Population Distribution and Age Structure on Baker Cypress Stands in Northern California and Southern Oregon

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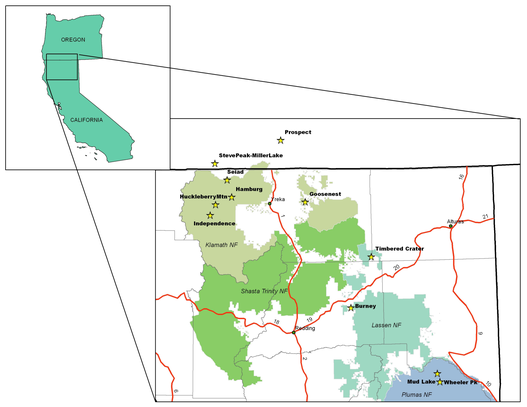
ABSTRACT

Baker cypress, *Callitropsis bakeri*, is a rare conifer, endemic to northern California and southern Oregon. Fire is essential for the successful regeneration of this species. However, long-term fire suppression in many of these stands has resulted in encroachment from other conifer species and an overall decline in the number of existing trees. The goal of our research has been to collect information on the current status in each of the 11 populations and to develop management guidelines that may help to prevent further decline. We collected information on stand age and density, cone distribution and seed number, seed viability, and fuel loading in each of the Baker cypress populations. Tree ages for most populations with no recent fire history range between 70—150 years. Age variation within a stand is dependent on the number of fires in recent years and fire intensity. Other factors affecting stand health include population size, soil type and cone number. We will discuss differences in tree distribution and density among Baker cypress populations and suggest how these differences may influence management decisions for conservation of this species.



Where to find Baker Cypress

Baker Cypress is found in 11 different general locations. The majority of these populations fall within the Klamath-Siskiyou bioregion with additional populations to the south as far down as Wheeler Peak on the Plumas National Forest. The northern most population occurs at Flounce Rock in Oregon just northeast of the Lost Creek Reservoir. Several of these populations are fairly small and cover 5 acres or less. Three populations cover more than 300 acres. The largest population occurs in California near Timbered Crater, at the junction of Siskiyou, Modoc and Lassen counties, where trees are scattered across approximately 7000 acres of lava flows.

Figure 3. Baker cypress near town of Seiad

HABITAT & APPEARANCE

Baker Cypress is a tree with reddish-brown bark and grey-green foliage. Trees average 28 feet in height with an average DBH of 7.6" but these measurements vary widely. The tallest Baker cypress measured was 92 feet while at sites with harsh soils it is possible to find trees 40–50 years of age that are still less than 1 foot in height. Baker cypress occurs on a variety of soil types, however the largest populations occur on ultramafic soils to the west and volcanic soils to the east. These environments are rocky and dry with shallow soils that may allow Baker Cypress to successfully compete against other species. In more mesic environments with deeper soils, other conifer species, such as Douglas fir and white fir eventually overtop Baker cypress. High light environments are optimal for good cone production. Large trees in the open environments may have over 10, 000 cones, but more typically trees have between 500—2500 cones. In locations where trees have been over-topped, cone production dwindles and trees will have lower cone numbers in the range of 50-250.

Location	National Forest	Estimated Size (acres)	Elevation	Soil Type
Seiad	Klamath	800	3,000-3,800	ultramafic
Independence	Klamath	< 5	4,800	granitic
Huckleberry Mtn.	Klamath	55	3,800-4,600	ultramafic
Goosenest Mtn.	Klamath	300	5,000-6,000	volcanic
Hamburg	Klamath	16	4,400-5200	ultramafic
Mud Lake / Wheeler Pk	Plumas	307 / 73	6,400-6,900	volcanic
Hat Creek / Burney	Lassen		4,500-5,000	volcanic
Timbered Crater	Lassen/BLM	7,000	3,500-4,000	volcanic
Flounce Rock-Prospect, OR	BLM	< 3	4,000	metasedimentary
Steve Peak, OR	Rogue Siskiyou	< 50		metasedimetary

REGENERATION AND FIRE

Baker Cypress is a fire dependent species. Cones remain closed on the tree until they are opened by fire or the tree dies. Fire is also important for removing above-ground vegetation and exposing bare mineral soil so that dropped seeds have a place to germinate. Fire in Baker Cypress stands is often a stand replacing event. Many populations are dense masses of pole-sized trees that create heavy ground and ladder fuels. When these stands burn at high to moderate intensity, these pole-size trees are removed leaving a habitat ideal for seedling germination. In our surveys we found very few seedlings that germinated without fire—maybe 10 total individuals across all plots. In comparison, in plots where fire had occurred within the past 3 years, seedling density was as high as 90 plants/sq. meter. There is also evidence that the high heat is important to fully open cones after fire and distribute seed. A graduate student at Humboldt State University is currently testing cones to see what the optimal temperature is for cone opening.

AGE STRUCTURE

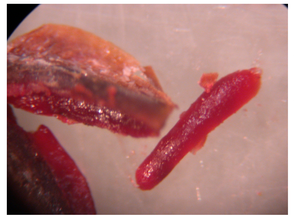
Age measures taken using cross-sections and cores indicated that the average age of all populations of Baker Cypress is 83. Locations with a recent fire history had the greatest variation in age structure, however even these had an average tree age of over 50 years. These stands tended to have pockets of even-aged trees indicating fires were hot enough to kill the existing trees. Very few locations had mixed-age stands. The few that did typically reflected a patchy burn pattern such as would occur at the edge of a fire. Hamburg has the highest average age of 149 years. This corresponds with forest records that have no recorded fire history at this site. In our sampling, the oldest tree core analyzed was 189 years. While there are trees that are likely to be older, wood rot makes the age difficult to assess, but it is doubtful that many trees make it past the 250 year mark.

Rot was found in the wood of most populations. Populations in dryer habitats such as Timbered Crater and the west side of Goosenest Mountain were less susceptible to rot, while trees in wetter habitats had more rot—this may be related to habitat type or soil conditions. Trees at Seiad had the greatest difficulty with rot—trees as small as 8" DBH could not be cored.

While older trees with rot may continue to survive for many years, crown health and cone production is limited. Older cones become lichen-covered and crack open reducing the amount of viable seed stored on the trees. If enough time passes without fire, these trees may not store enough seed to allow successful regeneration of the Baker cypress stand.

CONE NUMBER & SEED VIABILTY

Along with fire, successful regeneration of Baker cypress depends on an adequate seed store to produce the next generation. The amount of seed stored is dependent on the number of cones per tree, the number of seeds per cone and the viability of the seeds as well as overall tree density. The average number of seeds per cone ranged between 39 and 63 seeds. The highest number of seeds were found in cones from Timbered Crater. This number may be somewhat skewed due to a few cones collected at this site that had over 100 seeds per cone. Hat Creek and Mud Lake had the fewest number of seeds on average. Our testing of seed viability indicated an overall seed viability of about 15%. Seeds collected from Timbered Crater and Hat Creek had the highest percent of viable seeds while Seiad and Flounce Rock had the fewest. These numbers reflect only cones that were completely closed when collected. Most of the non-viable seeds were desiccated upon dissection indicating that even within the closed cone, seeds are still vulnerable to the environment.



Variation in cone numbers, seed numbers and viability result in a lot of variation in viable seed per tree.

Goosenest Mtn has an estimated average of over 4000 viable seeds per tree due to the large number of cones per tree and high seed viability. Seiad, in comparison, had an estimate of only 163 seeds per tree due to low cone numbers and low seed viability.

Location	Last Fire	Avg. Tree Age	Avg. Cones/ Tree	% closed Cones	Avg. DBH(")	Avg. Height (')	# seeds / cone	%viab	Viab. Seeds/ tree
Seiad	1987/1951	65	50-100	67	6.6	30	54	6	163
Independence	2006/1987	59	250-500	n/a	7.0	32	n/a	n/a	n/a
Huckleberry Mtn.	1987	72	50-100	74	8.8	35	57	14	443
Goosenest Mtn.	unknown	93	500-1000	57	6.8	29	56	18	4309
Mud Lake / Wheeler Pk	2007	113	100-250	80	9.6	39	41	19	1091
Hat Creek / Burney	unknown	53	100-250	67	8.8	34	40	15	704
Timbered Crater	2000/1910	78	250-500	40	6.2	25	63	16	1512
Hamburg	unknown	149	100-250	70	7.3	30	57	15	1047
Flounce Rock	unknown	132	100-250	90	7.1	24	34	9	482

Recommendations and Strategies for Maintaining Baker Cypress Populations.

In order to maintain our existing Baker cypress stands, it is important to introduce more frequent fire into these stands using prescription burning. The current rate of natural fires in these stands is too low to prevent them from the encroachment of other conifer species and the deterioration of adult trees presently seen in many of the stands. While some attempts have been made to restore Baker cypress by planting seedlings, the success of these few individuals is limited and does not achieve the regeneration that is seen after fire. Here are some recommendations for management:

- Baker cypress mature and produce cones after about 15 years. It is therefore recommended that prescription burns in the same area be conducted 25 –30 years apart.
- Fire severity should be high enough to remove above ground canopy and expose bare mineral soil. Recent research also indicates that 250° C is needed to successfully open cones.
- While many stands contain even age populations, stands benefit from having a mixed age structure. This ensures that should a natural fire event occur there is adequate seed to produce a next generation.
- Many stands require immediate action if they are to survive. The number of healthy adult trees in these stands make it important to develop a management plan for reintroducing fire.

METHODS

Data were collected from nine sites in Northern California on the Klamath, Lassen, and Plumas National Forests as well as the Bureau of Land Management Alturas resource district and one site in Southern Oregon. At each location one to six random 1/5th acre plots were established depending on the size of the *C. bakeri* stands. We recorded the species, diameter, height, and crown condition class for all trees with a DBH greater then 4 inches within each 1/5th acre plot. To estimate seedling and sapling densities, we recorded the species and diameter class for all saplings taller than 4.5 feet as well as the species and height class for all seedlings uder 4.5 feet tall within a 1/10th acre radius at the center of the larger plot.

We selected six *C. bakeri* individuals representing the entire range of size classes present within a stand. Cores were collected at the lowest possible location along the bole. We also estimated the number of cones per tree as well as the percentage of closed cones We collected a branch from each of these six trees and selected ten cones and placed in individual paper bags for processing in the lab.

Vegetation cover was measured using 1-meter quadrat frames placed at standard locations along transects radiating from plot center. Within each meter frame, we recorded the species and percent cover of all herbaceous plants as well as the percent cover of litter, rock, bare ground, moss, coarse woody debris (CWD), live tree bole, and scorch if the plot was burned. We also measured the canopy cover at each meter square location by taking the readings from a spherical densiometer at each side of the meter square. In addition to vegetation data, we also measured fuels data using modified Brown's transects.

In order to determine the age of the *C. bakeri* stands, we counted the rings on the cores taken from each plot. Each core was air dried for two weeks, mounted in a core holder and then sanded with find grade sandpaper in order to facilitate an accurate ring count using a dissecting microscope.

To understand the rates of regeneration we measured the age of serotinous *C. bakeri* cones by counting the rings of the branch supporting the cone. This number of rings should correspond to the age of the cone on the tree. We then counted the number of fully developed and underdeveloped seeds present in each cone, and whether it was closed, open or partially open at the time of collection. We then tested a sample of 20 fully developed seeds from each cone by exposing them to a tetrazolium staining agent (ASOA. 2000).

LITERATURE CITED

AOSA. 2000. Tetrazolium Testing Handbook. Ed. Jack Peters. Contribution No. 29. Association of Official Sed Analysts. New Mexico 88003.

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- USDA Forest Service: Plumas, Lassen and Klamath National Forests

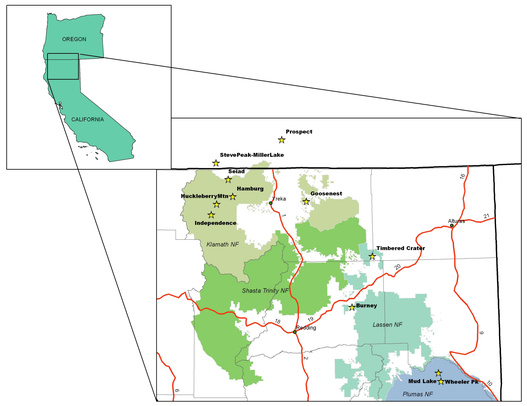

Figure 1. Known occurrences of Baker Cypress

Figure 4. Researcher Nancy Brown in Baker Cypress at Seiad

Figure 3. Baker cypress at Seiad

Figures 5 & 6. Independence Valley one year after fire. First year seedling.

Location	Last Fire	Average Tree Age	Average Cones/ Tree	% closed Cones	Average DBH(“)	Average Height (‘)	# seeds / cone	%viab
Seiad	1987/1951	65 ± 6	50-100	67	6.6 ± 0.3	30 ± 2	54 ± 1	6 ± 2
Independence	2006/1987	59 ± 10	250-500	n/a	7.0 ± 0.3	32 ± 2	n/a	n/a
Huckleberry Mtn.	1987	72 ± 4	50-100	74	8.8 ± 0.9	35 ± 3	57 ± 2	14 ± 2
Goosenest Mtn.	unknown	93 ± 6	500-1000	57	6.8 ± 0.3	29 ± 1	56 ± 2	18 ± 2
Mud Lake / Wheeler Pk	2007	113 ± 9	100-250	80	9.6 ± 0.5	39 ± 2	41 ± 2	19 ± 5
Hat Creek / Burney	unknown	45 ± 4	100-250	67	8.8 ± 0.9	34 ± 1	40 ± 1	15 ± 2
Timbered Crater	2000/1910	78 ± 3	250-500	40	6.2 ± 0.3	25 ± 1	63 ± 1	16 ± 3

Figure 4. Results of pre-treatment data collection

Location	National Forest	Estimated Size (acres)	Elevation	Soil Type
Seiad	Klamath	800	3,000-3,800	ultramafic
Independence	Klamath	< 5	4,800	granitic
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Timbered Crater	Lassen/BLM	7,000	3,500-4,000	volcanic
Flounce Rock-Prospect, OR	Rogue Siskiyou	< 3	4,000	metasedi-mentary
Steve Peak, OR	Rogue Siskiyou	< 50		metasedi-metary

Figure 2. Description of Baker cypress populations

Plot Name	Last Fire	# Baker cypress trees (1/5 acre)	# Baker cypress saplings (1/10 acre) (<4” DBH)	# Baker cypress seedlings (1/10 acre) (<3.5’ ht)
Seiad1	1987	25	20	1
Seiad2	unknown	10	0	0
Seiad4	unknown	45	9	0
Seiad5	1950	9	905	116
Indep3	2006	61	11	1019

Figure 7. Results of pre-treatment data collection

Figure 9. 3.1” DBH cross-section from Independence represent 100 years. An addition fire scar indicates a fire 40 years before 1987 fire.

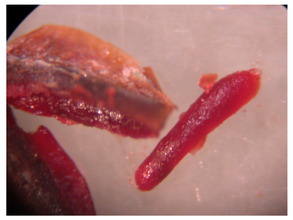

Figure 4. Chaos of regrowth in a 50-year-old stand inSeiad

Figure 4. Reneration at Timbered Crate “Adobe Fire”, Eight years after fire.