MANZANITA

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A Small Botanic Garden with Many Groves of Trees
Part 2: Our Redwood Groves *by Bart O'Brien*

Stephen Joseph

View into the Botanic Garden's Sierran redwood grove from the path below and to the east

California is home to many world-renowned trees. Three species of California native trees are so famous that US National Parks were named after them: Sequoia National Park (1890, our nation's second national park); Redwood National Park (1968, our 33rd national park); and Joshua Tree National Park (1994, our 53rd national park). And leave it to California to have two of these completely different superlative "redwoods" designated as our state trees in 1937. (Only one other state has two different state trees, and that's our neighbor to the east: Nevada. But Nevada waited 28 years before adding a second state tree (the first, in 1959, is *Pinus monophylla,* and the second in 1987, *Pinus longaeva*)—and just to be precise, Nevada clarified in 1997 that their second state tree is NOT the closely related *Pinus aristata*.)

Therefore, it should be of no surprise that any botanic garden displaying California's incredible flora would feature these trees, and our garden promptly planted two redwood groves. The first grove, of coast redwoods, was planted 75 years ago in 1941. The second grove, of Sierran redwoods, was grown from seeds collected and sown in 1942, though the resulting saplings were not planted until 1946, 70 years ago.

For a variety of reasons, both trees have been colloquially known as "redwoods" and as "sequoias." Redwood, due to the reddish-brown bark and the deep red color of the wood of both species. The name "sequoia" is a much more complicated matter and is still the subject of debate.

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FOR INFORMATION:

About the *Friends* and membership: 510-544-3169, info@nativeplants.org
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Our Redwood Groves continued from page 1

COAST REDWOOD

Sequoia sempervirens (D. Don) Endl.
Regional Parks Botanic Garden (RPBG) accession 1941.008 (originally Redwood Section accession #111)

This accession presently consists of 34 trees and provides the vast majority of the tree canopy in the coast redwood grove in the Redwood section of the Botanic Garden in beds 709, 711, 714, 716, 717, 718, 720, and 726.

Our trees were planted by a person referred to as "Reilly" on three different dates in 1941: February 20, April 8, and May 1 (Plant Cards), though the garden's founding director, James Roof (1951), wrote that "The fine young redwood forest on this site was planted in November 1941. . . . Much of the northwestern quarter of the garden (the upper Redwood Section) was covered with a dense stand of *Eucalyptus globulus* which was removed in 1941. Here and there an occasional eucalyptus stump remains to be seen." It is remarkable—and impressive—to see and understand the radical change from eucalyptus forest to coast redwood forest over the past 75 years.

In a later piece (1959), Roof noted, "The tall trees of Humboldt County's Prairie Creek Park are far enough back from the Redwood Highway, across the 'prairies' (meadows) so that they can be seen in perspective, from a distance, without craning the neck and looking upward from the immediate bases of the trees, as is usual in most redwood groves." In his last written comment about the Botanic Garden's coast redwood grove (1978), Roof stated, "As it increases in stature each year it promises that it will one day become a small but excellent copy of its great Prairie Creek prototype." And indeed it has succeeded.

Many people have commented on the fact that James Roof planted the coast redwoods in the Botanic Garden too close together, but it was Walter Knight (1988) who provided a proper context for that practice, "As in good botanic garden management, in 1941 a few more trees than necessary were planted as it was not known how they would respond to this habitat. They all thrived. Therefore in 1968 about a dozen trees had to be removed. Some had trunks to 24 inches in diameter." The actual number of coast redwoods planted to create the garden's coast redwood grove is not known, nor is the number of coast redwood trees that have been subsequently removed. What remains clear to all, however, is that the Botanic Garden's redwood forest display is probably the largest and best recreation of a natural ecosystem presented in our garden.

Explorer Discovery

Coast redwoods were among the earliest of California's trees encountered by European explorers. The first recorded account of coast redwoods is attributed to Father Juan Crespí of the Gaspar de Portolá 1769 expedition from San Diego to Monterey. On October tenth, the expedition recorded its first redwoods northwest of the Pajaro River, and Crespí wrote the following in his journal: "In this region, there is great abundance of these trees and because none of the expedition recognizes them, they are named red wood (palo colorado) from their color" (Evarts & Popper eds. 2001).

Famous Trees

In comparison to Sierran redwoods, there are relatively few individually named specimens of coast redwoods. Due to early (and continuing) successful fundraising efforts by the Save the Redwoods League, coast redwoods have tended to be named collectively with a grove name (examples include Rockefeller Grove, Stout Grove, Grove of Titans, Women's Clubs Grove, Raynal Bolling Memorial Grove, Founder's Grove, Tall Trees Grove, etc.). There are over 1,000 named groves of coast redwoods.

Currently, the tallest known tree in the world is a coast redwood named Hyperion. In Greek mythology, Hyperion was one of the twelve Titan children of Gaia (Earth) and Uranus (Sky). With his sister Theia, Hyperion fathered Helios (Sun), Selene (Moon), and Eos (Dawn). His name translates to "the high one." This redwood measures 379.3 feet tall and was discovered by naturalists Chris Atkins and Michael Taylor on August 25, 2006, somewhere in Redwood National Park. It was famously measured by Stephen Sillett in September that same year. This tree is believed to be between 600 and 700 years old.

Arlyn Christopherson

Coast redwood in Montgomery Woods State Natural Reserve, Orr Springs Road

Emerald Canary

Sierran redwood (*Sequoiadendron giganteum*), in upper reach of Redwood Meadow Grove, Sequoia National Park. Fire scars are common.

SIERRAN REDWOOD

Sequoiadendron giganteum (Lindl.) J. Buchholz
RPBG accession 1942.011 (originally Sierran section accession #147): Our plants create one large grove in the Sierran section in bed 649. There are currently 19 specimens from this accession present in our collection, plus the living stump.

All the Sequoiadendrons in this grove are connected to one another by their roots, and through this connection, the stump is kept alive—we know it's alive because it continues to grow new bark to heal its cut surface. If there were a fire or huge calamity that destroyed many of the other trees in the grove, it is possible, even likely, that vegetative buds in the living stump would become activated and grow new foliage. This does not happen under current conditions—it is too shady in the grove and the other trees are actively growing and expanding.

Seeds were collected from two locations: Whitaker's Forest, on Redwood Mountain, adjacent to Kings Canyon National Park in Tulare County; and the North Grove of Calaveras Big Trees State Park, above Dorrington, Calaveras County, near the Ebbetts Pass Highway. Both seed collections were a gift from Mr. Woodbridge Metcalf, extension forester of the University of California. All of the seeds were sown in January 1942, and the trees were planted in March 1946 by members of the Contra Costa Hills Club.

John Muir considered Whitaker's Forest to be one of the finest of the giant sequoia groves. Over 215 large Sierran redwoods occur on the property, which is operated as a research facility by the University of California's Center for Forestry. Whitaker's Forest contains the oldest permanent forestry research plots (dating back to 1915) in California.

The North Grove of Calaveras Big Trees State Park is the site of the "Discovery Tree" (see below), and has been a magnet for tourists from all over the world ever since.

Explorer Discovery

Although there were earlier reports by hunters and explorers of gigantic trees in the Sierra Nevada, no one took their accounts seriously. The person that is credited for bringing these spectacular trees to the public's imagination was Augustus T. Dowd, a hunter employed by the Union Water Company of Murphys. In the spring of 1852, Dowd was tracking a wounded grizzly bear and came upon the North Grove of Sierran redwoods. The report of his find to friends in Murphys was not believed, so Dowd invented a story of a large, dead grizzly bear, to lure people up to the site. His plan worked, and in June the *Sonora Herald* ran a story of the discovery of the Calaveras Grove. The first enormous tree that Dowd saw was subsequently named "The Discovery Tree." Within a year it was cut down and its stump was used as a dance floor, and a large portion of its bark was stripped and reconstructed for display in San Francisco and a year later in New York.

Famous Specimens

It became common practice to name favorite individual Sierran redwoods. Initially, these were rather generic names like Discovery Tree, Mammoth Tree, Mother of the Forest, and The Three Graces; later trees were named after cities and public figures.

Inexplicably, many of these early commemorative trees were then cut down in order to display portions of them—for profit—in other parts of the United States and in European capitals. When they were displayed, gawkers were told that the trees were thousands of years old, which made the practice that much more incredibly absurd: come and see a piece of this gigantic ancient tree that I killed so that you can see a small piece of it. It cost $0.50 per person to see parts of the Mammoth Tree, the first casualty of this folly. This nonsense incensed many people, and there is a quote capturing the stupidity of the situation by none other than John Muir:

> Forty-seven years ago one of these Calaveras King Sequoias was laboriously cut down, that the stump might be had for a dancing-floor [this was the Discovery Tree]. Another, one of the finest in the grove [the Mother of the Forest], more than three hundred feet high, was skinned alive to a height of one hundred and sixteen feet from the ground and the bark sent to London to show how fine and big that Calaveras tree was—as sensible a scheme as skinning our great men would be to prove their greatness. This grand tree is of course dead, a ghastly disfigured ruin, but it still stands erect and holds forth its majestic arms, as if alive and saying, "Forgive them, they know not what they do." Now some millmen want to cut all the Calaveras trees into lumber and money.

Perhaps the most famous living Sierran redwood is the General Sherman tree. It is said this tree was named after the Civil War General in 1879 by trapper James Wolverton. Measured by volume, it is the world's largest known single-trunked tree in the world. This tree is about 275 feet tall and is estimated to be roughly 2,200 years old. There were reports of even more massive coast redwoods, but, of course, these have all been cut down!

Want to know more?

Visit the Manzanita home page at nativeplants.org/publications/Manzanita-Newsletter to find:

- **In an addendum to Bart's article, a fascinating exploration of the twists and turns of naming the California redwoods, and why one of them should probably have the genus name *Americanus*. Plus a complete list of references that Bart used in researching his article.**
- **More science news from Anthony Ambrose and his research colleagues, including studies on the leaf morphology of redwoods.**
- **Links to other interesting articles on the web about the complex world of the coast redwood canopy.**

The View from the Top: Recent Insights from Coast Redwood Forest Canopy Science

by Anthony Ambrose, PhD, University of California, Berkeley and California Academy of Sciences

Anthony Ambrose

Looking down the trunk of a coast redwood in Montgomery Woods State Natural Reserve

I scramble to the top of a coast redwood tree (*Sequoia sempervirens*) to collect some leaves, pausing to look around and appreciate the view. It's four a.m., and the silent black sky is filled with stars, with faint outlines of the surrounding canopy visible on the horizon. It's a magical moment, and I feel lucky to be here.

I've climbed this redwood in the Santa Cruz Mountains to evaluate the effects of three years of severe drought on these iconic trees. I'm up here in the dark to take a leaf sample to measure the baseline physiological status of this tree at the time of peak summer moisture stress. As soon as light illuminates the tree crown, the leaves will start to photosynthesize, absorbing carbon dioxide from the atmosphere through tiny pores in the leaves called stomata. Because stomata are open during photosynthesis, water also evaporates from inside the leaf to the drier atmosphere through transpiration. Like sucking on a straw, transpiration creates tension which pulls on a continuous column of water inside the tree connecting the uppermost leaves with roots more than 260 feet (80 meters) below. Declining soil water availability and hotter, drier air increase this tension. Too much tension, and the column can break, disrupting the flow of water to the treetop.

Tired, yet energized by the climb, I make my way down to the ground. I'll be back later in the afternoon to collect another treetop leaf sample, which will allow our research team to evaluate the condition of the tree at the peak of physiological activity. We primarily measure the water potential of the leaf, which is a measure of how much tension the water in the leaf is under at the time of sampling. Together, pre-dawn and mid-day water potential measurements will allow us to evaluate how water-stressed the tree is and how well it can manage this stress. This information will help us quantify redwood tree vulnerability to drought and assist land managers to conserve these globally significant forests in an era of rapid climate change. According to climate models, the current California drought is just a preview of the future. How will these trees and all the other plants and animals of the redwood forest fare in a warming world?

Coast redwood is famous for being the tallest tree in the world, with the current champion standing more than 380 feet (116 meters) above the ground deep in the heart of Redwood National Park. Chances are high that the tallest and largest redwoods historically exceeded this height, considering more than 96% of the original ancient redwood forest has been logged. Thanks to heroic efforts by the Save the Redwoods League, Sempervirens Fund, and other conservation organizations, we have glorious examples of these old-growth forests now protected in many state and national parks in California. Beyond their tremendous ecological value, these protected areas are critical for serving as a baseline reference, to help us understand what these forests can become. They are the places where most redwood canopy science has occurred over the last several decades, providing key insights into the structure, physiology, and biodiversity of these amazing forests.

Recent research has revealed that the northernmost old-growth coast redwood forests contain more leaf area, total biomass, and aboveground carbon than any other forest on Earth. This research has also shown that the growth rates of coast redwoods—and many other tree species—continue to increase with size, independent of age. In other words, the tallest, largest, and oldest trees in the forest are growing the fastest. The largest redwoods in the forest, with their massive complex crowns, support the majority of biodiversity found in the redwood forest canopy, biodiversity that includes arboreal salamanders, mammals, insects, ferns, and other vascular and non-vascular epiphytes.

Redwoods in many, but not all, old-growth forests have also shown a slight surge in their growth over the last 40 or so years. But we still do not know exactly why these trees are growing more, whether current growth rates can be sustained indefinitely, or how redwoods growing in more marginal habitats outside of protected old-growth reserves are doing. Increasing atmospheric CO_2 and slightly warmer temperatures may be helping them to photosynthesize more. Changing light levels with diminishing fog may also play a role. But this may be a temporary phenomenon, and water availability is likely to become a

Anthony Ambrose

Trunk reiteration and complexity supporting epiphytic leather-leaf fern (*Polypodium scouleri*) and western hemlock (*Tsuga mertensiana* - light green) in a coast redwood tree in Prairie Creek Redwoods State Park more critical limiting factor in the coming years. While temperatures within the redwood range have risen slightly over the last century, they have not increased as much as in many other parts of California, while precipitation has not really changed much at all. But even if rainfall levels stay constant, at some point critical climatic and physiological thresholds may be crossed as global temperatures continue to climb, increasing the evaporative demand of the air, drying out soils, and negatively impacting the water and carbon balance of these trees and forests.

Redwoods are amazingly tough and have evolved adaptations that allow them to survive more than 2,500 years in a single location. Thick fire-resistant bark; abundant chemical defenses to ward off pests, pathogens, and decay; and prolific capacity for re-sprouting, all contribute to redwoods' extreme size and longevity. They also possess many physiological traits that help them cope with the biophysical constraints associated with getting taller. Prevalent summertime fog in the region provides an important source of water during the otherwise dry season, reducing evaporative demand on the trees, and condensing on the canopy and dripping to the ground.

Redwoods also have the ability to directly absorb fog water into their leaves, thereby bypassing the need to transport soil water more than 300 feet (100 meters) from the ground to the treetop, fighting gravity and friction along the way. This absorbed water can move through the trunk all the way back down to the roots, refilling and swelling the tree with water it can then use at a later time. How is this possible? Water moves along water potential gradients, diffusing from areas of high to low concentration. Under most circumstances, water has a higher concentration inside the leaf than outside, which drives water movement out of the leaf through transpiration. When fog or other water collects on the leaf, water can diffuse into the leaf instead, and can even drive reverse water movement back down through the branches and trunk, and possibly even into the roots. We've measured simultaneous multi-directional water flow in very tall redwoods, flow that changes dynamically over time depending on environmental conditions (i.e., shifting from dry sunny days to foggy nights and back again).

Anthony Ambrose

Trunk reiteration and complexity supporting epiphytic leather-leaf fern (*Polypodium scouleri*) in a coast redwood tree in Prairie Creek Redwoods State Park

Redwood leaves and wood also change dramatically within individual trees to accommodate vertical gradients in light, temperature, and water availability. This morphological and physiological plasticity allows the trees to optimize whole-tree function by fine-tuning each part of the crown to its local environment.

Although redwoods are highly resilient and able to adjust to a wide range of environmental conditions, every organism has a limit beyond which it cannot survive. Millions of years ago, redwood ancestors were found throughout the entire northern hemisphere. But past climatic changes have caused the redwood population to shrink to the small distribution it now occupies, suggesting that the

Fog burning off the old-growth coast redwood canopy of Jedediah Smith Redwoods State Park Anthony Ambrose

species may be vulnerable to future climate changes as well.

It's much hotter climbing in the middle of the day. By chance, a severe heat wave hits while we are measuring redwood, Douglas fir, and California bay laurel tree response to drought near Santa Cruz. It's over 100 degrees Fahrenheit and feels like it. I collect my treetop leaf sample, quickly take in the view, and rappel back down to the ground. I have another tree to climb today and need to stay on schedule.

Our measurements of leaf water potential during the heat wave show the trees were as water-stressed as we've ever seen but otherwise appeared to be doing fine. Compared to many other trees in the western United States, coast redwoods and their close cousins the giant sequoias (*Sequoiadendron giganteum*) have it good. Both species occupy some of the most favorable habitat conditions found in the entire state and these forests don't appear to be as stressed as many others throughout the region. Some redwood and giant sequoia trees have shed a portion of their foliage during the drought to minimize water losses. But they are in relatively good shape compared to the millions of dead and dying pines, firs, cedars, and oaks scattered across the landscape. We've found that a mature redwood can transpire several thousand liters of water on a single summer day, more than any other tree on the planet. It's not surprising, given that each mature tree supports millions upon millions of leaves. But this profligate water use requires coast redwoods and giant sequoias to grow in areas with an abundant and reliable water supply. What happens if that water supply shrinks in a hotter world? Redwoods are tough, but they're not invincible.

I'm back at the top of another redwood in Humboldt County the following spring. It's the beginning of the fourth year of California's historic drought, but it's cold and foggy on the north coast and our measurements show the tree is well hydrated. Climate models predict that this area will be a climate refuge for redwoods, as the species' distribution shifts north and contracts towards the coast. This gives me some hope. Change is constant on Earth, and redwoods have experienced a lot of it, both as individuals and as a species. The future is uncertain, but redwoods are resilient trees and the redwood forest ecosystem is more interconnected and complex than we imagine. Redwoods are full of surprises and we still have much to learn.

Dr. Ambrose is a canopy biologist in the Department of Integrative Biology at UC Berkeley and California Academy of Sciences, specializing in tall tree ecophysiology and canopy biodiversity. Anthony's research team consists of himself and two other core scientists from UC Berkeley, with a lot of assistance from volunteers, in collaboration with colleagues from other universities and institutions. *Major funding for their research comes from the Save the Redwoods League, through their Redwoods and Climate Change Initiative (RCCI). Additional funding comes from the National Science Foundation, Sequoia and Kings Canyon National Parks, the US Forest Service, and the Southwest Climate Science Center of the US Geological Survey.*

Redwood Forests, Living Under The World's Tallest Trees *by Glenn Keator, PhD*

Although the word "redwood" applies to both coast redwood (*Sequoia sempervirens*) and giant Sequoia (*Sequoiadendron giganteum*), the two trees differ greatly in their habitats, the coast redwood forming dense, nearly single-species coastal forests at their best development, the giant sequoia mixing with several other conifers at middle elevations in the Sierra.

The coast redwood is characterized by shallow, broadly spreading roots seldom more than three to four feet deep and dense crowns taller than any companion trees; it grows in humus-rich acid soils, the alluvial soils of flood plains supporting the greatest trees, while hillside forests with thinner, drier soils support somewhat smaller trees. If you were a plant living among redwoods, you would face strong competition for water and be challenged by dense shade and soils generally low in nitrogen.

Glenn Keator

The bizarre flower of slink pods (*Scoliopus bigelovii*)

Because coast redwoods live in the fog belt, the fog condensing on branches drips to the ground as rain, and because the winter rainfall is generally high and year-round temperatures mild with strong protection from the ocean winds, understory plants still find a way to thrive.

I'm going to focus on different aspects of the redwood forests, starting with the large trees and shrubs peripheral to the forest, then moving to the heavily shaded understory, the shade more critical for larger plants because the redwoods, being far taller, create too much shade.

Most other trees of these habitats—California bay (*Umbellularia californica*), Douglas-fir (*Pseudotsuga menziesii*), madrone (*Arbutus menziesii*), bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), and tanbark oak (*Notholithocarpus densiflorus*) in particular—are unable to grow in the understory of a mature forest. The same is true of many shrubs such as evergreen huckleberry (*Vaccinium ovatum*), California hazelnut (*Corylus cornuta californica*), thimbleberry (*Rubus parviflorus*), and numerous others, pushed to the edge of the forest or along water courses, where part-day sunlight is available.

Providing splashes of dramatic color, shrubs like rosebay (*Rhododendron macrophyllum*) with magnificent heads of rose-purple flowers, western azalea (*R. occidentale*) with sweetly perfumed white or pink flowers—both blooming at spring's end—along with the flame-colored leaves of vine maple (*Acer circinatum*) and that old villain poison oak (*Toxicodendron diversilobum*), whose stalwart stems climb tree trunks, are resplendent in late summer and early fall.

Meanwhile, inhabiting a narrow fringe along the north coast and subjected to strong winds, other conifers replace the redwoods, giving rise to the north coastal conifer forests that extend way beyond California's borders to the north. Among the often giant trees here are Sitka spruce (*Picea sitchensis*), grand fir (*Abies grandis*), western hemlock (*Tsuga heterophylla*), Port Orford cedar (*Chamaecyparis lawsoniana*), and western red cedar (*Thuja plicata*).

By contrast, the herbaceous plants like redwood sorrel (*Oxalis oregana*), wild ginger (*Asarum caudatum*), inside-out flower (*Vancouveria* spp.), vanilla leaf (*Achlys triphylla*) along with a plethora of ferns such as lady fern (*Athyrium filix-femina* var. *cyclosorum*), sword fern (*Polystichum munitum*), deer fern (*Blechnum spicant*), and five-finger fern (*Adiantum aleuticum*) tolerate nearly day-long deep shade. To survive, these understory plants have leaves with dense layers of chlorophyll-packed cells, a broad horizontal surface, or deeply dissected leaves, where the spaces between leaflets of the taller leaves allow light to seep through to the shorter leaves beneath.

The forest floor is also home to many plants with showy spring flowers, standing out in the shifting

Glenn Keator

Flowers of the rosebay rhododendron (*Rhododendron macrophyllum*) shafts of light on the dark forest floor. Look for the delightful wake-robin (*Trillium ovatum*), various violets (*Viola* spp.), fairy bells (*Prosartes smithii* and *P. hookeri*), false Solomon's seal (*Maianthemum* spp.), redwood bead-lily (*Clintonia andrewsiana*), the harbinger of winter's end, slink pods (*Scoliopus bigelovii*), and finishing with the glorious redwood lily (*Lilium rubescens*) and Columbia lily (*L. columbianum*). Most of these are able to flower quickly, ripen seed, and then go dormant during the summer and fall months.

But there's another layer, one that most naturalists have paid little attention to until recently: the plants living perched in the crowns of the trees, often hundreds of feet above the forest floor. These epiphytes include mosses, lichens, and especially the leather fern (*Polypodium scouleri*), along with various berry bushes that have managed this aerial feat when birds drop seeds on humus collecting on upper branches.

There are two intriguing questions about the lives of understory plants: how pollination and seed dispersal are achieved. The first is generally poorly understood, sometimes involving beetles and flies attracted by off-smelling flowers like wild ginger and slink pods, but the colorful displays generally adapted to bees are puzzling as most bees live in sunny environs. In addition, red columbine (*Aquilegia formosa*) and firecracker brodiaea (*Dichelostemma ida-maia*) are favored by hummingbirds.

Birds, in fact, are important animals in these forests with their myriad levels and niches for breeding and nesting, provided by tree architecture and abundant food in the form of tasty, brightly colored berries. Thus, within the same forest we find baneberry (*Actaea rubra*), thimbleberry, salmon berry (*Rubus spectabilis*), salal (*Gaultheria shallon*), huckleberries (*Vaccinium ovatum* and *V. parvifolium*), long-leaf barberry (*Berberis nervosa*), currants (*Ribes* spp.), and others, all helped along by birds eating and dispersing the seeds.

One other curious method of seed dispersal, occurring in several unrelated plants, is the presence of oil bodies (elaiosomes) on seeds, luring ants, which carry the seeds underground to their nests, eat the elaiosomes, and discard the body of the seeds, thus planting them. Ant plants include wild ginger, trillium, violets, inside-out flower, and western bleeding heart (*Dicentra formosa*).

Are there other forests with similar conditions in their understory and, if so, do they have a different flora to redwood forests? The answers are yes and no, yes, that closed-cone pine and north coastal coniferous forests have similar conditions, and no, the plants in those forests are basically the same ones just mentioned for redwood forests.

SAMPLES OF REDWOOD FORESTS TO VISIT

Even though redwoods grow as far south as deep protected canyons on the Monterey coast, their best development is north of the Bay Area and close to the Oregon border. Local redwood forests such as Muir Woods and Armstrong Redwood State Park, impressive in their own right, cannot compare to the lushness of forests in Prairie Creek Redwoods State Park, Redwood National Park, and Jedediah Smith Redwoods State Park, all north of Eureka, close to the coast. Among my favorites in these parks are:

Fern Canyon, Prairie Creek Redwoods State Park, a vertically walled canyon covered with thousands of five-finger fern

Skunk Cabbage Trail, Prairie Creek Redwoods State Park, which meanders through huge trees of north coastal coniferous and redwood forests with a plethora of moist habitats

Lady Bird Johnson Grove, Redwood National Park, a loop through prime upland redwood habitat

Jedediah State Redwoods State Park. Any of the short and loop trails along Hwy 199

Glenn Keator is chairman of the Friends *Advisory Council. He is a popular instructor of botany and field trip leader in the Bay Area, and he teaches the docent training course at the Regional Parks Botanic Garden. He is the author of a number of books on native plants.*

WHEN REDWOODS BURN

The coast redwood is well equipped to resist fire—the bark is thick and free of flammable resins, the dead snags fall off, and the trees readily regenerate from stump sprouts—yet sometimes the fire is so fierce and climbs so high that the trees are killed outright. When that happens, a series of events unfolds to restore the forest. The renewal sees prodigious amounts of redwood seeds that germinate best in litter-free soil and in full sun in concert with the red alder (*Alnus rubra*), which is the first tree to move in (at least in the northern forests), growing fast, shading vulnerable seedlings from the summer sun, and enriching the soil by releasing nitrogen from root nodules. As soon as the baby redwoods overtop the alders, the alders die out, and soon the forest has a new redwood canopy, but it will still take many years to restore the forest to its mature state.

Thus, it remains important to preserve old virgin tracts of forest, the mature trees tall, providing habitat for a variety of birds and plants perched in the upper crown. Although no one knows for sure just how long the process from seedlings to mature trees takes, and despite the fact that redwoods grow at astonishing rates—especially for an evergreen tree—the time is measured in hundreds of years.

As old redwoods eventually succumb to disease or—more often—have their roots undermined by wind and erosion, they leave holes in the forest that allow a local succession to occur. These forests—patchworks of mature forest, openings with varied ages of trees, and baby saplings in sunlit areas—create a diversity of habitats for all the animals, fungi, and plants that inhabit a healthy forest habitat.

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Redwood seedling growing under alder (drawing by Zora Thomas)

Can you spare a little time to help the *Friends*? We can always use an extra hand with the many projects we undertake on behalf of the garden. To learn more, send an email to
bgarden@ebparks.org
with "Friends Help" in the subject and someone will contact you to talk about our programs and learn about your skills and interests. We look forward to hearing from you!