The once open and park-like forests: The fire ecology of longleaf and ponderosa pine

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OUTLINE

Why talk about these two species together

Historical overview of the forests

Ecology of the species

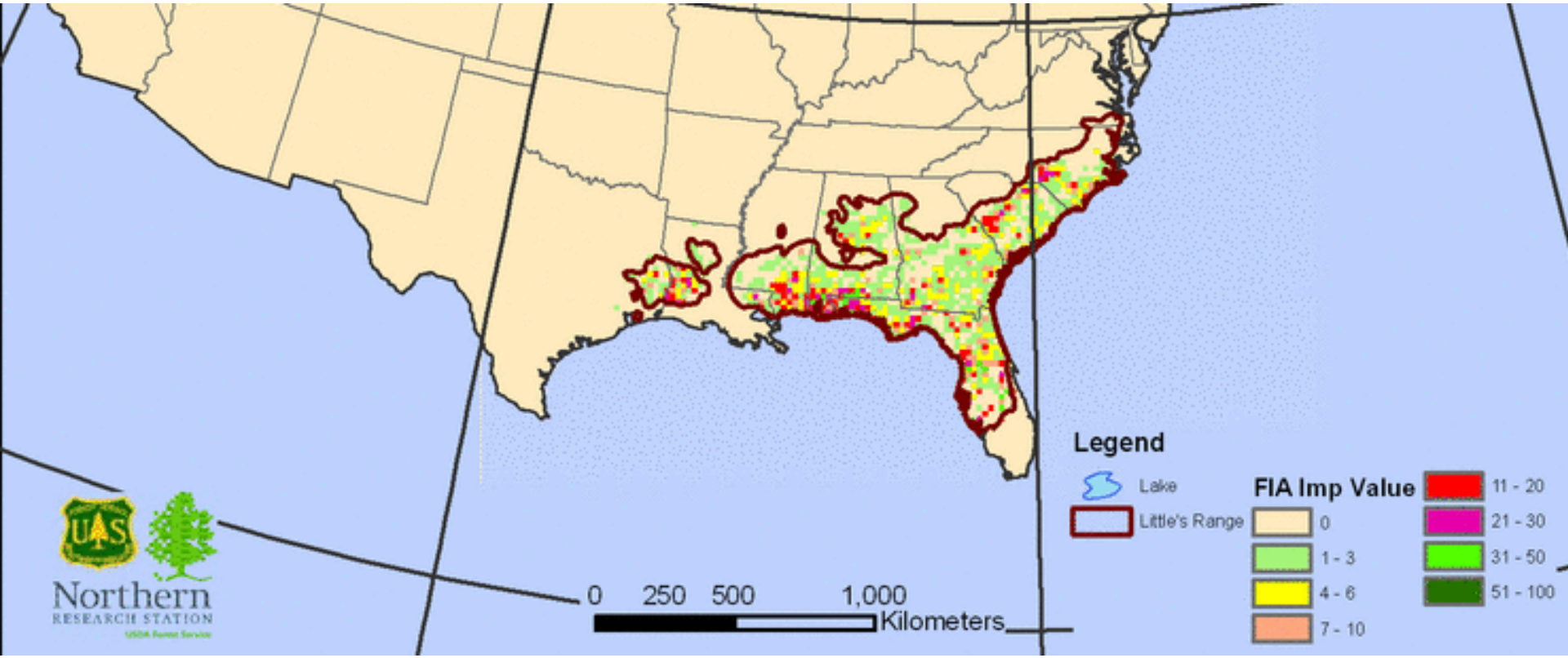
Rant about what “we do” with longleaf

More history

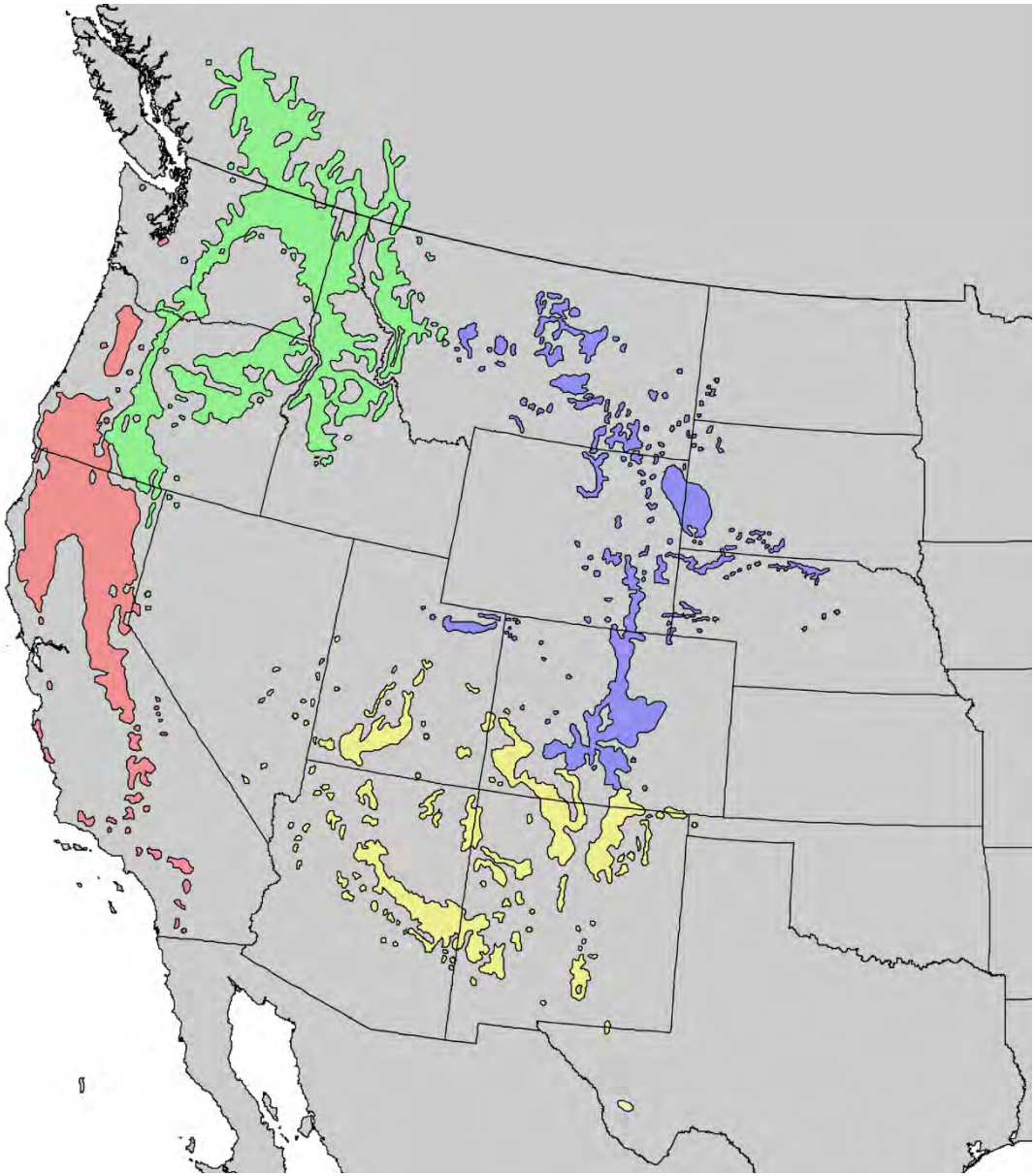
Conclusion

Why longleaf (swampy/marshy) and ponderosa (heavy) pine?

Longleaf pine range map



Ponderosa pine range map with sub-species



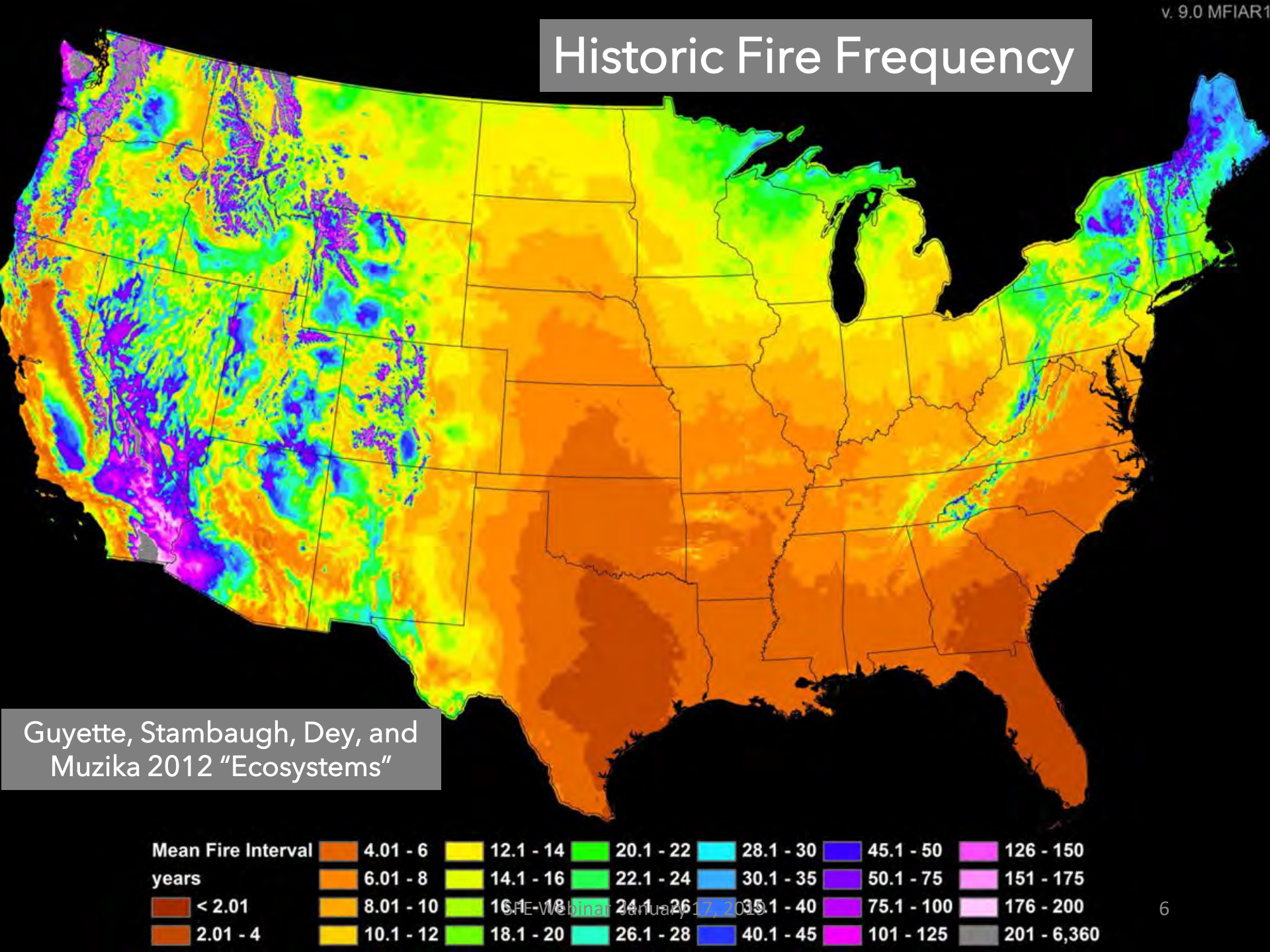
Principle species on over 27 million acres

California has the greatest concentration followed by Oregon and then a combination of Arizona and New Mexico

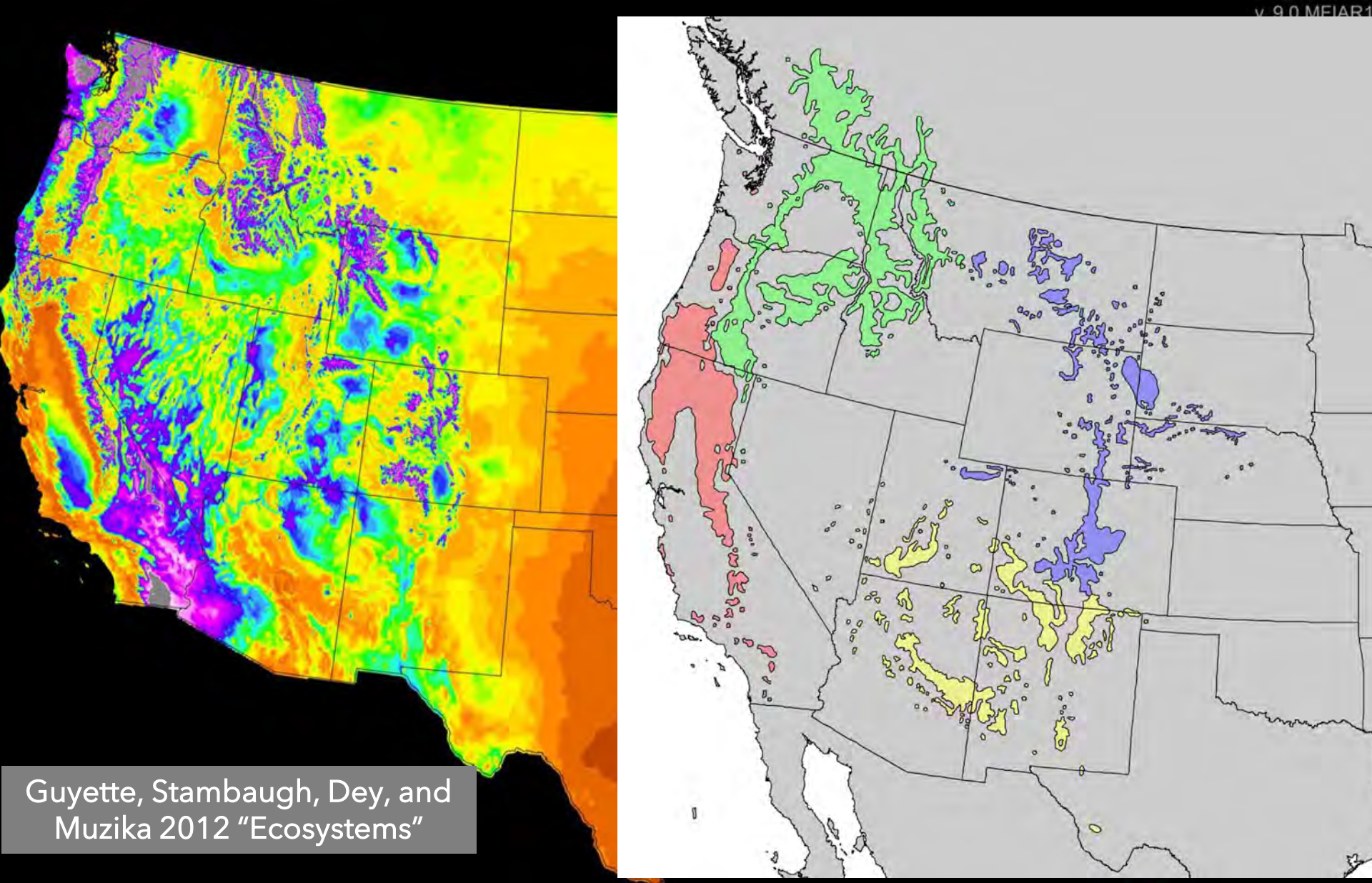
green - *Pinus ponderosa* subsp. *ponderosa*
red - *Pinus ponderosa* subsp. *benthamiana*
blue - *Pinus ponderosa* subsp. *scopulorum*
yellow - *Pinus ponderosa* subsp. *brachyptera*

and var. washoensis

Historic Fire Frequency

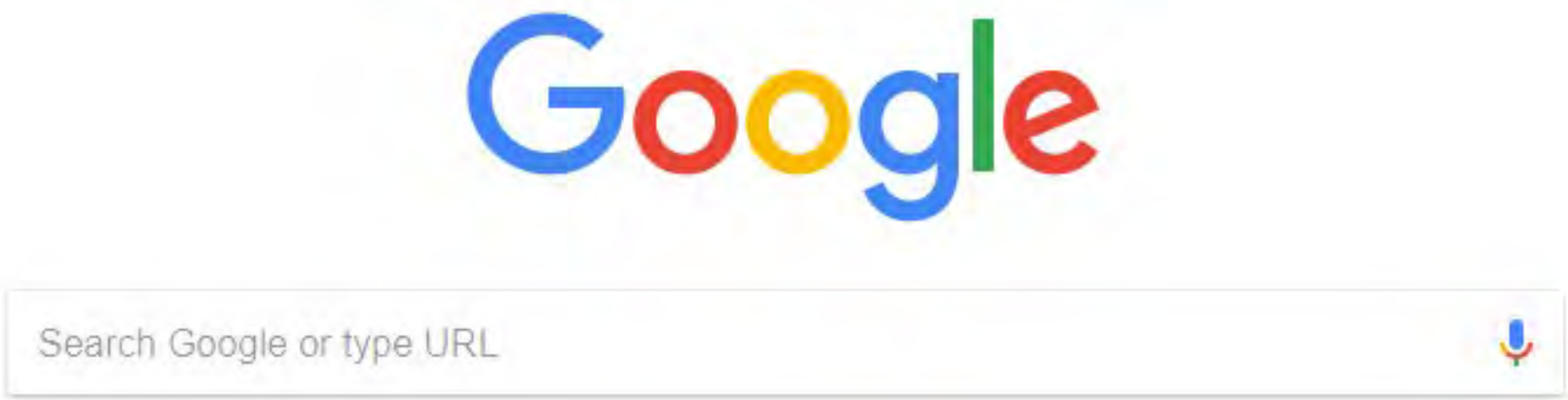


Guyette, Stambaugh, Dey, and Muzika 2012 "Ecosystems"


Guyette, Stambaugh, Dey, and Muzika 2012 "Ecosystems"
Mean Fire Interval
years
< 2.01
2.01 - 4
4.01 - 6
6.01 - 8
8.01 - 10
10.1 - 12
12.1 - 14
14.1 - 16
16.1 - 18
18.1 - 20
20.1 - 22
22.1 - 24
24.1 - 26
26.1 - 28
28.1 - 30
30.1 - 35
35.1 - 40
40.1 - 45
45.1 - 50
50.1 - 75
75.1 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 6,360

Where to begin?

Where else!



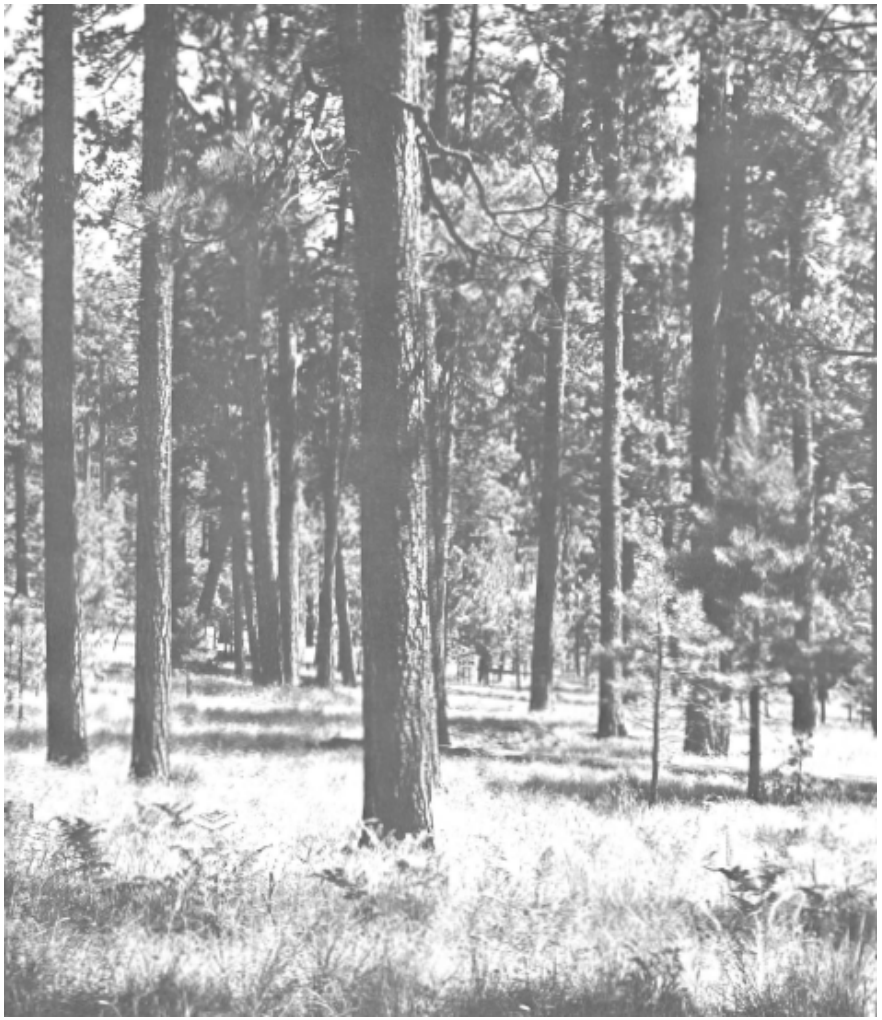
Google Scholar search:

"Ponderosa pine fire ecology"
over 36,000 hits

"Longleaf pine fire ecology"
over 14,700 hits

Very little difference in these two ecosystems

Longleaf pine at Greenwood Plantation – periodically burned for more than 75 years



Ponderosa pine in Malay Gap, Arizona – natural lightning fires every 6 or 7 years

The previous photographs came from:

Miscellaneous Publications | TALL TIMBERS RESEARCH STATION

Ponderosa Fire Management

A Task Force Evaluation of Controlled Burning in Ponderosa Pine Forests of Central Arizona

HAROLD H. BISWELL, HARRY R. KALLANDER, ROY KOMAREK, RICHARD J. VOGL, AND HAROLD WEAVER

MISCELLANEOUS PUBLICATION NO. 2

PUBLISHED BY

TALL TIMBERS RESEARCH STATION

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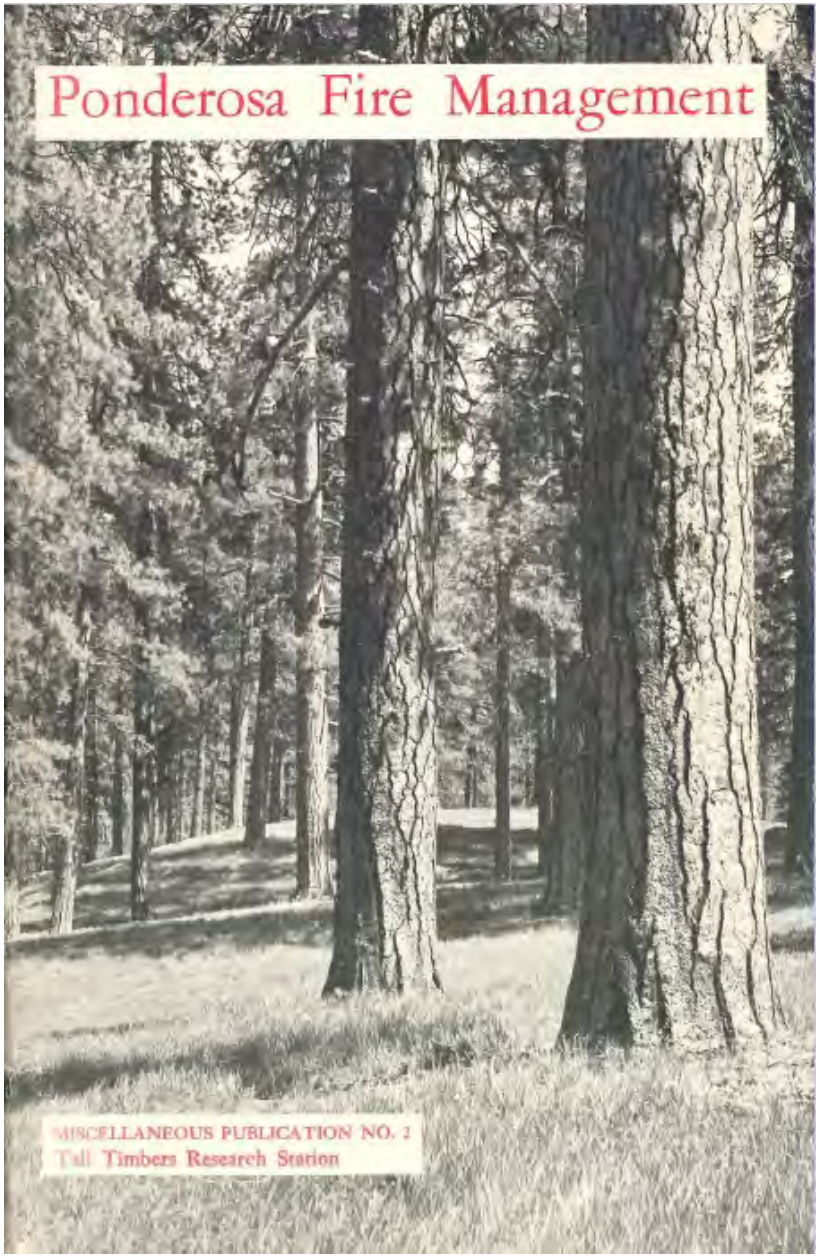


Historical overview of the two ecosystems

Bartram (1791), an early traveler through the Southeast, described communities he witnessed as:

"This plain is mostly a forest of the great long-leaved pine (P. palustris Linn.), the earth covered with grass, interspersed with an infinite variety of herbaceous plants, and embellished with extensive savannahs, always green, sparkling with ponds of water"

Steep hillside of weathered gneiss along Chestnut Creek about three miles below Verbena, Chilton County. Trees mostly longleaf pine. (February 2, 1906)

R. Harper (1943) Monograph 10: Forest of Alabama. Geologic Survey of Alabama, University, Alabama

Longleaf pines, boxed for turpentine in the old-fashioned way, on rocky hills about a mile south of Marble Valley, Coosa County. (February 2, 1913) R. Harper (1943) Monograph 10: Forest of Alabama. Geologic Survey of Alabama, University, Alabama

Longleaf pine forest on nearly level sandy loam 4 ½ miles north of Jasper on road to South Lowell, Walker County. (April 1, 1906)

R. Harper (1943) Monograph 10: Forest of Alabama. Geologic Survey of Alabama, University, Alabama

Lt. Edward Beale (1857), traveling through northern Arizona:

"It is the most beautiful region I ever remember to have seen in any part of the world. A vast forest of gigantic pines, intersected frequently with open glades, sprinkled all over with mountain meadows and wide savannahs, and covered with the richest grasses, was traversed by our party for many days."

Weaver, H. 1961. Ecological changes in the ponderosa pine forest of Cedar Valley in southern Washington. Ecology 42(2):416-420.

FIG. 1. The open parklike appearance still prevails on limited portions of the ponderosa pine forest in the upper Klickitat drainage. Ground cover consists principally of pinegrass. Almost all of Cedar Valley once looked like this.

Ecology of the two species

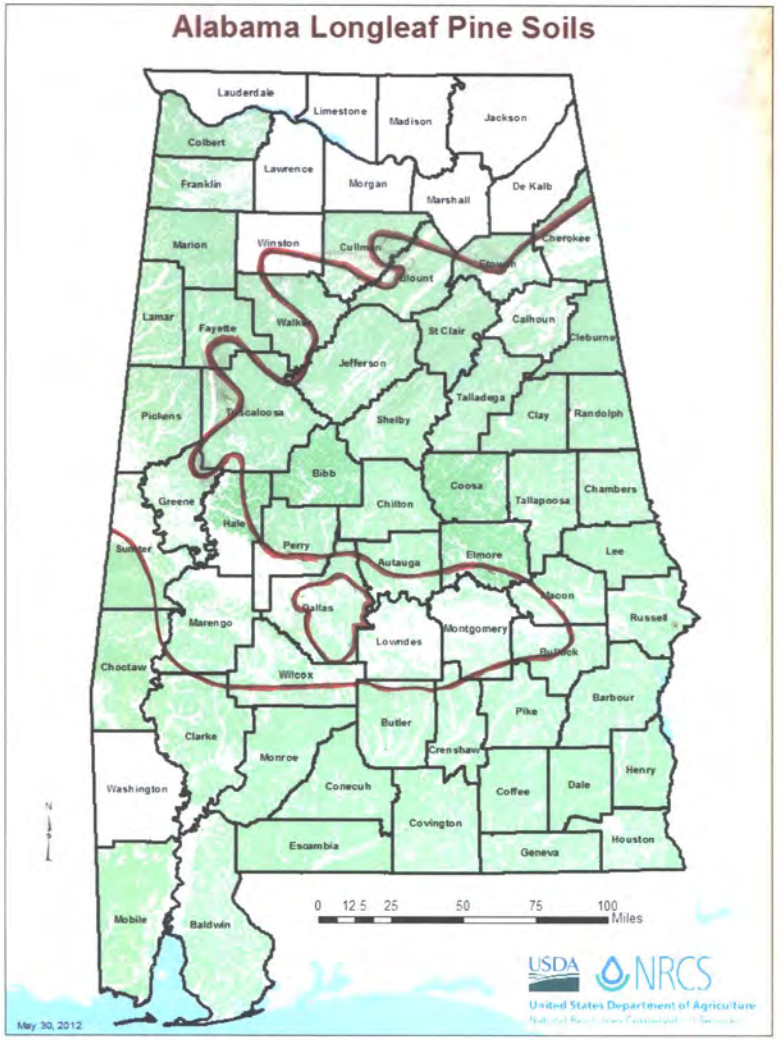
Ecology of longleaf and ponderosa pine

Historically, forests for both species often contained many small, even-aged groups rather than a true uneven-aged structure (several 1000/acre)

Ecology of longleaf and ponderosa pine

Longleaf: sea level to 1,800′
Ponderosa: sea level
to 10,000′

Both species occur on most any soil within their range



Ecology of longleaf and ponderosa pine

- No regularity in seed production
- Average interval between heavy cone crops is 8 years for both species
- Heavy seed not disseminated very far – 120’
  - Ponderosa: distribution of summer rainfall limits seedling establishment

Ecology of longleaf and ponderosa pine

- Buds have thick outer scales to help protect meristematic tissue from heat

Ecology of longleaf and ponderosa pine

- Long needles with high moisture content around terminal buds help to protect meristematic tissue within bud

Ecology of longleaf and ponderosa pine

Thick bark that develops early in life (Ponderosa can take fire when basal diameter reaches 2″)

Exfoliating bark which sloughs off when bark is on fire

(This is a problem for both trees when fire is lacking and a heavy mulch layer develops at the base of a tree)

Ecology of longleaf and ponderosa pine: Fire Return Intervals

Longleaf: 1-10 years

Ponderosa: 2-47 years (much of this dating resulted from fire-scar research)

It is very site-specific

S. Fitzgerald (2005) Fire ecology of ponderosa pine and the rebuilding of fire-resilient ponderosa pine ecosystems. USDA Forest Service Gen. Tech. Rep. PSW-GTR-198

Table 1 – Fire return intervals by region and plant series for climax and seral ponderosa pine (adapted from Agee (1994) and Baker and Ehle (2001)).

Geographic Region	Mean Fire Return Interval	Median Fire Return Interval	Composite (C) or Point (P) Sample	Plant Series	Study
Central Washington (E. Cascades)	18.8	15.5	C	Douglas-fir	Wright and Agee (2004)
	20.6	17.4	C	Grand fir (dry)	Wright and Agee (2004)
	7	6.7	C	Douglas-fir	Everett and others (2000)
	7-11	--	C	Douglas-fir	Wischonfske and Anderson (1983)
	23.9	20.6	C	Grand fir (wet)	Wright and Agee (2004)
Northeast Washington	10-24	--	P	Douglas-fir	Finch (1984)
Northern Rocky Mountains:					
Western Montana	6-11	--	P	Ponderosa pine	Arno (1976)
	7-19	--	P	Douglas-fir	Arno (1976)
South Dakota (Black Hills)	20-23	--	C	Ponderosa pine	Brown and Sieg (1996)
	10-12	--	C	Ponderosa pine	Brown and Sieg (1999)
Central Oregon (E. Cascades)	16-38	--	C	Ponderosa pine (dry)	Bork (1985)
	7-20	--	C	Ponderosa pine (mesic)	Bork (1985)
	9-25	--	C	White fir	Bork (1985)
North-central Oregon (E. Cascades)	11-16	--	P	Ponderosa pine	Weaver (1959)
	3-36	--	P	Ponderosa pine	Soeriaatmadja (1966)
Northeast Oregon (Blue Mts.)	10-43	20	C	Ponderosa pine	Heyerdahl and others (2001)
	10		P	Douglas-fir	Hall (1976)
	12-53	5-15	C	Douglas-fir	Heyerdahl and others (2001)
	47	--	P	White fir	Weaver (1959)
	13-71	15	C	White fir	Heyerdahl and others (2001)
South-central Oregon (Cascades)	9-42	--	C	White fir	McNeil and Zobel (1980)

Table 1 -- continued

Northern California (S. Klamath Mts.)	11.5	--	C	Ponderosa & limber pine	Taylor and Skinner (2003)
	13.0	--	C	Douglas-fir	Taylor and Skinner (2003)
	13.0	--	C	Douglas-fir/white fir	Taylor and Skinner (2003)
	12.5	--	C	Douglas-fir/ponderosa pine/incense-cedar	Taylor and Skinner (2003)
	13.5	--	C	Douglas-fir &limber pine	Taylor and Skinner (2003)
Northern California (N. Klamath Mts.)	12.0-15.5	--	C	Douglas-fir	Taylor and Skinner (1998)
Northern California (S.Cascades Mts.)	21.4	12.0	C	Ponderosa pine	Norman and Taylor (2003)
Central California (Westside Sierras)	9-18	--	C	White fir	Kilgore and Taylor (1979)
Central Rocky Mountains:					
San Juan Mts.	6-13	5-9	C	Ponderosa pine	Grissino-Mayer and others (2004)
	19-30	19-29	C	Mixed conifer	Grissino-Mayer and others (2004)
Northern Front Range	8.3-22.4	6.4-11.6[1]	C	Ponderosa pine	Veblen and others (2000)
	17.2-18.6	8.1-10.4[1]	C	Douglas-fir	Veblen and others (2000)
Southern Rocky Mountains:					
North-central Arizona	3.7	4	C	Ponderosa pine	Fulé and others (1997)
	7.4	6	C	Ponderosa pine	Fulé and others (2003)
	8.7	5	C	Mixed conifer	Fulé and others (2003)
Arizona	4-12	--	P	Ponderosa pine	Weaver 1951
Arizona	1.8	--	C	Ponderosa pine	Dieterich 1980
Southwest New Mexico	5-8	--	C	Ponderosa pine	Swetnam and Dieterich (1985)

[1] Weibull median probability interval

Ecology of longleaf and ponderosa pine: Fire Seasonality

Longleaf: lightning season (historically)

Ponderosa:
northcentral WA – 80% late growing season
eastern OR – no consistent timing
northern CA - 93% dry midsummer through early fall
AZ - 40% late spring; 60% July to September

Ecology of longleaf and ponderosa pine

Longleaf most fire tolerant conifer in the Southeast

Ponderosa most fire tolerant conifer in the West

Well-suited to survive frequent, low-intensity fires

THE RESULT: open and park-like forests

My longleaf pine rant!

Recent conversation:

Consulting forester: "We planted longleaf 11 years ago and now the stand looks like garbage. It is filled with loblolly and sweetgum. There's a bunch of us that will never plant it again."

Kush: "How often did you burn it?"

Consulting forester: "We never did. We do not recommend using fire in young pine stands."

My longleaf pine rant!
Longleaf pine plantation

My longleaf pine rant!
If you have loblolly pine, sweetgum, etc…seed source nearby, it will fill in the stand if it is not burned

My longleaf pine rant!
The tree with the ribbon is the only longleaf pine visible from the photo point

My longleaf pine rant!

Findings in 2014

Species	Density (trees/ac)	Basal Area (ft^2/ac)
Longleaf	75	9.7
Loblolly	545	69.3
Hardwoods	540	55.9

Most people still refer to this as a longleaf pine plantation

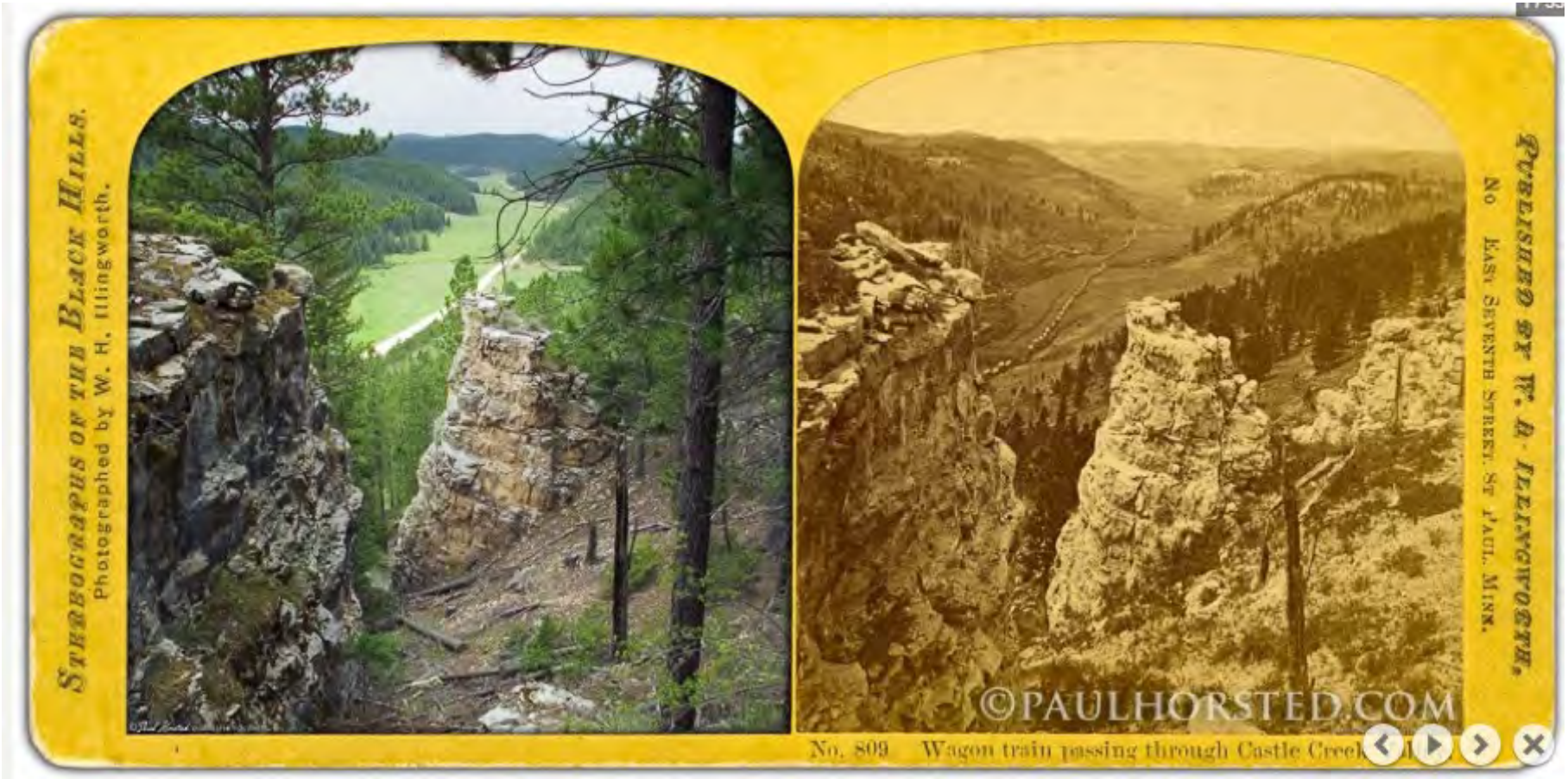
IT IS NOT A LONGLEAF PINE PLANTATION

8-year old loblolly pine plantation – Never burned and still a few years away from being able to be burned safely

8-year old longleaf pine plantation; burned 3 times since planting – It can be done!!!

What has happened ponderosa pine forests

Increase in ponderosa pine on the surrounding hills – no longer the open, park-like forest



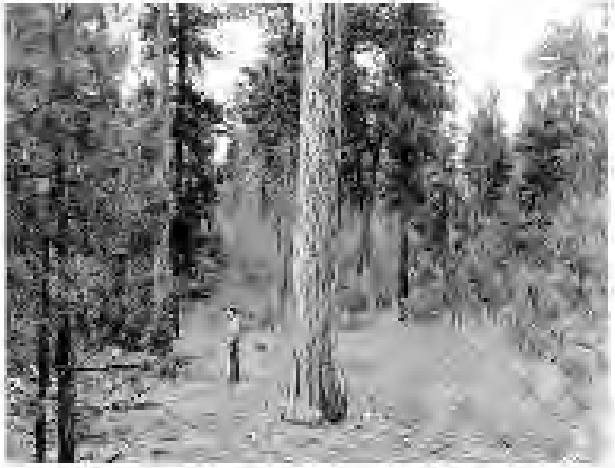
Right – Photograph taken in 1874 when General Custer came through the Black Hills

Left – Photograph taken in 2000 with approximate same vantage point

Photos courtesy of Paul Horsted/custertrail.com (Grafe and Horsted 2002)

Ponderosa pine photo series

1909



1948

1989

Forest development on the Bitterroot National Forest in Montana in a ponderosa pine stand after harvest (1909) in which fire was excluded since 1895. Note the changes in vertical arrangement and horizontal continuity in forest stand structure. (Gruell and others 1982, Smith and Arno 1999, Graham and others 2004)

Biswell, H.H. 1958. Prescribed burning in Georgia and California compared. Journal of Range Management 1958 11(6): 293-297

Left: Second-growth ponderosa pine at Hobergs before burning. Note the understory of dead manzanita and the extremely high fire hazard. *Right:* The area was broadcast burned, after which the dead manzanita was burned in small piles. The great reduction in wildfire hazard is apparent.

Weaver, H. 1943. Fire as an ecological and silvicultural factor in the ponderosa pine region of the Pacific Slope. Journal of Forestry 41(1):7-15.

Figure 1. This stagnating stand of 37-year-old reproduction near Nespelem. Washington, is typical of the dense even-aged stands of ponderosa pine that have developed since the advent of total fire exclusion.

Figure 2. A portion of the stand shown in Figure 1 as it appeared in 1941 after being thinned by a surface fire in 1914. In the background and to the right can be seen the edge of the stagnating thicket, along and outside of the 1914 fire line.

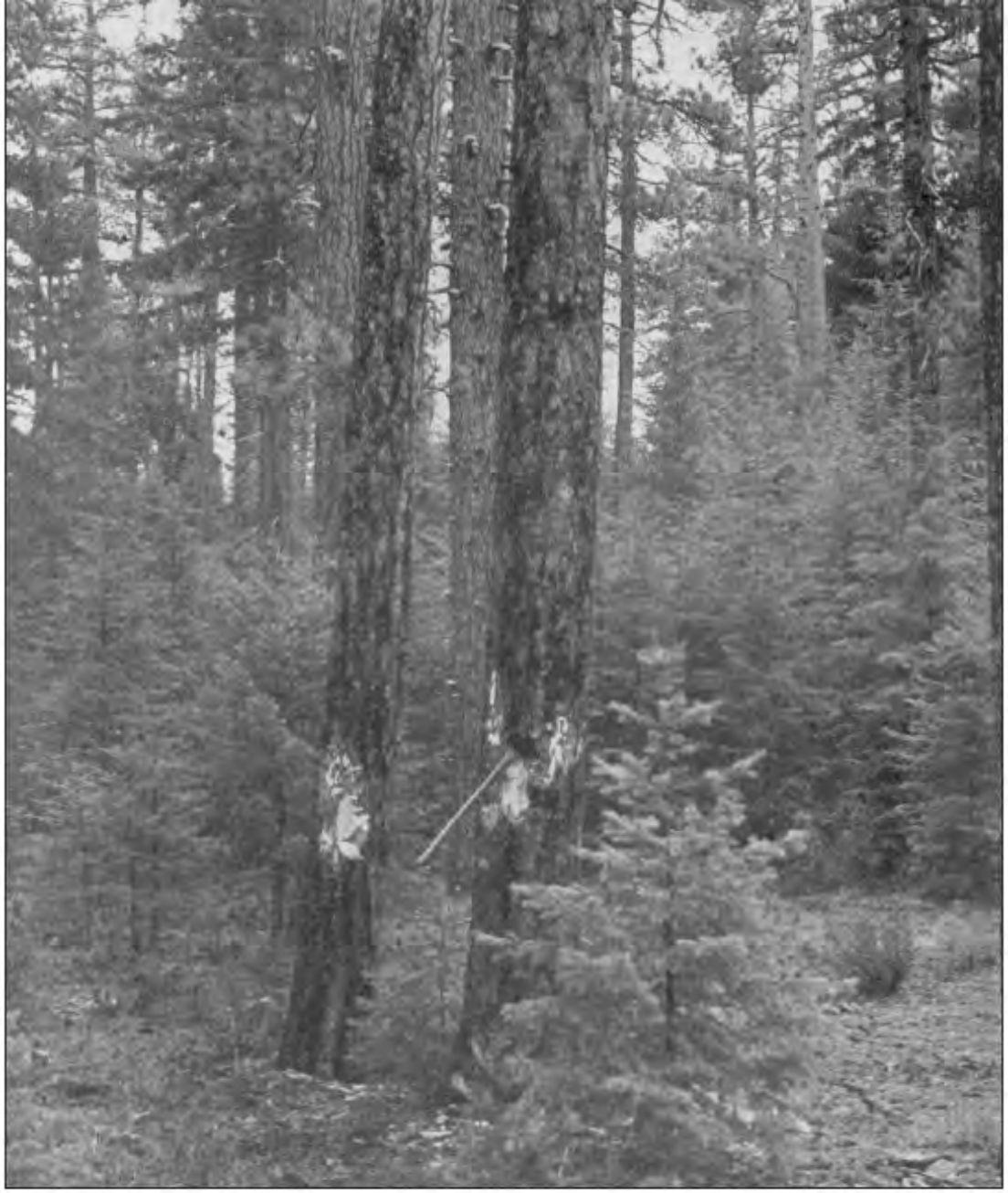


Figure 3. This stand near Badger Creek, Warm Springs Indian Reservation, Oregon, is typical of vast areas of the ponderosa pine region where, as a result of total fire exclusion, dense even-aged stands of Douglas-fir reproduction are monopolizing the ground under the mature ponderosa pines.

Historical comments to serve as almost my final remarks

Biswell's final remarks from Tall Timbers Miscellaneous Publication No. 2, 1973

SUMMARY

Fire has played an integral role in the evolution of the ponderosa pine. Through a long evolutionary period its preservation as a species was assured by the development of resistance to fire. Periodic lightning-set fire occurring at intervals of about 6–7 years maintained low fuel levels. Thus, fires were usually of low intensity and effectively pruned back woody competing vegetation, prepared a receptive soil surface for seed fall and thinned seedling regeneration to prevent the development of stagnated "dog-haired" thickets of reproduction.

One of the most primeval-like ponderosa pine forest areas remaining in western United States is located in the Malay Gap area of the San Carlos Indian Reservation. We urge the San Carlos tribe to set aside this area as a natural reserve for observation, comparison and ecological research. In certain places there has been no logging or fire control previous to 1947. If such a reserve is established, controlled burning at 6–7 year intervals is recommended. When fuels have been reduced, lightning-set summer fires may be permitted to run their course with minimum surveillance.

Longleaf pine literature

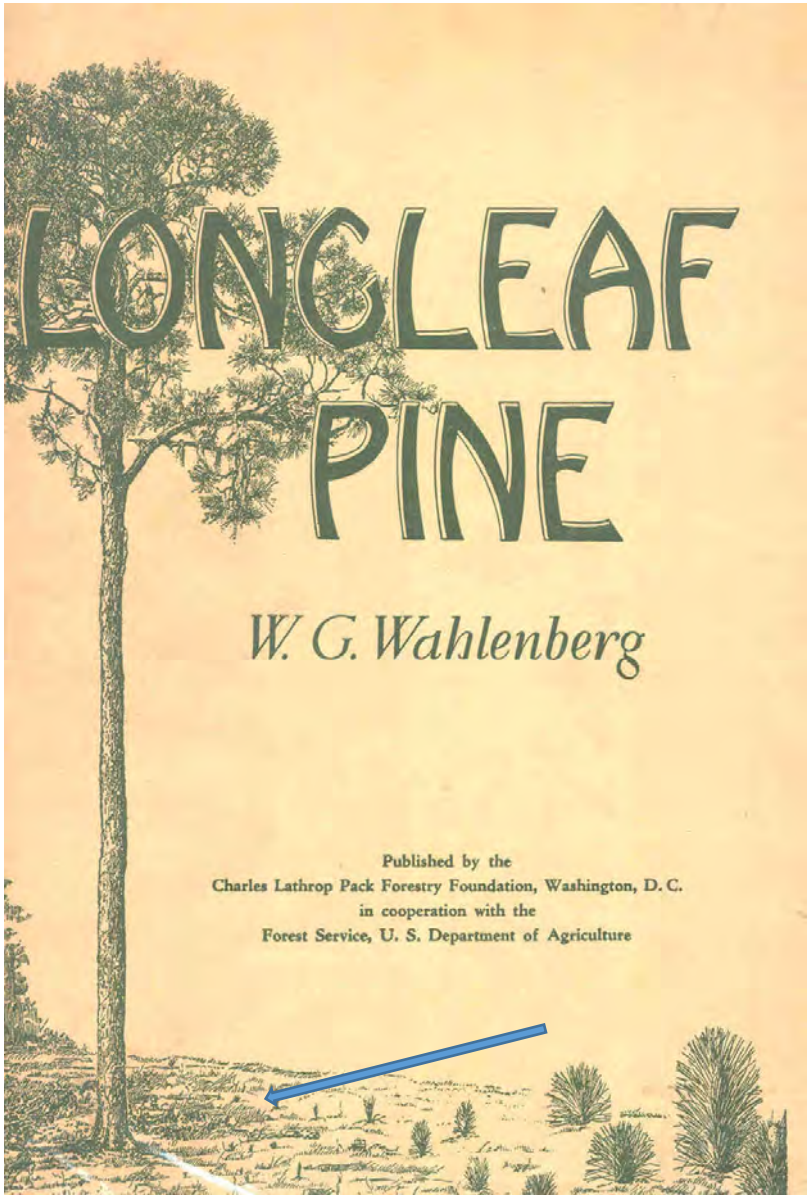
Gifford Pinchot, 1899. The relations of forests and forest fires. National Geographic Magazine, 393-403.

"Almost all trees readily yield to slight surface fires during the first 10-15 years of their life. To this statement longleaf pine is a conspicuous and rare exception."

H.H. Chapman (1932. Is the longleaf type a climax? *Ecology* 13:328-334)

" It must be emphasized that a forest type is the form of vegetation best adapted to survive not merely a few selected conditions like soil and climate, but all the conditions that arise over the life span of the individual trees of which it is composed. In the longleaf pine type of the south fire at frequent but not necessarily annual intervals is as dependable a factor of site as is climate or soil. "

"The conception of a climax type as one which has reached a stage of permanent equilibrium or perfect adaptation to these constant factors of site should include the longleaf pine type of the south, which presents by far the greatest area and most permanent characteristics of any climax to be found in the United States."



Wahlenberg (1946) wrote:

"Mismanagement of longleaf pine has been the rule rather than the exception, due to the ignorance of the unique life history and incomplete knowledge of factors determining the life and death of seedlings and hence the succession of forest types."

Chapman H.H. 1947. Prescribed burning versus public forest fire services Journal of Forestry 45:804-808

Forest Service was guided by the knowledge of destructive fires elsewhere in the country and thus wanted total fire exclusion in the South

The writer first began his observations on the ecology of southern pines in the Missouri Ozarks in 1907, where fires were evidently the cause of destruction of practically all small, shaded seedling shortleaf pines on uncut areas. But in 1908, in the longleaf pine hills of north central Alabama, the absolute necessity of a ground fire to expose mineral soil was demonstrated on contrasted areas where the seed crop was so large that every worm hole in the rotten logs contained a sprouting seedling pine! At that time the writer concluded that close observation of ecological behavior must be substituted for precepts inculcated in the classroom and in existing practice, and that for a given species and region, the behavior of the species and its reaction to environment might not conform to that of other species in distant regions with different environment. This seemed like a sensible view in the light of the fact that man proposes but nature disposes, and that only by conforming with natural laws can he turn them to his benefit —as he has done in agriculture.

Our investigation of the ecological role of fire in securing longleaf pine reproduction and survival was fortunately located permanently at Urania, Louisiana from 1920 to date, on the land of Henry Hardtner, to whose willingness to cooperate in actually applying the technique of prescribed fire and taking the risk, on his own property, the South and the profession owe a debt which can never be repaid. By 1926 it had been learned that a fire preceding the seedfall was only the first step. Exclusion of subsequent fires had the following results:

a. Prevented all subsequent establishment of longleaf seedlings.

b. Permitted competing species of pines and hardwood to exterminate established longleaf seedlings by shade.

c. Most important of all, permitted brown spot disease to defoliate, stunt, and kill the seedlings and decimate the stand.

Take-home message

Look at the groundcover and its structure

Some grasses, a pretty good coverage of low, woody shrubs

Photo: Dr. Sharon Hermann

Take-home message

Look at the groundcover and its structure

Heavy grass component; little woody shrub cover

Photo: Dr. Sharon Hermann

Take-home message

Photograph taken in October: Examine the fire effects

Stephen J. Pyne (1982) Fire in America: A cultural history of wildland and rural fire. Princeton University Press

Chapter 3:
Our Pappies Burned the Woods: A Fire History of the South

"The fire history of the South is in good part a history of its FUELS."

CONCLUSIONS

Ecological change for longleaf and ponderosa pine

- Heaving grazing and active fire suppression after 1910 disrupted the natural fire regime
- Grazing heavily impacted most of the forests
- What forests were left had above-normal fuel accumulations and abundant tree regeneration
- Where logging removed many of the larger trees, other species filled in (Douglas-fir and true firs for ponderosa creating ladder fuels)

Biswell, H.H. 1958. Prescribed burning in Georgia and California compared. Journal of Range Management 1958 11(6): 293-297

Number of Days Suitable for Burning

The number of days suitable for prescribed burning varies from spot to spot depending on combinations of objectives and fuel conditions. A day suitable for burning one area may not always be suitable for another.

In Georgia, records were never kept of the number of days suitable for prescribed burning on the Experimental Range. However, there were never more than 20 to 25 days per winter when all favorable conditions combined for safe effective burning in any one spot.

In California, however, records have been kept for four seasons of the days suitable for prescribed burning at Hobergs. These records extended over the period from the time the duff and upper soil were first thoroughly wet in the fall to April 1 of the next year. The number of days varied from 47 to 74 per season for the four periods. Once ponderosa pine needles are thoroughly wet the lower layers dry out slowly, providing long periods for prescribed burning. For example, in January and February, 1952-53, burning was possible for 29 successive days before the lower layers became so dry that much of the duff was destroyed. Again, in 1955-56 prescribed burning was possible on successive days for a full month. The greater number of days suitable for burning in California than in Georgia was due mainly to the slower drying out of the fuel next to the soil and less to the importance of direction and intensity of wind.

Where are we at today with longleaf and ponderosa pine: Fire Re-introduction

- Prescribed burning is limited due to heavy accumulations of surface and ladder fuels
- Other mechanical treatments are being used prior to burning to reduce fuels
  - Mowing, pruning, thinning
- Herbicides are very beneficial (required) in the South; very little mention with ponderosa

For longleaf pine

The fuels are not the same and the season is not the same as when longleaf pine was evolving

For longleaf pine

Burn longleaf early in life

Burn longleaf often in life

Burn longleaf in the growing season

Thank you for your time and attention!
Any questions?