Developing an Extent Map for Pinyon-Juniper Woodlands in the US West

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Overview

As a part of the Intermountain West Joint Venture (IWJV)-organized Pinyon-Juniper (PJ) collaborative, we are developing extent maps of PJ woodlands in the US West. In addition to mapping the distribution of woodlands westwide, these maps serve to constrain other datasets representing components of ecological integrity, created in later stages of the project. For these purposes, we define PJ woodlands as areas capable of supporting pinyon or juniper species (Table 1).

Specifically, we are developing the following data layers:

A. Current Existing PJ: A map of where PJ woodlands currently (as of 2024) exist in the western US. Where are they now?
B. Current Potentially Climatically Suitable PJ: A map of where PJ woodlands could potentially exist in the current time period (2024), without accounting for disturbance or dispersal limitations. Where could they be now, in the absence of disturbances?

To produce each of these maps, we developed an interactive web application using Google Earth Engine (GEE) (Gorelick et al., 2017) to explore the sensitivity of map outputs to a few different parameters. The current version of the app is located here:

Public viewer: https://iwjv-apps.projects.earthengine.app/view/pj-map-viewer-v1

Focal Species and Community Types

To define what we considered to be a PJ woodland, we focused on the common tree species that typify these ecosystems in the US West (Noel et al., 2025) (Table 1). These species have different ranges, and occupy a wide range of environmental conditions. However, they all inhabit dry woodland environments in the US West that are collectively referred to as PJ (Romme et al., 2009). In practice, resulting map products assume a PJ woodland is any woodland that contains at least one of the PJ species defined here, either directly through species-specific data sources (FIA) or products that derive PJ woodlands through combined sources (e.g. LANDFIRE, RAP).

Table 1: Tree species included in our definition of PJ woodlands in the US West.

Scientific Name	Common Name	Currently Included (y/n)
Juniperus californica[†]	California juniper	Y, but not yet in occurrence data
Juniperus coahuilensis	Redberry Juniper	Y, but not yet in occurrence or SDM data
Juniperus deppeana[†]	Alligator juniper	Y
Juniperus flaccida	Drooping juniper	Y, but not yet in occurrence or SDM data
Juniperus monosperma[*†]	One-seed juniper	Y
Juniperus occidentalis[*†]	Western juniper	Y
Juniperus osteosperma[*†]	Utah juniper	Y
Juniperus pinchotii	Pinchot juniper	Y, but not yet in occurrence or SDM data
Juniperus scopulorum[*†]	Rocky Mountain juniper	Y
Pinus cembroides[†]	Mexican pinyon	Y
Pinus edulis[*†]	Twoneedle pinyon	Y
Pinus monophylla[*†] includes subspecies *californiarum* and *fallax*	Singleleaf pinyon	Y

*Species included in the PJ functional group for RAP estimates.
[†]Species included in Noel et al. (2025) species distribution models.

For several of our data layers, we rely on maps of vegetation community types, as developed through the LANDFIRE program (Rollins, 2009). Specifically, we utilized the

LANDFIRE Biophysical Settings (BPS), Environmental Site Potential (ESP), and Existing Vegetation Type (EVT) datasets.

- BPS is a modeled representation of the vegetation system that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of modeled past disturbance regimes. Basically, this layer represents the most likely vegetation community in the late 1800s throughout our study area.
- ESP represents the vegetation that could be supported at a given site based on the biophysical environment. This is the current "potential" vegetation or climax community at a site, in the absence of disturbance and disregarding competition.
- EVT represents the vegetation community that currently exists at a site, as of the year 2024.

We used the most recent version of each LANDFIRE product (2020 BPS data, 2016 ESP, 2024 EVT). BPS and ESP layers are modeled and therefore are relatively insensitive to current landscape conditions or disturbance, and change little over time. EVT is specific to the year of the mapping effort, and represents likely vegetation types in the year 2024. To identify PJ community types, we queried the type name field in each LANDFIRE layer ("BPS_NAME", "ESP_NAME", and "EVT_NAME") for the terms "Pinyon" or "Juniper". LANDFIRE does not utilize the alternative spelling piñon in its class IDs. We then reclassified each LANDFIRE layer to a binary presence/absence layer, representing whether a 30x30m pixel represented a PJ woodland type (1) or other cover type (0).

LANDFIRE code	Description
3016	Colorado Plateau Pinyon-Juniper Woodland
3017	Columbia Plateau Western Juniper Woodland and Savanna
3019	Great Basin Pinyon-Juniper Woodland
3025	Madrean Pinyon-Juniper Woodland
3049	Rocky Mountain Foothill Limber Pine-Juniper Woodland
3059	Southern Rocky Mountain Pinyon-Juniper Woodland
3115	Inter-Mountain Basins Juniper Savanna
3116	Madrean Juniper Savanna
3119	Southern Rocky Mountain Juniper Woodland and Savanna
3202	Juniperus occidentalis Wooded Herbaceous Alliance
3203	Juniperus occidentalis Woodland Alliance

Other datasets were also included for specific purposes, as described below.

Data Layers

A. Current Existing PJ

This data layer represents the likely current extent of PJ woodlands, as of the year 2024. It combines 10 specific PJ classes from the LANDFIRE EVT dataset, as well as a few additional datasets. For a 30x30m pixel to be mapped as current PJ it must meet the following criteria: (1) defined as a PJ woodland based on LANDFIRE EVT, (2) at least 4% PJ cover from the Rangeland Analysis Platform (RAP) dataset in 2024 (Allred et al., 2025), (3) at least 1 sq m/ha of combined tree basal area of species listed in Table 1 in the early 2000s (Wilson et al., 2013), and (4) within 5 km of known occurrence records for species listed in Table 1 based on field records from US Forest Inventory and Analysis (FIA), BLM Assessment, Inventory, and Monitoring (AIM), or the Global Biodiversity Information Facility (GBIF). For FIA records, we used "fuzzed" coordinates, rather than true plot coordinates. More information on occurrence records is described in Noel et al. (2025). Criteria 2-4 can be easily adjusted in the GEE app to determine the sensitivity of final maps to threshold values, however, we assumed that the values above are reasonable defaults. For example, 4.1% is the reported root-mean-squared-error

(RMSE) in PJ fractional cover from RAP (Allred et al., 2025), and therefore 4% represents a reasonable threshold to differentiate presence and absence of PJ while accounting for mapping uncertainty.

B. Current Potentially Climatically Suitable PJ

This data layer represents the likely potential extent of PJ woodlands in the western US – what places could they potentially exist based on the biophysical environment. To develop this layer, we combined the three classified LANDFIRE layers (BPS, ESP, EVT), assuming that a location would be a potential location for PJ woodlands if it was suitable under past environmental conditions and disturbance regimes, under current environmental conditions, or was mapped as having PJ woodlands present in 2024. To be defined as current potential PJ, we required the following criteria be met: (1) Mapped as PJ in LANDFIRE BPS, ESP, or EVT datasets, (2) classified as 'suitable' for at least one pinyon or juniper species based on species distribution models of Noel et al. (2025) under current climate, (3) within 5 km of known occurrence records of PJ species in Table 1. Criterion 3 can be adjusted in the GEE app, while the others are currently held constant.

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