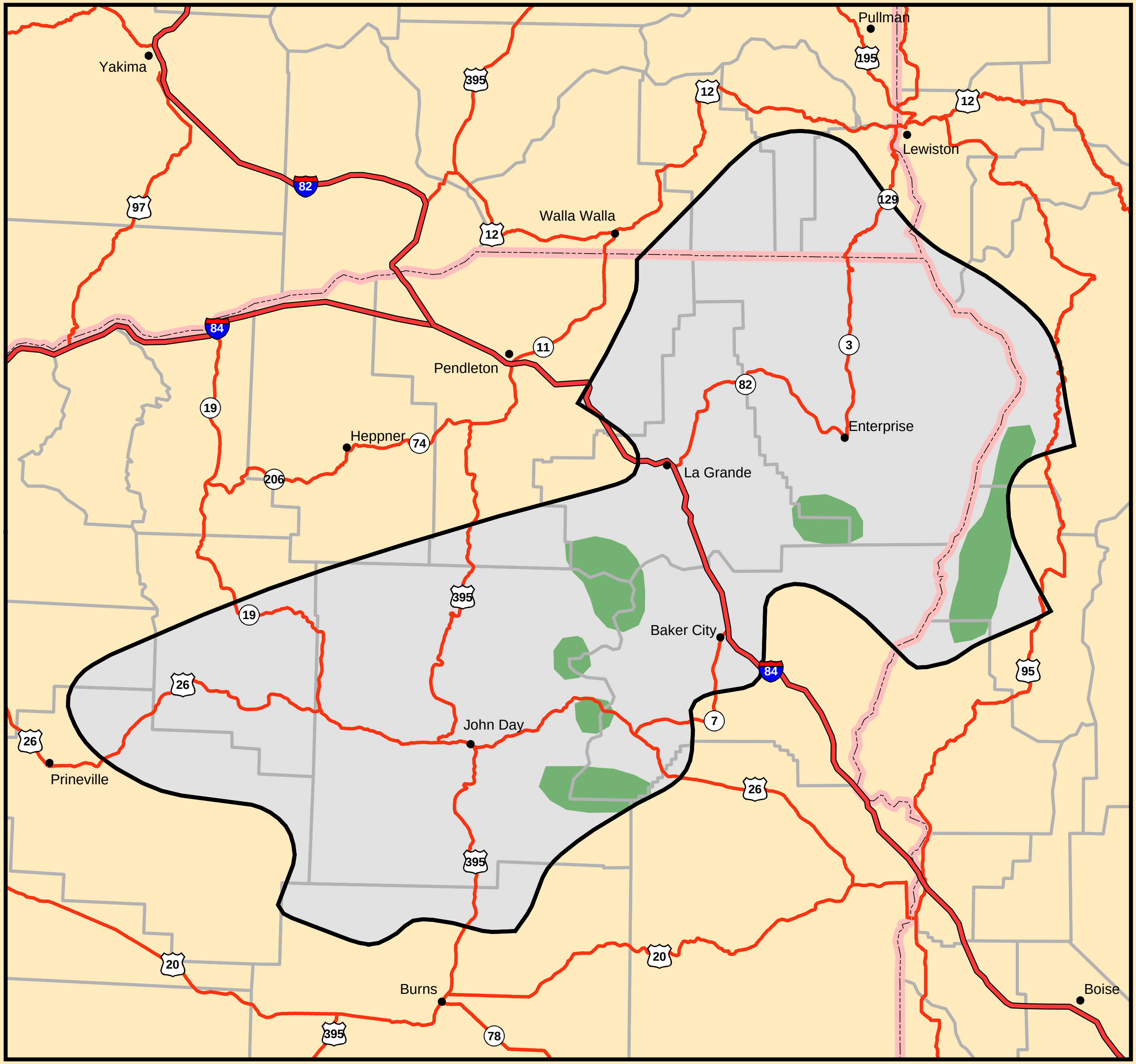
County Boundaries

Interstate Highways

US/State Routes

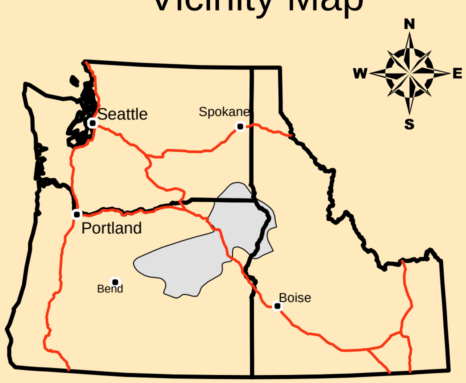
* Representations of Tree Species Range Maps from "Atlas of United States Trees" by Elbert L. Little, Jr. (1966-1977)

** Bailey's Ecoregion M332G




0 10 20 40 60 80 100 Miles

Vicinity Map




The Forest Service cannot assure the reliability or suitability of this information for any particular purpose. Original data elements were compiled from a variety of sources and may not meet National Mapping Accuracy Standards. This information my be updated, corrected, or otherwise modified without notification.

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## APPENDIX 2: SILVICULTURE WHITE PAPERS

White papers are internal reports, and they are produced with a consistent formatting and numbering scheme – all papers dealing with Silviculture, for example, are placed in a silviculture series (Silv) and numbered sequentially. Generally, white papers receive only limited review and, in some instances pertaining to highly technical or narrowly focused topics, the papers may receive no technical peer review at all. For papers that receive no review, the viewpoints and perspectives expressed in the paper are those of the author only, and do not necessarily represent agency positions of the Umatilla National Forest or the USDA Forest Service.

Large or important papers, such as two papers discussing active management considerations for dry and moist forests (white papers Silv-4 and Silv-7, respectively), receive extensive review comparable to what would occur for a research station general technical report (but they don't receive blind peer review, a process often used for journal articles).

White papers are designed to address a variety of objectives:

(1) They guide how a methodology, model, or procedure is used by practitioners on the Umatilla National Forest (to ensure consistency from one unit, or project, to another).

(2) Papers are often prepared to address ongoing and recurring needs; some papers have existed for more than 20 years and still receive high use, indicating that the need (or issue) has long standing – an example is white paper #1 describing the Forest's big-tree program, which has operated continuously for 25 years.

(3) Papers are sometimes prepared to address emerging or controversial issues, such as management of moist forests, elk thermal cover, or aspen forest in the Blue Mountains. These papers help establish a foundation of relevant literature, concepts, and principles that continuously evolve as an issue matures, and hence they may experience many iterations through time. [But also note that some papers have not changed since their initial development, in which case they reflect historical concepts or procedures.]

(4) Papers synthesize science viewed as particularly relevant to geographical and management contexts for the Umatilla National Forest. This is considered to be the Forest's self-selected 'best available science' (BAS), realizing that non-agency commenters would generally have a different conception of what constitutes BAS – like beauty, BAS is in the eye of the beholder.

(5) The objective of some papers is to locate and summarize the science germane to a particular topic or issue, including obscure sources such as master's theses or Ph.D. dissertations. In other instances, a paper may be designed to wade through an overwhelming amount of published science (dry-forest management), and then synthesize sources viewed as being most relevant to a local context.

(6) White papers function as a citable literature source for methodologies, models, and procedures used during environmental analysis – by citing a white paper, specialist reports can include less verbiage describing analytical databases, techniques, and so forth, some of which change little (if at all) from one planning effort to another.

(7) White papers are often used to describe how a map, database, or other product was developed. In this situation, the white paper functions as a 'user's guide' for the new product. Examples include papers dealing with historical products: (a) historical fire extents for the Tucannon watershed (WP Silv-21); (b) an 1880s map developed from General Land Office survey notes (WP Silv-41); and (c) a description of historical mapping sources (24 separate items) available from the Forest's history website (WP Silv-23).

These papers are available from the Forest's website: [Silviculture White Papers]

| Paper # | Title |
|---|---|
| 1 | Big tree program |
| 2 | Description of composite vegetation database |
| 3 | Range of variation recommendations for dry, moist, and cold forests |
| 4 | Active management of Blue Mountains dry forests: Silvicultural considerations |
| 5 | Site productivity estimates for upland forest plant associations of Blue and Ochoco Mountains |
| 6 | Blue Mountains fire regimes |
| 7 | Active management of Blue Mountains moist forests: Silvicultural considerations |
| 8 | Keys for identifying forest series and plant associations of Blue and Ochoco Mountains |
| 9 | Is elk thermal cover ecologically sustainable? |
| 10 | A stage is a stage is a stage…or is it? Successional stages, structural stages, seral stages |
| 11 | Blue Mountains vegetation chronology |
| 12 | Calculated values of basal area and board-foot timber volume for existing (known) values of canopy cover |
| 13 | Created opening, minimum stocking, and reforestation standards from Umatilla National Forest Land and Resource Management Plan |
| 14 | Description of EVG-PI database |
| 15 | Determining green-tree replacements for snags: A process paper |
| 16 | Douglas-fir tussock moth: A briefing paper |
| 17 | Fact sheet: Forest Service trust funds |
| 18 | Fire regime condition class queries |
| 19 | Forest health notes for an Interior Columbia Basin Ecosystem Management Project field trip on July 30, 1998 (handout) |
| 20 | Height-diameter equations for tree species of Blue and Wallowa Mountains |
| 21 | Historical fires in headwaters portion of Tucannon River watershed |
| 22 | Range of variation recommendations for insect and disease susceptibility |
| 23 | Historical vegetation mapping |
| 24 | How to measure a big tree |
| 25 | Important Blue Mountains insects and diseases |
| 26 | Is this stand overstocked? An environmental education activity |
| 27 | Mechanized timber harvest: Some ecosystem management considerations |
| 28 | Common plants of south-central Blue Mountains (Malheur National Forest) |
| 29 | Potential natural vegetation of Umatilla National Forest |

| Paper # | Title |
|---|---|
| 30 | Potential vegetation mapping chronology |
| 31 | Probability of tree mortality as related to fire-caused crown scorch |
| 32 | Review of “Integrated scientific assessment for ecosystem management in the interior Columbia basin, and portions of the Klamath and Great basins” – forest vegetation |
| 33 | Silviculture facts |
| 34 | Silvicultural activities: Description and terminology |
| 35 | Site potential tree height estimates for Pomeroy and Walla Walla Ranger Districts |
| 36 | Stand density protocol for mid-scale assessments |
| 37 | Stand density thresholds related to crown-fire susceptibility |
| 38 | Umatilla National Forest Land and Resource Management Plan: Forestry direction |
| 39 | Updates of maximum stand density index and site index for Blue Mountains variant of Forest Vegetation Simulator |
| 40 | Competing vegetation analysis for southern portion of Tower Fire area |
| 41 | Using General Land Office survey notes to characterize historical vegetation conditions for Umatilla National Forest |
| 42 | Life history traits for common Blue Mountains conifer trees |
| 43 | Timber volume reductions associated with green-tree snag replacements |
| 44 | Density management field exercise |
| 45 | Climate change and carbon sequestration: Vegetation management considerations |
| 46 | Knutson-Vandenberg (K-V) program |
| 47 | Active management of quaking aspen plant communities in northern Blue Mountains: Regeneration ecology and silvicultural considerations |
| 48 | Tower Fire…then and now. Using camera points to monitor postfire recovery |
| 49 | How to prepare a silvicultural prescription for uneven-aged management |
| 50 | Stand density conditions for Umatilla National Forest: A range of variation analysis |
| 51 | Restoration opportunities for upland forest environments of Umatilla National Forest |
| 52 | New perspectives in riparian management: Why might we want to consider active management for certain portions of riparian habitat conservation areas? |
| 53 | Eastside Screens chronology |
| 54 | Using mathematics in forestry: An environmental education activity |
| 55 | Silviculture certification: Tips, tools, and trip-ups |
| 56 | Vegetation polygon mapping and classification standards: Malheur, Umatilla, and Wallowa-Whitman National Forests |
| 57 | State of vegetation databases for Malheur, Umatilla, and Wallowa-Whitman National Forests |
| 58 | Seral status for tree species of Blue and Ochoco Mountains |

## REVISION HISTORY

**May 2010:** First version of this white paper was prepared in October 2004. Minor revisions in May 2010 added new life-history traits, and provided missing information for some existing traits.

**March 2017:** For a March 2017 revision, modifications involved adding an appendix describing a white-paper system, along with a white-paper header and associated formatting. Appendix 1, which provides range maps showing Blue Mountains distribution for 16 tree species, was also added during this revision.