The Coast Redwood
Sequoia sempervirens
A Primer
(8.5” x 11”)

Michael Roa

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If you find a typo or other error, please let me know so that I can correct it in the *Primer* posted on the Sempervirens Fund website and in any future printings. Thank you!
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Stewards of the Coast and Redwoods

Introduction

The coast redwoods can be experienced on many levels, from enjoying a casual stroll in the cool shade under their canopies to serious study of their role in mitigating climate change. This booklet provides an introduction to the coast redwood, *Sequoia sempervirens.* It is a resource for those who want to learn and teach about the natural and cultural history of the coast redwoods.

There are many children's books that provide the most basic information about coast redwoods, as do brochures available at many parks. Basic information is also available on Save the Redwoods League's and Sempervirens Fund's websites, as well as on various online videos. This booklet can supplement those.

There are also books that go into great detail about the trees and the redwood forest community, but the beginning docent or interpreter may not want to go into that much depth.

I wrote *Redwood Ed – A Guide for Teachers and Learners*, which is published by California State Parks, in 2005. *Redwood Ed* includes a review of the natural and cultural history of the coast redwoods and suggestions for activities for before, during, and after a class field trip to the redwoods. At over 400 pages in length, *Redwood Ed* provides much more than a beginning docent or interpreter needs.

Most of the information in this *Primer* is found in *Redwood Ed*. To save space in this *Primer*, I have not cited information that is common knowledge or is cited in *Redwood Ed*. I have cited in the text of this *Primer* information not in *Redwood Ed*. Photographs are also cited at the end of the *Primer.* (See page 43.)

This booklet will be useful to those who are just beginning their studies of the coast redwoods and the redwood forest. Some resources for further investigation are listed at the end. (See page 45.)

I hope that you find this to be a useful resource that will help you to not only learn about these magnificent trees but to spend many hours enjoying, exploring and sharing about California's coast redwoods.

Mike Roa

Three Redwoods

Here in California we have three tree species that are commonly called redwood. Two are native and one has been widely planted.

- the dawn redwood (*Metasequoia glyptostroboides*)
- the giant sequoia (*Sequoiadendron giganteum*)
- the coast redwood (*Sequoia sempervirens*)

Fossil evidence suggests that all three are fairly closely related. They are all classified in the family Cupressaceae. Ancient relatives of today's redwoods lived throughout the northern part of the northern hemisphere about 180 million years ago.

The Dawn Redwood (*Metasequoia glyptostroboides*):

Fossils show that the dawn redwood once lived throughout the high northern latitudes. It was thought to be extinct until the 1940s, when it was found in China. Since World War II, it has been widely planted as an ornamental tree, including in California.

Unlike the coast redwood and the giant sequoia, the dawn redwood is deciduous, losing its needles in the winter. Some coast redwood parks have specimen trees for comparison.

The Giant Sequoia (*Sequoiadendron giganteum*):

The giant sequoia also once lived throughout northern North America, but millions of years ago changing climate reduced its range to 70-80 groves on the western side of the Sierra Nevada Mountains.

The giant sequoias are the most massive things on Earth, unless you consider clones of multiple stems of aspen trees, thousands of mushrooms connected to each other by their mycelia or other multi-stemmed organisms.

Giant sequoias can live over 3000 years. They don't grow as tall as the coast redwoods, but the mass of the largest individual giant sequoias is greater than that of the largest coastredwoods. As of this writing, the tallest giant sequoia is about 316 feet tall, and the widest is about 31.5 feet in diameter.

The giant sequoia can be distinguished from the coast redwood by its scale-like needles andits egg-sized cone. Some coast redwood parks have specimen trees for comparison.

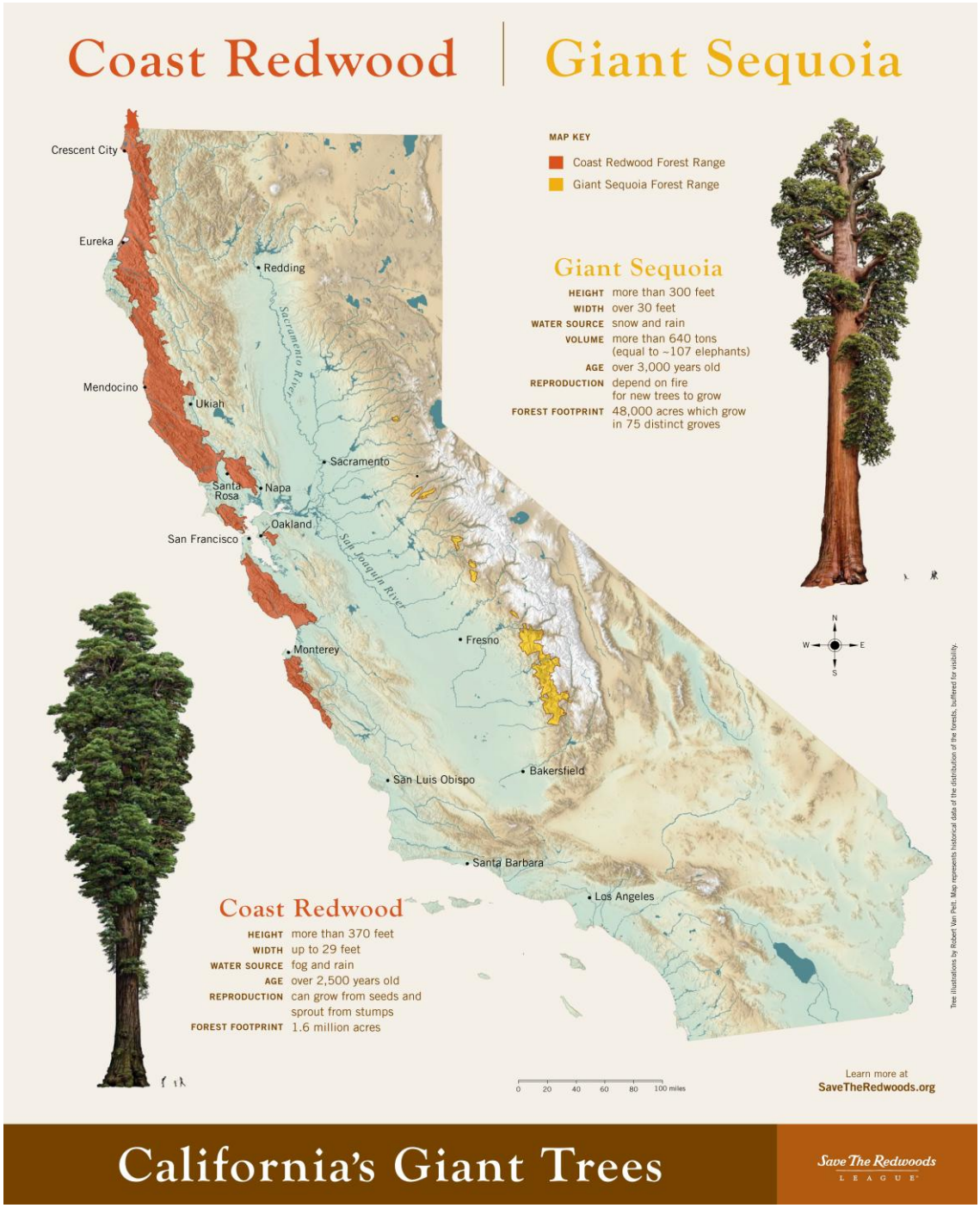
The Coast Redwood (*Sequoia sempervirens*):

The coast redwood is the topic of this booklet. It grows naturally only in a narrow belt along the west coast of California, extending from the Big Sur region into southern Oregon. In its natural range, redwood is dependent on the summer fog found within 50 miles of the coast. (See page 4.)

But coast redwoods will grow elsewhere if they have the right conditions; summer water is especially important. Summers are pretty dry in Sacramento and Redding, but with the aid of summer watering, redwoods are growing there. And redwoods are grown commercially in New Zealand!

Left to right:

- dawn redwood needles and cone
- giant sequoia needles and cone (enlarged view of needles)
- coast redwood needles and cones
  female (ovulate) cone at top
  male (pollinate) cones at branchlet tips on the right



This map, provided by Save the Redwoods League, is available on their website. at: https://www.savetheredwoods.org

Cultural History

Native Californians

Native Californian people have inhabited California for well over 10,000 years – for time immemorial. There is evidence that by about 4,500 years ago, humans occupied the entire coast of California. Native Californian populations in the redwood region were some of the densest in California.

At least 15 different tribes inhabited the redwood region when Europeans arrived in the 1700s. Rugged terrain tended to isolate groups from each other, which led to the development of different languages and cultures. Each tribe used locally available resources. Plentiful resources such as fish and acorns reduced the need to interact with one another, but trade was fairly common anyway.

In the redwood region, most Native Californian settlements were along streams or in open areas such as oak woodlands. Deer, elk, rabbits, and other game preferred the grassy upland prairies and meadows to the shady redwood forests. Grass seeds and acorns from oaks and tanoaks were important food sources found in the prairies. Salmon, steelhead and other fish were in the streams. Some foods such as huckleberries, hazelnuts, bay/laurel nuts, ferns and other plants could be found in the forest.

Many plants, including forest plants, were used for medicines. Especially in the north, redwood logs were fashioned into canoes. Redwood bark, ferns, and other plants were used in basketry. (Mead's *The Ethnobotany of the California Indians* is an excellent resource for learning about Native Californian uses of plants.)

Yurok canoe

Pomo basket made partly from hazelnut sprouts

The straight-grained, knot-free wood of fallen redwoods was a valuable forest resource. When a large redwood falls, it often splinters into "boards" that could be used for a variety of purposes. Tools made from elk antlers could be used to split the wood into usable boards. Large pieces of bark were also used like boards.

Replica of Yurok sweat lodge. Note plank house replica in the distance.

Replica of a Miwok bark dwelling or Kotcha

Native Californians regularly burned the prairie grasslands to keep the forests from taking over the meadows and to encourage the next year's grass seeds. Those fires undoubtedly sometimes spread into the redwood forests. Fires were also intentionally started in the forests to encourage new growth in hazelnuts and elderberries, whose straight young shoots were used in basketry and arrow-making. Clearing out the understory in the forest made travel easier and made it harder for enemies to sneak up on villages.

Interpretive displays, experienced docents, interpreters, State Parks District Tribal Liaisons and often the tribes themselves can provide information about local tribes and how they related to the redwoods in the past and how tribes still live in the region and continue to practice traditions such as ceremonies, resource gathering, traditional burning and sharing of other traditional ecological knowledge. Some parks have posted signs acknowledging that the park is on ancestral tribal land.

State Parks has a Reexamining Our Past Initiative page that may be of interest. Go to: https://www.parks.ca.gov/?page_id=30464

Logging the Giants

Without metal tools such as axes and saws, Native Californians were unable to cut down large trees. They did, however, sometimes fell a tree by repeatedly burning its base and then scraping away the charred wood.

In the late 1700s and early 1800s, Spanish settlers used redwood for posts and beams in their missions. The Russians used fallen trees and driftwood logs when they built Fort Ross in 1812, and they did cut some trees for lumber and to clear space.

During the Mexican era in California (circa 1820 – 1848), there was little logging of redwoods. The Mexicans were more interested in raising cattle than felling huge trees. The beginnings of small-scale logging operations were, however, established during this period.

With the discovery of gold in 1848, California's population exploded. The redwoods in the Oakland hills were soon felled to build San Francisco and other cities. The Santa Cruz Mountains provided lumber for San Jose and other South Bay Area cities. The forests and mills around Eureka became major suppliers of redwood lumber for California and beyond.

Logging with human-powered saws and axes was difficult, dangerous, and time-consuming work. It might take a team of men a week or more to fell a large redwood.

Felled trees were cut ("**bucked up**") into manageable lengths and hauled to the mills by mule or oxen teams. Often a streambed was the easiest route, and many miles of fish habitat were destroyed. The development of steam engines made moving the logs easier. Railroads were built to move the logs from the hills to the mills and lumber from the mills to the growing cities. Schooners moved the wood along the coast and across the seas. After World War II, trucks and tractors replaced oxen and railroads, and gas-powered saws replaced muscle-powered saws and axes. The housing boom that followed the war sparked an unprecedented logging boom.

In the early days, large trees were too big for the steam-powered sawmills. Dynamite was sometimes used to break the huge logs into pieces that could be handled by the mills. Other times the knot-free (clear) logs were sawn into shorter lengths for "split product" such as railroad ties, fence posts, grape stakes and shingles.

When cutting the huge trees by hand, the forests must have seemed inexhaustible, but by the 1970s, about 95% of the original redwood forest had been cut.

Note the long "whipsaw" behind the man in the foreground and the springboards on which the fellers stand. Springboards enabled fellers to get above the flared base of the tree, which required a lot of sawing but yielded little lumber.

A train load of logs on its way to the mill. Note the devastation of the forest.

Sawing (“bucking up”) and splitting a huge tree to make railroad ties or other “split product”

Moving logs from the woods to the mill.

Dragging a log from the woods. (1950s?). Note the devastation of the soil.

Conservation: Saving (at least some of) the Giants

Even in the 1800s, people became alarmed at the rapid loss of the redwood forests. In 1864, President Lincoln signed legislation to preserve some of the giant sequoias. In 1900, the Sempervirens Club (now Sempervirens Fund) campaigned to save coast redwoods in the Santa Cruz Mountains, and the California Redwood Park (now Big Basin Redwoods State Park) was created in 1902. In 1918, Save the Redwoods League began efforts to protect groves of coast redwoods. Sempervirens Fund remains active in the South Bay Area today and Save the Redwoods League continues working to protect both coast redwoods and giant sequoias.

The beginnings of theSempervirens Club (now Sempervirens Fund)

The California Federation of Women's Clubs campaigned to save the redwoods in the early 1900s.

Redwood Parks

The automobile and the creation of the Redwood Highway (Highway 101) allowed increasing numbers of people to visit, see and learn to appreciate the redwoods. More state and local parks were created and a movement to create a redwood national park began.

As one would expect, there was strong resistance from communities dependent on the logging industry, but Redwood National Park was finally opened in 1968. As of this writing, there are nearly 50 state parks and numerous county parks that have redwoods.

The Redwood Empire Today

Trees that grow after an area is logged are called **second-growth**. Lumber from second-growth trees is still a valuable resource. Logging is now regulated by a variety of laws, and modern forestry practices such as cloning, replanting, careful road design and intentional burning are used. Tourism is an important industry in areas that have parks, and today's park managers try to accommodate large numbers of visitors while protecting the ecosystem. Today's Redwood Empire has a diversified economy in which both redwood harvesting and redwood tourism are important.

Today there is increasing acknowledgement of the Native Californian people who have lived in redwood country since time immemorial and still live here. Parks and tribal groups increasingly partner for mutual benefit.

Natural History: The Tree

What's so special about coast redwoods?

1. Coast redwoods are the tallest trees in the world. The tallest known tree, named Hyperion, is over 381 feet tall. (Z. Moore, personal communication, 8.15.25)
2. Coast redwoods don't only grow tall, they also grow to large diameters. Some are almost 30 feet across.
3. Coast redwoods can have a huge volume of wood. A large redwood can have enough wood to build over 20 modest sized five-room houses.
4. Coast redwoods can grow rapidly. Young sprouts can grow up to 6 feet in height in a single year.
5. Coast redwoods can live over 2,000 years.
6. Coast redwoods are one of the few conifers that can sprout new trees from stumps or damaged trees.
7. Coast redwoods are resistant to (but not immune to) attacks by insects, fungus and fire.
8. Coast redwood lumber is not only beautiful but durable, and it has many other desirable properties such as its resistance to attack by insects and fungi.
9. Coast redwood and the giant sequoia are California's state trees.

Anatomy and Adaptations of the Coast Redwood

The Stem (or Bole):

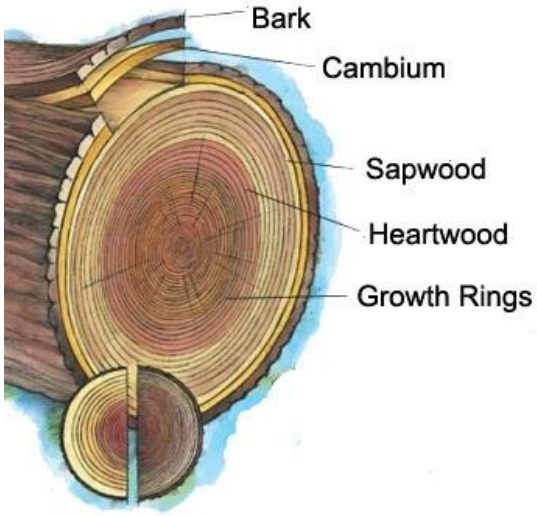
The functions of the **stem** are to hold the leaves (needles) up to the sun, to bear the cones so that wind can disperse both pollen and seeds, to deliver water and minerals to the needles and to transport the products of photosynthesis to the rest of the tree. **Phloem** cells move materials downward (they **flow** down), while **xylem** cells move materials up (towards the **sky**). The xylem is the woody part of the tree, and the phloem is the inner part of the bark.

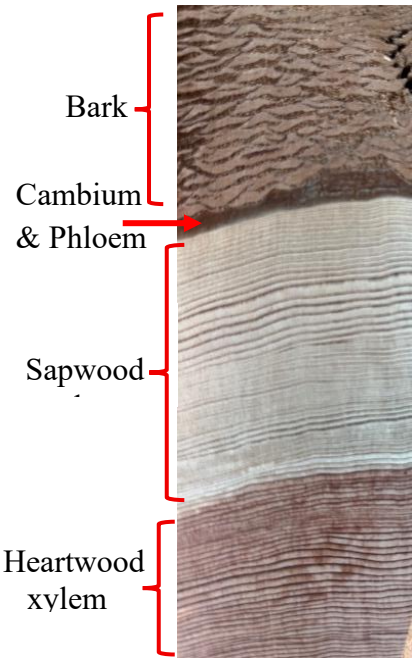
A thin layer of **cambium** cells produces xylem and phloem.

The outer section of the xylem is light in color. This living **sapwood** actively carries water and other chemicals (sap) upward to the leaves.

Eventually the cells of the sapwood die and become **heart-wood**. The chemicals that give redwood its red color are called **tannins**. Tannins are stored in the heartwood and make it resistant to rot and insects. A thousand-year-old redwood has had a lot more time to store tannins than a hundred-year-old tree, so its wood is much more resistant to fungus and insects.

11.

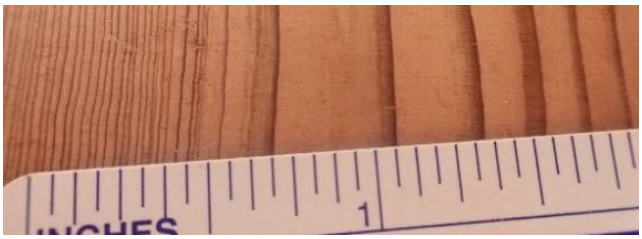




The heartwood's main function is to support the tree. If fire can penetrate the bark and get into the heartwood, some of the heartwood may be burned out, creating a **fire cave** or **goosepen**. If most of the cambium and sapwood survive the fire, the tree may live for hundreds of years with a fire cave.

When the tree has plenty of sunshine and water, the cambium produces large light colored xylem cells with thin cell walls. This is called **earlywood** or spring growth. In late summer and fall the growth slows and small cells with thick cell walls form dark rings. This is called **latewood** or summer growth. So a single year's growth is shown by both a light and a dark ring.

When a redwood tree is young, or when there is plenty of light and water, rapid growth produces wide rings. A rapidly growing redwood can have rings showing over an inch of growth in radius in a single year! As a tree ages, or in years when there is little rain or sunlight, narrow or "tight" rings form. Even though a large old tree may have rings that are only one-fiftieth of an inch apart, that tree can still be adding hundreds of pounds of wood each year because the wood is added throughout the stem, branches, and roots.



Radius growth varying from about 1/50 inch per year to over 1/4 inch per year

Change from slow to fast growth is called “release,” and is probably due to increased light due to logging or windfall. Note “early” (light colored) and “late” (dark) wood

Rapid growth rate: about 1 inch per year in radius

At the left, very slow growth rate of about 1/70 inch per year in radius

To precisely determine the age of a tree, one would need to count the rings at the base. The ages of living trees are usually estimated based on stumps or fallen trees in the same area.

A tool called an increment borer can be used to drill into a tree and remove a sample of the rings, but that sample can only show the number of rings and growth rate for the length of the core. Cores can be useful in determining changes in growth rate due to drought or other causes, or to find evidence of fire or other damage. Cores taken at different heights can be used to estimate the growth rate of the tree and, therefore, its age.

When an area is logged or the trees are removed by fire, the increased sunlight can cause sprouts or seedlings to grow rapidly. On the other hand, a tree growing in a shady forest may grow very slowly. So a tree with a 3-foot diameter growing in a shaded forest area may be hundreds of years old, while a 3-foot diameter tree growing in a sunny area may be only 50 years old! This rapid growth enabled by ample light is one reason why some lumber companies used to clearcut.

Burls:

Redwoods often have growths known as **burls**. Two types of burl form on the trunk. One type forms in response to a wound such as a falling tree scraping off some bark or fire breaching the bark. It is sort of like scab or scar tissue. Other trunk burls form on the trunk for reasons that are unclear, but may be due to infections. They may form hundreds of feet up the trunk and become quite massive.

Basal burls form at the base of the trunk, at the root collar. Basal burls are a natural reproductive structure. Basal burls have buds that can sprout and grow a new tree if the tree is cut or falls with roots remaining in the ground. Many sprouts may form at the base of a tree or stump, and they compete for light.

Redwood burls can have a variety of beautiful patterns such as lace, swirls, or “bird’s-eye,” making burl wood very desirable to woodworkers. Sometimes people will actually cut down a tree or take a chain saw to the base of a tree just to get the burl wood. Ethical woodworkers use wood from salvaged stumps or from trees cut legally.

Burl and beautiful wood can be found in salvaged stumps. Note salvaged stumps in the background.

The result of burl poaching in Redwood National Park

The Branches:

A large redwood may have hundreds of branches, some of which may be tree-size! The diameter of a branch on a tree in San Mateo County is nine feet! (Z. Moore, personal communication, 8.15.25) Branches, stems, and roots store or sequester a lot of carbon in their wood, which, via photosynthesis, comes from CO_2 from the air. This carbon storage is important in this time of rapid climate change.

A fire burning in the understory of a forest could possibly climb into the canopy and burn the life-sustaining leaves by climbing a "**fire ladder**" of dead lower branches or understory trees such as bay, tanoak, or young redwoods. Like many other trees, the lower branches of redwoods tend to break off, a process called **self-pruning**. So shedding the lower branches removes a potential fire ladder of dead branches.

The Leaves (Needles):

Needles are the leaves of conifers. Unlike other conifers, the coast redwood has two types of needles. Most of the needles are arranged feather-like and are about an inch long. These (relatively) large needles photosynthesize even in the shady redwood forest.

Higher in a mature tree, the needles get smaller. Branchlets **near** the top of the tree may have small feather-like needles that are only a half-inch long on a length of the stem with other needles clinging closely against it. The needles **at** the top of a mature tree are small and grow tight against the twig. These scale-like needles have less surface from which water might evaporate as they wave in the sun. Branchlets with needles from high in the tree can often be found on the ground after a windy night or storm.

Stomata are tiny holes on the lower surface of leaves. CO_2 enters and O_2 exits through the stomata. Water exits through the stomata in a process called **transpiration**. But redwood needles, especially at the top of the tree, have the ability to take water **in** through the stomata, a process called foliar water uptake. This is very valuable during the long summer dry period when most of the forest's water is in the form of summer fog.

Redwood Needle Types

Left to right:
Needles from top.
< 0.25" long

Needles from near the top.
~ 0.4" long

Right two:
Needles from most of the tree.
Up to 1" long.
Male cones on right specimen.
Light colored new growth in mid-May at the tip.

The Bark:

Like our skin, a tree's bark is its first line of defense. A red-wood's bark can be a foot or more thick, but is typically 4-6 inches thick. It provides an effective protective layer.

California's **Mediterranean climate** means that we get very little, if any, rain from May until October or November. For about half of the year plants and animals living in California need to be adapted to survive long periods of dry fire-prone conditions.

Lightning is the main cause of fires that aren't started by people. Rain usually accompanies lightning. Redwood bark is soft and spongy, so when a thunderstorm hits, the tree is usually covered with a wet spongy layer of bark. But many fires are started by "dry lightning," so the wet sponge isn't always there! Even when the bark is dry, the air between the fibers that make it spongy is a poor conductor of heat. The tannins in the bark are also fire-resistant.

If the bark is breached by fire, a branch or the top of the tree breaks, a falling tree scrapes some bark off, or the bark is damaged by some other means, fungus and insects may be able to get to the sapwood and eventually even into the heartwood. The tree can often recover from such wounds, but fungus can cause a tree to have rot growing inside even as the tree continues to grow for hundreds of years after the injury.

Redwood bark provides resistance to insects, but isn't inpenetrable. Several types of insects, including termites and some beetles, will feed on the cambium or sapwood. But insects generally don't like the heartwood because of its tannins.

If an insect does breach the thick bark, the tree can produce **resin**. Newly produced resins are thick and sticky, sometimes entrapping the invading insect. The resin soon hardens, effectively plugging a small hole or coating a small injury. Redwoods produce much less resin than pines or firs. Resin is very flammable. Having less resin makes redwoods less susceptible to fire damage.

The Roots:

Coast redwoods do not have taproots. They have shallow roots that spread out in all directions, sometimes for over 100 feet. A 250 foot tall tree might have roots that only go down eight or ten feet! The wide root system spreads out the weight of the massive tree.

The roots also intertwine with those of neighboring trees, providing additional protection from being toppled by the wind ("**windthrow**").

A tree growing near a stream is susceptible to being undercut as the stream erodes the bank. Due to the redwoods' shallow roots, streambank erosion is a common cause of treefall. Past efforts to prevent erosion and treefall in parks have altered the natural stream processes, sometimes harming fish and other aquatic life.

The interconnectedness of roots doesn't just provide physical support. With the aid of root fungi called **mycorrhizae**, the roots can collect and pass nutrients and water from tree to tree.

The roots near the surface have a chance to harvest water that condenses on the leaves and falls to the forest floor, which is called "**fog drip**."

Eventually the tree will fall. The base of the tree, the **root crown**, contains many buds. When the tree falls, some of the roots often remain in the soil. Those roots may continue to live and provide water and minerals for sprouts that grow from the root crown buds, thereby producing a new generation of trees growing from the roots of the tree that fell. Those root crown sprouts, being supported by the existing root system, can grow up to six feet in a single year!

When the tree falls, its roots usually pull up a lot of soil with them, and bare soil is exposed in the resulting hole (a **root pull)**.That exposed soil, coupled with the new opening in the canopy that allows light to reach the forest floor, may provide an opportunity for redwood seeds to germinate.

Reproduction by Seed:

Redwood seeds are borne in cones and pollinated by the wind during the rainy season (November - March). They mature during the next rainy season, opening on dry days from September to March. The pollen-producing (pollinate) "male" cones and seed (ovulate) cones develop on separate branches of the same tree; most female cones develop high in the tree. (Noss).

A mature tree may produce thousands of cones, each of which might have 50 or more seeds. Only 5-10% of the seeds might be capable of germinating. (Barbour).

In order to germinate and produce a seedling, a seed needs to survive attacks by fungi and insects while in the cone. Then it needs to grow roots through layers of duff to reach the soil before the young roots dry out or are attacked by fungi or an animal. Seeds can also successfully grow if they fall onto a rotting log or stump. (Noss)

So, the odds of any given seed producing a seedling are small, but in order to replace itself, a tree only needs to have one successful offspring from billions of seeds produced over a lifetime that may reach over 2000 years. (Z. Moore, personal communication, 8.15.25)

Seeds in a magnifying box. (Affixed to card stock with clear nail polish)

Human cells have 23 pairs of chromosomes, and about 20,000 genes. Coast redwood has six copies of each of its 11 chromosomes, or 66 chromosomes per cell. Those chromosomes carry about 118,000 genes. The DNA genome of those 118,000 genes has about 26.5 billion "letters." All of those chromosomes, genes, and combinations of DNA letters provide many opportunities for mutations to produce variability. That variability has enabled redwoods to survive diseases and changes in their environment for millions of years. (Moore).

Reproduction by Sprouting:

As noted above, the root crown or **root collar** has many buds. Those buds can produce new stems or roots if the original ones are damaged by fire, wind breakage, logging, grazing or something else. If a tree falls but some of its roots remain in the ground, new shoots may emerge along the fallen stem as well as from the root collar. When root crown sprouting occurs after a tree is cut, it is often called **stump sprouting**, and it is an important way that coast redwood forests regenerate after logging.

This young redwood grew from the root crown of the fallen tree. After just 3 years it was over 10 feet tall.

Several new trees often sprout around a stump, forming what is called a "fairy ring" or "**family circle**" of clones of the original tree. But because redwoods have so many genes that mutate, those clones aren't necessarily genetically identical. And some trees in a circle may be sprouts from a nearby tree's roots or from a seed.

Young sprouts around a small stump.

A family circle around a stump.

Natural History: The Redwood Forest Ecosystem

What is a redwood forest ecosystem?

An **ecosystem** consists of the living organisms in a place (the **biotic community**) and the non-living or **abiotic** part of the ecosystem, which determines what can live there.

What are the main abiotic factors in a redwood ecosystem?

MOISTURE is the main **limiting factor** determining where the coast redwoods live. The redwood region extends along the coastal fog belt about 450 miles from just north of the California border to just south of Big Sur. (See the map on page 4.) The average annual rainfall in the north is about 60 inches. The average annual rainfall in the Big Sur area is about 40 inches. There is some variation in the vegetation from north to south, but the dominant plants and many other organisms are the same.

A tree as large as the coast redwood needs water even during California's long dry season. In the summer, California often has coastal fog. (Summer fog has been decreasing in recent years.) As noted previously, the coast redwood's needles have the ability to take water in (foliar water uptake), and the shallow roots can take in some fog that condenses and then falls from the needles as fog drip.

As fog and storms approach from the west, the moist air is forced to rise and cool, resulting in more precipitation on the west side of the coastal mountains. Especially in the southern part of the redwood's range, this **rain shadow** effect causes redwoods to grow better on the west side of the mountains. Where there isless rain and fog, the redwoods also do better on north-facing slopes in valleys where they are sheltered from the wind and sun.

Too much rain can cause flooding that topples trees. It can also bring nutrient-rich silt to the valley floors. Roots can sprout into the new layer of soil, and seeds might be able to germinate.

SUNLIGHT is the other main limiting factor for the redwoods. Redwoods that have ample light and water can add over an inch in radius in a single year, but mature redwoods growing in a shady forest might only add $1/50^{th}$ of an inch to their radius in a year.

When a stand of trees is clearcut, the second-growth trees can grow very rapidly in the newly available sunlight, but a forest of trees that are all the same age and size does not support the diverse community of organisms that an old-growth forest supports. Shade limits what types of plants can grow in the understory.

TEMPERATURES in the natural range of the coast redwood are relatively moderate. Summers can get quite warm; winters maybe rainy but are generally mild.

Coast redwoods are not well adapted to snow. The occasional snowfall usually results in many broken branches.

WIND affects redwoods in a variety of ways. The trees in a healthy stand of redwoods shelter each other from strong winds. But if trees are removed by logging, fire, landslides, or other means, the remaining trees may be subject to windthrow or blowdown. Redwoods don't have taproots, but their long, interlocking roots help protect from windthrow.

Along the coast, wind can bring salt spray to the trees, and redwoods don't do well with salt spray. Redwoods can, however, grow well on high bluffs where the salt spray doesn't reach them.

Another problem caused by wind is its drying effect. Wind can push fog away, increase water loss from the leaves (transpiration), and remove moisture from the soil.

SOIL provides nutrients to the plants in the forest. The largest redwoods usually grow in the alluvial flats along streams where there is ample water and occasional floods replenish the topsoil. Those floods and the changing courses of streams may topple trees, so the oldest trees are often found on hillsides.

As noted elsewhere, **FIRE** is a natural factor in the redwood forest ecosystem, and the coast redwood's bark provides effective protection from low-intensity fires. Fire can burn the leaf litter that obstructs seed germination, allowing seeds to reach the soil while also providing nutrients.

Before people began suppressing fire, fires started by lightning or Native Californian people would burn in the forests with a fire return interval of 2-40 years, depending on location. Since wehave been suppressing fires, many forests now have been accumu-lating fuel on the forest floor for over a hundred years. If/when itcatches fire, this huge **fuel load** can result in intense fires. Understory plants have grown up, providing potential fire ladders that could allow flames to reach into the redwood forest canopy.

In the late summer of 2020, several fires burned in the redwood region, including the CZU Lightning Complex in Big Basin and the Walbridge Fire in Armstrong Redwoods State Natural Reserve.

Less than five years after those fires burned, the redwood forest community is recovering surprisingly rapidly from those devastating fires, but return to pre-fire conditions will take hundreds of years.

Sorrel, ferns and other plants on a recovering hillside at Armstrong Redwoods, 2025.

Big Basin redwoods with *Ceanothus* and other understory plants, 2025.

Above: Burned trees sprout new foliage (epicormic sprouting)

Above: A new branch sprouts from a burned trunk.

Left: Sprouts from the root crown of a burned tree.

What are some characteristics of the coast redwood community?

"Old-growth" generally refers to a stand of trees that has not been logged. "Old-growth" doesn't just mean that the forest is made up of old trees, nor does it mean that humans haven't affected the forest. Native Californians have used fire for thousands of years.

What qualifies as an "old" tree? 100 years old? 200 years old? Spanish explorers and Mexican settlers cut some redwoods over 200 years ago. The forests that the early settlers encountered and logged when they came to the redwood region in the 1700s and 1800s now have trees that are 200 years old. Are they "old growth?" Definitions of old-growth vary, but generally refer to forests that have:

- trees of varying ages
- many "relatively old" trees, including never cut stands
- downed logs of varying sizes
- a multi-layered canopy
- shade-tolerant species
- standing dead trees (snags)
- abundant tree cavities (which provide habitat for animals)

A helpful mnemonic is **O.W.L.S.:**

O: Old and young trees
W: Woody debris, including downed trees
L: Layered canopy, including shade-tolerant species
S: Snags and trees with cavities

Trees that regrow after a stand of trees is logged for the first time are referred to as second-growth. The next round of logging results in third-growth trees. Ample sunlight allows second-

growth redwoods to grow much faster than trees growing in a shady uncut stand. Eventually, second-growth forests can develop characteristics of old-growth forests. Most redwood parks contain a mix of old-growth stands and older regenerating second-growth trees. Stands that were logged many years ago may have old-growth characteristics today.

To make harvesting easier, much logging in the past was done by **clearcutting** entire stands of trees. Clearcutting results in a stand of trees that are all the same age. Such a stand will take a great many years to develop the characteristics of a healthy old-growth forest.

Forest Layers

Forests have several layers. Some trees typically grow faster than most of the others. They emerge above the crowns, forming the **emergent** layer. The tops of the majority of the trees form the **canopy.**

The canopy shades most of the forest below. Beneath the canopy is the **understory** layer. Shrubs, bushes, and herbaceous plants form **shrub** and **herb** layers, which may be considered part of the understory.

The **forest floor** layer consists mostly of fallen logs, leaves, twigs, decaying plant material (**duff**), and low-growing organisms such as fungi, moss and some other plants. Sunlight is the main factor that determines what will grow beneath the mature trees.

As a log decays, the decaying wood becomes spongy and able to hold moisture. Dust and decaying leaves may form soil on and in the log. This can provide an ideal substrate for seed germination. A fallen log with plants growing on it is called a **nurse log**.

Stumps, of course, also decay and can accumulate soil and decaying plant material. Like nurse logs, stumps can provide ideal growing conditions for plants. Ferns, mosses, redwood sorrel, huckleberries, tanoaks, hazelnuts, redwoods and other plants commonly grow on such "**nurse stumps**."

The plants growing on nurse stumps and logs provide habitat for a variety of animals.

Old redwoods often have large branches protruding from the main stem. These branches can be several feet across. Dust, leaves, twigs, and other detritus can accumulate on top of them forming **canopy soil** that may be 3 feet thick! (Z. Moore, personal correspondence, 8.15.25)

Eventually, communities of lichens, moss, ferns, fungi and even trees can grow in the accumulated canopy soil. Birds such as the marbled murrelet may nest on these mats, and many other vertebrates and invertebrates also make their homes in them.

A dead but still standing tree is called a **snag**. Snags provide habitat for hundreds of species of plants and animals such as moss, lichens, insects, tree frogs, woodpeckers, squirrels, and bats.

Streams

Many redwood forests have streams ranging from ephemeral creeks to year-round rivers. Streams constantly erode their banks
and change course. Such erosion and course changing can undercut trees, roads, and other park features. When a tree falls into a stream, it often forms a partial dam that can cause flooding. So for many years streams were lined with cement and logs to stop undercutting, and logs (**large woody debris – LWD**) were removed to try to stop flooding.

Streams support a variety of aquatic and riparian organisms, including invertebrates, amphibians and salmonids (salmon and trout). Salmonids need cool water and gravelly streambeds where they lay their eggs. Redwoods provide cooling shade. Logs partially blocking a stream can form a pool of deep cool water. And a natural streambed provides gravel for egg laying. Current practices generally leave fallen trees in the creeks. Sometimes LWD is even added to the stream! And some streambeds are being returned to their natural state to help salmonid populations recover.

Common Organisms

A few words about names: An organism's name is probably the least important thing about it, but visitors often want to know the names of plants and animals that they see. Knowing a name can help one connect to an organism. Docents and interpreters should be able to identify the most commonly seen organisms, but should also know (and share with visitors) something about them. (See page 50 of Roa's *Redwood Ed* for a more extensive discussion about names.)

Sequoia sempervirens was given the scientific name *Sequoia sempervirens* by a botanist named Stephan Endlicher in 1847. *Sequoia* may refer to the Cherokee Indian Sequoyah, or to studies of the sequence of related fossil species. *Sempervirens* can mean either ever living, a reference to the tree's longevity, or it can be translated as ever green, to distinguish it from the similar bald cypress, which loses its leaves. (Barbour)

In order to keep this booklet short, only a very few of the hundreds of species of organisms that live in the redwood forest are discussed. These are some of the organisms that visitors are most likely to see throughout the redwood region. See the Resources section (page 45) for some sources of additional information.

Plants:

Bigleaf Maple: *Acer macrophyllum*

Bigleaf maple seeds have "wings" that help them float slowly to the ground, spinning like a helicopter blade. This helps spread the seeds away from the parent tree, thus reducing competition.

Life size

Douglas-fir: *Pseudotsuga menziesii*

Douglas-fir is not a true fir, hence the genus name ***Pseudo****tsuga.* And "tsuga" refers to hemlocks. True firs have cones that stand upright on the twigs and fall apart when mature. Douglas-fir cones hang down and fall from the tree intact. The cones are easily identified by the bracts that extend out beyond the edges of the scales. Cones are about 1.5-2.5 inches long. Redwood needles splay out in a feather-like manner, while Douglas-fir needles grow all around the twig, similar to a bottle brush.

Douglas-fir is moderately shade tolerant. In the redwood region, it grows mostly in openings and upslope from the redwoods, and is more common in the northern part of the redwood range.

"Female" (ovulate) cone (life size)

"Male" (pollinate) cones

Bay (Bay-Laurel, California Bay, Oregon Myrtle, Pepperwood): *Umbellularia californica*

Bay trees will readily sprout from root crowns The leaves, especially when green, have a strong odor.

Our bay is not the same species as the commercial bay leaf.

Tanoak (Tanbark-Oak): *Notholithocarpus densiflorus*

The tanoak is more closely related to chestnuts than to oaks. Tanoak acorns were a very important food source for Native Californians. In a good year, a single large tree could provide 200 pounds of acorns. Maintaining space for tanoaks was one reason that they used fire to keep prairies open. As its common name implies, the bark of tanoak was used in tanning leather.

Life size

Poison Oak: *Toxicodendron diversilobum*

Poison oak grows as a shrub where there is ample sunlight, but it grows as a vine in the shady forest. The leaves usually look like oak leaves but, as the species name implies, are quite variable.

Many visitors have heard the adage “Leaves of three, leave it be,” but many redwood forest plants have three leaves. Poison oak loses its leaves in the winter, but the stems still have oils that can produce a rash. The stem often has short branches jutting out alternately to the side, sort of like arms, and the stem tapers relatively little. A six foot long stem might be only the diameter of a pencil. “If it doesn’t taper, it’s not safer,” and “Stubby arms can still do harm.”

Young leaves are dark red or light green in the spring; old leaves turn pink or red in the late summer and fall.

Leaves in fall

Not deeply lobed

Deeply lobed

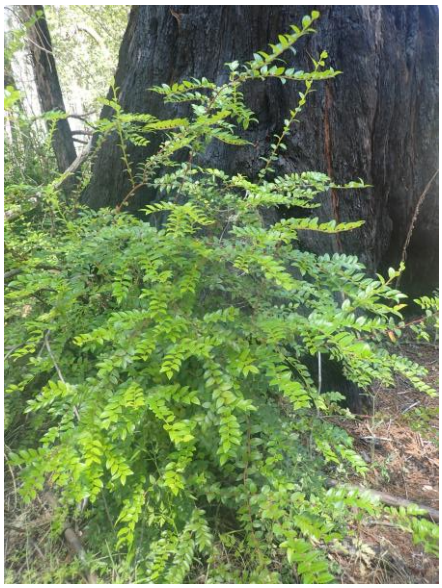
Not tapered, stubby arms

Trillium: *Trillium ovatum*

Trillium is the genus name for several showy plants, including the western trillium or wake robin. The flowers turn reddish as they get older.

Evergreen Huckleberry:
Vaccinium ovatum

There are over 400 species in the genus *Vaccinium*, including blueberries and cranberries. Most species are deciduous, but the evergreen huckleberry isn't. All produce fruit that is prized by wildlife. Huckleberry is more common in the central and northern regions than in the south.



Redwood Sorrel: *Oxalis oregana*

Although the leaves of redwood sorrel look like clover leaves or shamrocks, they are neither. The leaves stick straight out when it is shady; they droop down when in sunlight. This reduces water loss through transpiration by shading the stomata on the undersurface.

Thimbleberry: *Rubus parviflorus*

Thimbleberry plants can be over six feet tall with thornless canes that grow from underground stems called **rhizomes**. The deciduous leaves look a bit like soft, fuzzy maple leaves. The fruit, which is actually a cluster of fruits, like a raspberry, has a mild taste.

California (Beaked) Hazelnut: *Corylus cornuta*

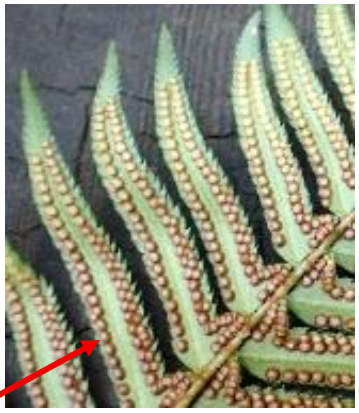
The California hazelnut has very soft, fuzzy leaves and produces a nut that looks like a smaller version of the commercial hazelnut or filbert. The stems that emerge from the ground after a fire were used by the Native Californians in their basketry.

Life size

Sword Fern: *Polystichum munitum*

The **frond** of the sword fern has many leaflets (**pinnae**) projecting out from each side. The pinnae have a projection that looks sort of like the hilt of a sword, hence the common name.

Ferns reproduce by **spores**, which are produced in structures called **sporangia**. Sword fern sporangia are contained in **sori** found in two rows on the underside of the pinnae. To some, the sori look a bit like insect eggs. Sori are usually present in the late apring or summer.



Sori

Bracken Fern (Brake): *Pteridium aquilineum*

Bracken fern grows worldwide. Spores are produced in sori along the edge of the underside of the pinnae (leaflets). They also reproduce by sprouting from their underground stems, called rhizomes. This ability helps ferns survive fires. Unlike wood ferns, bracken fronds emerge from the ground separately.

Unlike most ferns, which remain green all year, bracken ferns turn yellow and die back each year.




Wood Fern: *Dryopteris* spp.

Wood ferns are sometimes confused with bracken. Several wood fern fronds emerge from the ground in one place. Sori are kidney or horseshoe shaped and found in rows along the center of the pinnae.




Animals:

Note: "spp" indicates that the name applies to more than one species.

Banana Slugs: *Ariolimax* spp

California banana slug

There are several species of banana slug in California. Banana slugs can be all yellow, have dark spots, or be yellow-brown, or even black or white. They obtain moisture through gills on the lower sides of their body. The gills must be moist to function, so when it is dry they seek shelter in holes in the ground, under damp logs, or in other moist places. Banana slugs are hermaphroditic; each individual has both male and female genitalia.

While most commonly seen feeding on plants or fungi, they are omnivorous. They will feed on many types of plants, mushrooms, and even dead animals and scat.

Left: Button's banana slug
Right: Banana slugs mating

Yellow-spotted Millipede: *Harpaphe haydeniana*
Bark Centipede: *Scolopocryptops* spp

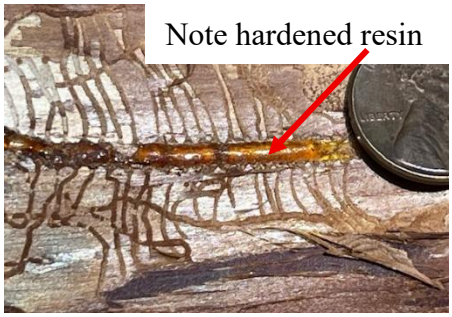
Millipedes have two pairs of legs per body segment; centipedes have one pair. Millipede bodies are usually more rounded than those of centipedes. Millipedes are herbivores; centipedes are carnivores. Millipedes will often curl up if threatened. The yellow-spotted millipede fluoresces ("glows") under UV light.

Bark Centipede

Redwood Bark Beetle: *Phloesoinus sequoiae*

While the bark, resin, and tannins of redwoods make them resistant to insects, there are a few insects that will feed on redwood needles or wood.

Quarter-inch long redwood bark beetles will sometimes attack stressed, dying, or dead redwoods. They lay their eggs just under the bark, and the larvae feed on the phloem and cambium. As they feed, bark beetles leave grooves in the wood, so they are sometimes called engraver beetles. The redwood bark beetle larval feeding galleries look sort of like a centipede. If they go all the way around the branch or tree, they can actually kill it, a process called girdling. Branches showing the galleries of bark beetles can often be found on the forest floor.



Note hardened resin

Common Raven: *Corvus corax*
American Crow *C. brachyrhynchos*

Ravens and crows can often be seen and heard in the redwood forest. They have a variety of calls. One raven call sounds like knocking on wood and this "rattle" may be mistaken for a woodpecker.

A raven's beak is more stout than that of a crow, and ravens have a blunt wedge-shaped tail, while crows have a more rounded tail. Ravens are significantly larger.

Crow

Raven

Crow

Steller's Jay: *Cyanocitta stelleri*
California Scrub Jay: *Aphelocoma californica*

People sometimes call the Steller's jay a "bluejay," but true bluejays are found east of the Mississippi. Jays easily become accustomed to people and they may hang around picnic areas and campgrounds looking for food.

Scrub jays are common, but more so in dryer areas.

Left: Steller's Jay (Note the crest)

Right: Scrub Jay

Dark-eyed (Oregon) Junco: *Junco hyemalis*

The dark-eyed junco is commonly seen hopping around on the ground looking for seeds. Their coloration and markings are variable, but look for a dark head and l ighter body.

Black-tailed (Mule) Deer: *Odocoileus hemionus*

Black-tailed deer are often seen in the redwood region, and can become pests if they become too acclimated to people. They are generally smaller than the white-tailed deer found in the east.

Squirrels and Chipmunks: *various genera and species*

The Douglas squirrel or chickaree (*Tamiasciurus douglasii*) is one of several squirrel species, including the western gray and northern flying squirrel, found in the redwood region.

Please don't feed the bears (or deer, squirrels, crows, or jays)!

People often want to feed animals. They may also inadvertently feed them by leaving crumbs along trails or at picnic tables. Doing so draws animals to areas where they might be injured by cars or dogs or cats. Too many crows or jays in an area can lead them to prey on other animals, including the eggs of endangered marbled murrelets. Scavenging human food is harmful both nutritionally and in terms of dangerous behaviors. Some parks have instituted "Crumb Clean" campaigns to educate the public.

Fungi and Lichens:

Turkey Tail Fungus: *Trametes versicolor*

The color of turkey tail fungus is quite variable, hence the species name *versicolor*. It is not considered edible, but it does seem to have some medicinal properties.

Beard Lichens: *Usnea* spp

People often think that this lichen is "Spanish Moss," which is a flowering plant that lives in tropical and subtropical climates, including the southeastern U.S.

When damp, these lichens are fairly elastic. A common name for some beard lichens is "old man's beard."

Environmental Concerns

Climate change: When I wrote *Redwood Ed* in 2005, climate change wasn't among the environmental issues that I discussed.

The ultimate effect of climate change on the redwoods is unclear at this time. Increased CO_2 and reduction of fog due to climate change has increased growth in wetter areas. But rising temperatures and less fog in drier areas result in slower growth rates and drier overall conditions. Climate change also leads to more frequent and more severe wildfires and droughts and to more frequent and severe floods. Climate change can also lead to changes in pests and pathogens. (Save the Redwoods League and personl correspondence with Zane Moore)

Through the process of photosynthesis, redwoods and other plants remove carbon from the atmosphere and store it in various compounds. Coast redwood forests have been shown to store more carbon per acre than any other forest type. (Giant sequoia forests come in second.) (Save the Redwoods League)

Other environmental issues that are likely to come up include:

Compaction of soil: Compaction of soil, especially wet soil, reduces the ability of both water and air to reach the roots. Even people walking on the forest floor can compact the soil enough to damage redwoods' shallow roots. Limiting the compacted area by staying on trails can help protect the trees.

Erosion and siltation in creeks and rivers: Fires and landslides can cause erosion;. Logging, conversion to other uses and improperly engineered roads are major causes of erosion. Erosion and siltation can destroy fish habitat and change stream flow so that banks are eroded and trees undercut.

Overcrowding in parks: For many years, overuse of parks – "loving them to death" – has been a concern. Unless people can experience nature, they won't want to protect the environment or parks. But too many visitors causes problems such as soil compaction, loss of the tranquility that people seek, law enforcement issues, and demand for more infrastructure such as parking, trails, restrooms and other amenities that impact the environment.

Overdevelopment or inappropriate development in parks: In parks, the problem isn't just how many people want to visit. Another issue is what kind of development is appropriate. How "natural" should parks be and how much of the land should be converted to roads, buildings, restrooms, visitor centers, campsites or trails? Some redwood "parks" are actually "natural reserves," which allow less intensive use. In most parks, there is an ongoing attempt to restore areas to a more natural state.

Fires (or lack of fires): Even though redwoods are fire resistant, fire can kill them, and land that has had the vegetation burned off is more susceptible to erosion. Climate change, coupled with fuel accumulated due to years of fire suppression, makes fires more destructive.

Relatively frequent fires can help reduce the fuel load in forests. Current management, sometimes in conjunction with tribal groups, uses prescribed burning and less fire suppression to reduce fuel loads. And the burning of duff may facilitate reproduction by seed.

Flora and Fauna – Endangered species: The coast redwoods are home to many organisms that, for a number of reasons, are threatened or endangered. These include not only well-known species such as the northern spotted owl, marbled murrelet, Califonia condor and some "runs" of salmon, but lesser-known species such as the Humboldt marten (*Martes americana humboldtensis*) (right). Habitat loss, especially due to early logging, is a major cause of species endangerment.

Note: Local resources such as state parks scientists, ecologists, and interpreters can tell you about local endangered and invasive species, which vary depending on the park.

Flora and Fauna – Invasive Species: Both plants and animals can move into an area and displace or cause other problems for local native species, often because the invasive species' natural predators don't follow. Examples include English Ivy, the Himalayan (or Armenian) blackberry, and the barred owl.

Himalayan blackberry (*Rubus armenianus*) has 3-5 leaflets and stout spines.

CA. blackberry (*R. ursinus*) has 3 leaflets and relatively slender spines.

The northern spotted owl (*Strix occidentalis caurina*)(below, left) is endangered, primarily by habitat loss due to logging and development. But the invasive barred owl (*S. varia*) (below, right) has moved into the Pacific Northwest from the east and not only competes with the northern spotted owl but also interbreeds with it.

And last but not least:

Nature deficit disorder: Richard Louv's *Last Child in the Woods* makes the point that people tend to love and want to protect what they know. If people don't get out into nature, they are less likely to care about protecting it. In today's society, most people don't spend much time in nature. And, of course, spending time in nature is healthy…it's a win – win for people and nature! This makes it especially important for docents, interpreters, teachers, and others to try to help people have experiences in nature that are enjoyable, informative and inspiring.

Hints for New Redwood Educators

Parks have training programs to help new docents and interpreters get started. Those programs will go into much more depth about interpretation than this *Primer* can provide, but here are some ideas that you may find useful.

1. **Be kind to yourself.** It takes time to learn all that you will want to know about redwoods, and it takes time and practice to develop your skills.
2. **It's okay to say "I don't know."** It's even better to say "I don't know, but I'll find out," – and then follow up.
3. **Learn from others.** Shadowing experienced docents and interpreters is the best way to learn. Keep in mind that every docent and every visitor group is different. You will develop your own style and your own "schtick."
4. Sometimes we hear or read things that aren't true. (e.g.: "Redwood doesn't rot." If it really didn't, the forest would be full of down trees!) **If in doubt, check it out.** And if you aren't sure about something that you would like to share, or aren't sure about an answer, it's okay to say something like "I'm not sure, but here's what I think:" or "I've heard xxx, but I'm not sure about that."
5. Have a plan, but take advantage of "**teachable moments**" such as when a cone is found, a deer or banana slug seen, or a question asked.
6. Let the group's interest and questions guide you. **Know (and listen to) your audience.**
7. Don't always call on the same person to answer a question. **Try to involve everybody.**
8. **Don't tell; ask.** Try to engage visitors by asking questions. Maybe something like: What do you notice about that leaf? What might feed on this plant? What does that leaf remind you of? Does anybody see a different kind of fern? How is that leaf different from that other leaf? How are they same?
9. If you ask a question, don't stop at the first answer. Try to **get all of the visitors to think** about the question. Maybe say something like "Does anybody have another idea?" or "Could there be another reason?"
10. Endeavor to help the visitors make a **connection** to the site. Don't just simply give facts and names. Invite them to use all of their senses, including touch and smell. (Be careful with taste!) Your goal is to **engage and connect**, not just educate.
11. **A picture is worth a thousand words.** Have laminated images of things that are of interest but that may not be seen on a given tour, such as historic pictures, a map of redwood ranges, or flowers or fungi that may not be "in season."
12. If a picture is worth a thousand words, **a thing is worth a thousand pictures.** Use specimens and other "realia." Maybe pass around coast redwood and giant sequoia cones, a magnifying box with a couple of seeds, a branchlet that fell from high in a tree the previous night or a "stuffie" of a banana slug or raccoon. The forest itself will provide the most useful teaching resources, and the better you know your local forest, the better you can use those resources.

13. People will want to know the names of organisms. But **don't just tell them the names.** Maybe ask them what they notice, or what they would name the organism. Share something about the organism in addition to the name. How did Native Californians use this plant? Maybe learn some organism names in other languages.

Conclusion

The coast redwood forest has many delights to share with us and much to teach us. We are all students and teachers. When we help others have enjoyable and informative experiences among the redwoods, we help both those people and the redwood forest community. If you are a beginning interpreter or docent, you have a wonderful – and wonder-filled – adventure to look forward to as you learn about and spend time in the redwoods. Thank you for helping to protect these wondrous trees by sharing them with others.

Acknowledgments

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Z. Moore, personal correspondence, 8.15.25: Dr. Zane Moore provided some statistics in an emailed review of a draft of this Primer.

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(Accessed by Michael Roa 5.29.25)

Page 31: Scimitar: image from the Internet at: https://www.buyingasword.com/brass-hilt-caribbean-pirate-sword/

Page 33: Banana Slugs mating: Courtesy of Orenda Randuch, CA. State Parks Volunteer

Page 33: Yellow-spotted Millipede in UV light: Courtesy of Leslie Carrow, Stewards of the Coast and Redwoods

Page 33: Bark Centipede: Ben Keen 2.13.20 Port Alberni, BC Canada
https://www.inaturalist.org/observations/38695565
(Accessed by Michael Roa 5.27.25)

Page 34: Redwood Bark Beetle: Javier E. Merdado, Bark Beetle Genera of the U.S., USDA APHIS PPQ, Bugwood.org

Page 34: Common Crow (upper right): Kim Gauen 7.22.18 Hamilton County, IL
https://www.inaturalist.org/observations/14650910
(Accessed by Michael Roa 6.2.25)

Page 34: Raven: Courtesy of Leslie Carrow, Stewards of the Coast and Redwoods

Page 34: Common Crow (lower right): Joshua 6.27.22 Vancouver, B.C, Canada
https://www.inaturalist.org/observations/123794725
(Accessed by Michael Roa 6.2.25)

Page 35: Steller's Jay: Irene 5.9.25 Mt San Jacinto State Park, CA
https://www.inaturalist.org/taxa/8234-Cyanocitta-stelleri/browse_photos?photo_license=cc0
(Accessed by Michael Roa 6.2.25)

Page 35: California Scrub Jay: Irene 5.15.25 Salinas, CA
https://www.inaturalist.org/observations/265664166
(Accessed by Michael Roa 5.29.25)

Page 35: Dark-eyed Junco: Andy Kleinhesselink 10.2.18 Hilgard Ave, Los Angeles, CA
https://www.inaturalist.org/observations/17134505
(Accessed by Michael Roa 5.29.25)

Page 35: Black-tailed (Mule) Deer Sean Height 5.11.23 Lane County, Oregon
https://www.inaturalist.org/observations/161512768
(Accessed by Michael Roa 7.21.25)

Page 36: Douglas Squirrel: Steven Smethurst 3.15.21 Burnaby, B.C. Canada https://www.inaturalist.org/observations/71347351
(Accessed 7.21.25 by Michael Roa)

Page 38: Humboldt (Coastal) Marten: Tatian Gettleman, Public Domain, https://www.fws.gov/media/coastal-marten

Page 40: Northern Spotted Owl Shane Jeffries USFS.jpg, Shane Jeffries/USFS, Public Domain, https://www.fws.gov/media/threatened-northern-spotted-owl-shane-jeffries-usfsjpg

Page 40: Barred Owl: Malheur NWR Ray Bosch USFWS.jpg, Ray Bosch/USFWS, Public Domain, https://www.fws.gov/media/barred-owl-malheur-nwr-ray-bosch-usfwsjpg

Page 40: Courtesy of Leslie Carrow, Stewards of the Coast and Redwoods

Resources for Further Investigation

Barbour, Michael et al. *Coast Redwood: A Natural and Cultural History*. Los Olivos, CA: Cachuma Press, 2001. (A very thorough and well-written natural and human history of the coast redwoods.)

Engbeck, Joseph. *Saving the Redwoods.* San Francisco, CA. Save the Redwoods League, 2018. History of efforts to save the redwoods, especially Save the Redwoods League's role.

Forestry Institute for Teachers (F.I.T.) The Forestry Institute for Teachers is a weeklong program intended to help ducators understand forest ecology and management. Sessions are held in various places around the state, including in Humboldt County. There is an application fee, but also a stipend that more than covers the fee if you do a forest education project. And lodging and meals are included. https://www.forestryinstitute.org/

Hewes, Jeremy. *Redwoods: The World's Largest Trees.* San Francisco, CA: Rand McNally and Company, 1981 (Clearly written and richly illustrated. Science and human history of both coast redwoods and giant sequoias.

Mead, George R. *The Ethnobotany of the California Indians*. La Grande, OR.: E-Cat Worlds, 2003. (An excellent resource forinformation on over 1,300 California plants, including uses, Indian names, and other information. Libraries may have other resources giving information about uses by local tribes.)

Noss, Reed, ed. *The Redwood Forest: History, Ecology, and Conservation of the Coast Redwoods*. Covelo, CA: Island Press, 2000. (Goes into greater depth about the science of the redwoods than Barbour's *Coast Redwood*.)

The Redwood National and State Parks website has natural and cultural history information at: https://www.nps.gov/redw/index.htm

Roa, Michael. *Redwood Ed – A Guide to the Coast Redwoods for Teachers and Learners*. Sacramento, CA: California State Parks, 2007. (Provided the starting point for this booklet. Includes information on natural and cultural history of the redwoods and also activities for before, during, and after a field trip to the redwoods.) Available on the California State Parks website at: https://www.parks.ca.gov/?page_id=25395

Save the Redwoods League: Their website has lots of information.
https://www.savetheredwoods.org

Sempervirens Fund: While their focus is on redwoods in the Santa Cruz Mountains, their website has information about redwoods in general. https://sempervirens.org

This *Primer* is available for downloading at their Read and Watch page at:
at: https://sempervirens.org/learn/read-watch/

Stewards of the Coast and Redwoods has a number of resources on their website. Those include "cards" with photos and information about many organisms. Here's a link to the Volunteer Resources section. Go to the Armstrong Redwoods Docents section and scroll down to find the basic and advanced organism cards. (You might beinterested in taking a look at some of the other resources there such as the keys and "Features Cards" that were developed for use at Armstrong Redwoods State Natural Reserve, in Sonoma County.)

https://stewardscr.org/volunteer-resources/

About the author:

Mike Roa served as a teacher in grades 4-12 and in other roles in public education for over 40 years. He is also the author of several articles and books on science and environmental education, *including The Environmental Science Activities Kit, A Guide to the Side of the Sea, Redwood Ed,* and *The Conifer Connection.* (The last three are published by California State Parks.)

He is currently the lead docent at Armstrong Redwoods State Natural Reserve, in Guerneville, California, and serves on the organizing committee for the North Bay Science Discovery Day. (www.northbayscience.org)

He lives in Sebastopol with his wife J.T. O'Neill. You can contact him at:

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Columbia Lily *Lilium columbianum* Prairie Creek Redwoods State Park July, 2025