

10240

Madrean Lower Montane Pine-Oak Forest and Woodland

BpS Model/Description Version: Aug. 2020

Modelers		Reviewers	
Mike Babler	mbabler@tnc.org	Reese Lolley	rlolley@fs.fed.us
None	None	Guy McPherson	grm@ag.arizona.edu
None	None	None	None

Vegetation Type

Forest and Woodland

Map Zones

14, 15, 24

Geographic Range

Sierra Madre Occidental and Sierra Madre Oriental in Mexico, Trans-Pecos Texas, New Mexico, and Arizona, generally south of the Mogollon Rim.

Biophysical Site Description

The Madrean encinal of the interior North American Southwest is characterized by evergreen oaks, alligator junipers, and Mexican pines that range in height from 15-50ft (6-15m); the understory is dominated by graminoids (Brown 1994). With increasing elevation, alligator juniper and evergreen oak trees give way to a mixture of relatively mesic evergreen oak species and pines.

Kuchler (1964) includes this type within type number 31, the oak-juniper woodland. Coarse-scale PNVGs included this type with type number 26, chaparral. This PNV type is included in Bailey's (1995) and McNab and Avers's (1994) ecoregions within the Chihuahuan Semi-Desert Province, Basin and Range Section (321A), and the Arizona-New Mexico Semi-Desert Mountains Province (M313) within the White Mountain-San Francisco Peaks Section (M313A) and Sacramento-Monzano Mountain Section (M313B).

Vegetation Description

These forests and woodlands are composed of Madrean pines and evergreen oaks intermingled with patchy shrublands on most mid-elevation slopes (1,500-2,300m elevation). Tree species include *Quercus arizonica*, *Q. emoryi*, *Q. grisea*, *Cupressus arizonica*, *Juniperus deppeana*, *Pinus arizonica*, *Pinus discolor*, *P. engelmannii*, and *P. ponderosa*. Subcanopy and shrub layers may include typical encinal and chaparral species such as *Agave* spp., *Arbutus arizonica*, *Arctostaphylos pringlei*, *Arctostaphylos pungens*, *Garrya wrightii*, *Nolina* spp., *Quercus hypoleucooides*, *Q. rugosa*, and *Q. turbinella*. Some stands have moderate cover of perennial warm-season grasses such as *Bouteloua curtipendula*, *B. gracilis*, *Muhlenbergia emersleyi*, *M. longiligula*, *M. virescens*, and *Schizachyrium cirratum*. Graminoids decrease in cover and biomass with increasing cover of woody plants.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
---------------	------------------------	--------------------

QUEM	<i>Quercus emoryi</i>	Emory oak
JUDE	<i>Juncus debilis</i>	Weak rush
PIEN2	<i>Pinus engelmannii</i>	Apache pine
MUHLE	<i>Muhlenbergia</i>	Muhly
PIPO	<i>Pinus ponderosa</i>	Ponderosa pine

Species names are from the NRCS PLANTS database. Check species codes at <http://plants.usda.gov>.

Disturbance Description

The fire regime of this ecological system is poorly understood. Particularly at the lowest elevations, dominant trees rarely record fires, and they resprout after fire. The increasing abundance of pines with increasing elevation partially mediates this situation and provides limited information about fire regime at these higher elevations.

It would seem that fire occurrence was determined primarily by fire occurrence in adjacent ecosystems and was ignited by lightning during early summer. However, this information is poorly documented; based on contemporary ecological knowledge, models that assume specific fire regimes are little more than guesses. These follow, in the sincere hope they will be ignored or improved upon.

This system likely is predisposed to stand-replacement fires during any stage of stand development. Replacement fires are assumed to have occurred every century or so coincident with hot, dry, windy conditions during early summer. Surface fires and mixed-severity fires likely occurred more frequently, perhaps on the magnitude of every 5-30yrs (with considerable variability around the mean frequency).

Drought likely was the most common disturbance after fire. Multi-decadal drought probably thinned stands but did not cause or contribute to stand replacement.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	124	19	10	200
Moderate (Mixed)	189	12	50	300
Low (Surface)	33	69	15	100
All Fires	23	100		

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

This type usually was distributed across the landscape in patches of 100s to 1,000s of acres. In particularly dissected topography, this type may have occurred in smaller patches.

Adjacency or Identification Concerns

This system generally is found at higher elevations and more mesic sites than semi-desert grassland. It may be bordered by, and confused with, pinyon-juniper woodland or interior chaparral (e.g., Great Basin pinyon-juniper woodland [Brown 1982], the juniper-pinyon or juniper steppe types of coarse-scale PNVG [Schmidt et al. 2002], and PNV [Kuchler 1964]).

Indicator species of this type include alligator juniper, evergreen oaks, Mexican pines, mountain muhly, blue grama, and sideoats grama.

Issues or Problems

Few components of the fire regimes are known with certainty. Fire scars are rare, and most trees in this system cannot be aged accurately with conventional dendrochronological techniques. Information about fire regimes is extrapolated from adjacent systems or from the few pine trees in upper-elevation patches of this system; thus, caution is warranted when interpreting these models. Fire season can be inferred more reliably than fire frequency; most fires likely occurred during early summer as a result of lightning associated with early “monsoonal” thunderstorms. Fire season likely is equally or more important than the fire frequency, despite the overwhelming attention to the latter instead of the former.

Madrean encinal is described as OCWI in the FRCC guidebook coarse scale description.

Lehmann lovegrass (*Eragrostis lehmanniana*) was purposely introduced into North America in the 1930s and has spread to the lower and drier edge of Madrean encinal. By continuing to spread and therefore add fine fuel, it may contribute to significantly increased fire frequency in this system. Lehmann lovegrass may have an advantage over native grasses following fire.

Native Uncharacteristic Conditions

Tree cover >70% is uncharacteristic.

Comments

Succession Classes

Mapping Rules

Upper Layer Lifeform	Height (m)	Canopy Cover (%)									
		0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Herb	0-0.5	A	A	A	A	A	A	A	A	A	A
Herb	0.5-1.0	A	A	A	A	A	A	A	A	A	A
Herb	>1.0	A	A	A	A	A	A	A	A	A	A
Shrub	0-0.5	A	A	A	A	A	A	A	A	A	A
Shrub	0.5-1.0	A	A	A	A	A	A	A	A	A	A
Shrub	1.0-3.0	A	A	A	A	A	A	A	A	A	A
Shrub	>3.0	A	A	A	A	A	A	A	A	A	A
Tree	0-5	A	A	A	A	A	A	A	UN	UN	UN
Tree	5-10	C	C	B	B	B	B	B	UN	UN	UN
Tree	10-25	D	D	D	D	D	D	D	UN	UN	UN
Tree	25-50	D	D	D	D	D	D	D	UN	UN	UN
Tree	>50	D	D	D	D	D	D	D	UN	UN	UN

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

Description

Class A	21	Early Development 1 - All Structures
----------------	-----------	---

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
MUHLE	Muhlenbergia	Muhly	Lower
BOUTE	Bouteloua	Grama	Lower
QUEM	Quercus emoryi	Emory oak	Upper
JUDE2	Juniperus deppeana	Alligator juniper	Upper

Description

Post-fire graminoids and herbaceous dicots with 10-30% cover dominated by grama and muhly grasses, asters, penstemons, and mid-height shrubs such as manzanita and silktassel. Alternate succession is used to account for the xeric soils by dividing the proportion of this type by the duration of Class A: $25\%/30\text{yrs} = 0.0083$.

Maximum Tree Size Class

Seedling <4.5ft

Class B	37	Mid Development 1 - Closed
----------------	-----------	-----------------------------------

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
JUDE2	Juniperus deppeana	Alligator juniper	Mid-Upper
QUEM	Quercus emoryi	Emory oak	Upper
MUHLE	Muhlenbergia	Muhly	Lower

Description

Woodlands in relatively productive draws and northerly aspects (average canopy cover is 50%).

Maximum Tree Size Class

Pole 5-9" DBH

Class C	25	Mid Development 1 - Open
----------------	-----------	---------------------------------

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
MUHLE	Muhlenbergia	Muhly	Lower
JUDE2	Juniperus deppeana	Alligator juniper	Mid-Upper
QUEM	Quercus emoryi	Emory oak	Upper

Description

Grasslands on southerly slopes and ridges, often with relatively shallow or poorly developed soils. Herbaceous cover is 25-70% (average cover is 50%); scattered trees and shrubs comprise 5-15% cover.

Maximum Tree Size Class

Medium 9-21" DBH

Class D 17 Late Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
MUHLE	Muhlenbergia	Muhly	Lower
JUDE2	Juniperus deppeana	Alligator juniper	Upper
QUEM	Quercus emoryi	Emory oak	Upper

Description

Open woodland derived from succession on slopes and ridgetops and from thinning on relatively productive soils. Woodland has 5-35% canopy, 25% average; alligator juniper, oaks, mountain mully, blue grama, and sideoats grama.

Maximum Tree Size Class

Large 21-33" DBH

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:OPN	29
Mid1:OPN	30	Late1:OPN	129
Mid1:CLS	30	Late1:OPN	129
Late1:OPN	130	Late1:OPN	999

Probabilistic Transitions

Disturbance Type	Disturbance occurs In	Moves vegetation to	Disturbance Probability	Return Interval (yrs)	Reset Age to New Class Start Age After Disturbance?	Years Since Last Disturbance
Mixed Fire	Early1:ALL	Early1:ALL	0.005	200	No	0
Replacement Fire	Early1:ALL	Early1:ALL	0.0066	152	Yes	0
Alternative Succession	Early1:ALL	Mid1:CLS	0.03	33	Yes	0
Surface Fire	Early1:ALL	Early1:ALL	0.03	33	No	0
Wind or Weather or Stress	Mid1:OPN	Mid1:OPN	0.005	200	No	0
Mixed Fire	Mid1:OPN	Mid1:OPN	0.01	100	No	0
Replacement Fire	Mid1:OPN	Early1:ALL	0.01	100	Yes	0

Surface Fire	Mid1:OPN	Mid1:OPN	0.03	33	No	0
Wind or Weather or Stress	Mid1:CLS	Early1:ALL	0.005	200	Yes	0
Replacement Fire	Mid1:CLS	Early1:ALL	0.0066	152	Yes	0
Surface Fire	Mid1:CLS	Mid1:CLS	0.03	33	No	0
Mixed Fire	Late1:OPN	Late1:OPN	0.01	100	No	0
Wind or Weather or Stress	Late1:OPN	Early1:ALL	0.01	100	Yes	0
Replacement Fire	Late1:OPN	Early1:ALL	0.01	100	Yes	0
Surface Fire	Late1:OPN	Late1:OPN	0.03	33	No	0

References

Alexander, R.R. and F. Ronco, Jr. 1987. Classification of the forest vegetation on the National Forests of Arizona and New Mexico. Res. Note RM-469. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 pp.

Anderson, H.E. 1982. Aids to Determining Fuel Models For Estimating Fire Behavior. Gen. Tech. Rep. INT-122. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 22 pp.

Arno, S.F. 2000. Fire in western forest ecosystems. Pages 97-120 in: J.K. Brown and J. Kapler-Smith, eds. Wildland fire in ecosystems: Effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.

Bailey, R.G. 1995. Descriptions of the ecoregions of the United States. 2nd ed. Rev. and expanded (1st ed. 1980). Misc. Publ. No. 1391 (rev.), Washington DC: USDA Forest Service. 108 pp. with separate map at 1:7,500,000.

Baker, W.L. and D.J. Shinneman. 2004. Fire and restoration of piñon-juniper woodlands in the western United States. A review. Forest Ecology and Management 189: 1-21.

Barton, A.M. 2002. Intense wildfire in southeastern Arizona: transformation of a Madrean oak-pine forest to oak woodland. Forest Ecology and Management 165: 205-212.

Barton, A.M. 1999. Pines versus oaks: effects of fire on the composition of Madrean forests in Arizona. Forest Ecology and Management 120: 143-156.

Brown, D.E, editor. 1982. Biotic communities -- southwestern United States and northwestern Mexico. Desert Plants 4(1-4): 1-342.

Brown, J.K. and J. Kapler-Smith, eds. Wildland fire in ecosystems: Effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.

DeBano, L.F., P.F. Ffolliott, A. Ortega-Rubio, G.J. Gottfried, R.H. Hamre and C.B. Edminster, technical coordinators. 1995. Biodiversity and Management of the Madrean Archipelago: The Sky Islands of the Southwestern United States and Northern Mexico. General Technical Report RM-264. Fort Collins, CO: USDA Forest Service Rocky Mountain Experiment Station.

Dick-Peddie, W.A. 1993. New Mexico vegetation past present and future. University of New Mexico Press, Albuquerque, NM. 244 pp.

Ffolliott, P.F., G.J. Gottfried, D.A. Bennett, V.M. Hernandez C., A. Ortega-Rubio and R.H. Hamre, technical coordinators. 1992. Ecology and Management of Oak and Associated Woodlands: Perspectives in the Southwestern United States and Northern Mexico. USDA Forest Service Rocky Mountain Experiment Station General Technical Report RM-218, Fort Collins, Colorado.

Ffolliott, P.F. et al., technical coordinators. 1996. Effects of Fire on Madrean Province Ecosystems: A Symposium Proceedings. USDA Forest Service General Technical Report RM-GTR-289. 277 pp.

Germaine, H.L. and G.R. McPherson. 1999. Effects of biotic factors on emergence and survival of *Quercus emoryi* at lower treeline. *Écoscience* 6: 92-99.

Gruell, G.E. 1999. Historical and modern roles of fire in pinyon-juniper. Pages 24-28 in: S.B. Monsen, R. Stevens, R.J. Tausch, R. Miller and S. Goodrich, compilers. Proceedings: ecology and management of pinyon-juniper communities within the Interior West. 15-18 Sept 1997, Provo, UT. Proceedings RMRS-P-9. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.

Hardy, C.C., K.M. Schmidt, J.P. Menakis and R.N. Samson. 2001. Spatial data for national fire planning and fuel management. *Int. J. Wildland Fire*. 10(3&4): 353-372.

Haworth, K. and G.R. McPherson. 1994. Effects of *Quercus emoryi* on herbaceous vegetation in a semi-arid savanna. *Vegetatio* 112: 153-159.

Kuchler, A.W. 1964. Potential Natural Vegetation of the Conterminous United States. American Geographic Society Special Publication No. 36. 116 pp.

McClaran, M.P. and G.R. McPherson. 1999. Oak savanna of the American Southwest. Pages 275-287 in R.C. Anderson, J.S. Fralish and J. Baskin, editors, *Savannas, Barrens, and Rock Outcrop Plant Communities of North America*. Cambridge University Press, Cambridge, England.

McNab, W.H. and P.E. Avers. 1994. Ecological subregions of the United States: section descriptions. USDA Forest Service, Ecosystem Management, Washington DC. WO-WSA-5. 250 pp. plus appendices and maps.

McPherson, G.R. and J.F. Weltzin. 1998. Response of understory to overstory removal in southwestern oak woodlands. *Journal of Range Management* 51: 674-678.

McPherson, G.R. and J.F. Weltzin. 2000. The role and importance of disturbance and climate change in U.S./Mexico borderlands: a state-of-the-knowledge review. USDA Forest Service Rocky Mountain Research Station General Technical Report RMRS-GTR-50.

NatureServe. 2004. International Ecological Classification Standard: Terrestrial Ecological Classifications. Terrestrial ecological systems of the Great Basin US: DRAFT legend for Landfire project. NatureServe Central Databases. Arlington, VA. Data current as of 4 November 2004.

NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.

Romme, W.H., L. Floyd-Hanna and D. Hanna. 2003. Ancient pinyon-juniper forests of Mesa Verde and the West: a cautionary note for forest restoration programs. Pages 335-350 in: P.N. Omi and L.A. Joyce. tech. eds. Fire, fuel treatments, and ecological restoration: conference proceedings. 16-18 April 2002. Fort Collins, CO. Proceedings RMRS-P-29. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 475 pp.

Schmidt, K.M., J.P. Menakis, C.C. Hardy, W.J. Hann and D.L. Bunnell. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. Gen. Tech. Rep. RMRS-GTR-87. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 41 pp. + CD.

Soule', P.T. and P.A. Knapp. 1999. Western juniper expansion on adjacent disturbed and near-relict sites. *Journal of Range Management* 52: 525-533.

Soule', P.T. and P.A. Knapp. 2000. *Juniperus occidentalis* (western juniper) establishment history on two minimally disturbed research natural areas in central Oregon. *Western North American Naturalist* (60)1: 26-33.

Swetnam, T.W. and C.H. Baisan. 1994. Historical Fire Regime Patterns in the Southwestern United States since AD 1700. Pages 11-32 in: C.T. Allen, tech ed., Fire Effects in Southwestern Forests, Proceeding of the Second La Mesa Fire Symposium, General Technical Report RM-GTR-286.

Swetnam, T.W. and C.H. Baisan 1996. Fire histories of montane forests in the Madrean Borderlands. Pages 15-36 in P.F. Folliott et al. tech. coords., Effects of fire on Madrean Province Ecosystems, A symposium proceedings, USDA Forest Service General Technical Report RM-GTR-289.

Tausch, R.J. and N.E. West. 1987. Differential Establishment of Pinyon and Juniper Following Fire. *American Midland Naturalist* 119(1): 174-184.

USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2002, December). Fire Effects Information System, [Online]. Available: <http://www.fs.fed.us/database/feis/> [Accessed: 11/15/04].

Webster, G.L. and C.J. Bahre, editors. 2001. *Changing Plant Life of La Frontera: Observations on Vegetation in the United States/Mexico Borderlands*. University of New Mexico Press, Albuquerque. 260 pp.

Weltzin, J.F. and G.R. McPherson. 1999. Facilitation of conspecific seedling recruitment and shifts in temperate savanna ecotones. *Ecological Monographs* 69: 513-534.

Weltzin, J.F. and G.R. McPherson. 2000. Implications of precipitation redistribution for shifts in temperate savanna ecotones. *Ecology* 81: 1902-1913

Wright, H.A., L.F. Neuenschwander and C.M. Britton. 1979. The role and use of fire in Sagebrush-Grass and Pinyon-Juniper Plant Communities. Gen. Tech. Rep. INT-GTR-58. Ogden, UT: USDA Forest Service, Intermountain Research Station. 48 pp.