CALIFORNIA NATURAL HISTORY GUIDES

INTRODUCTION TO TREES of the SAN FRANCISCO BAY REGION

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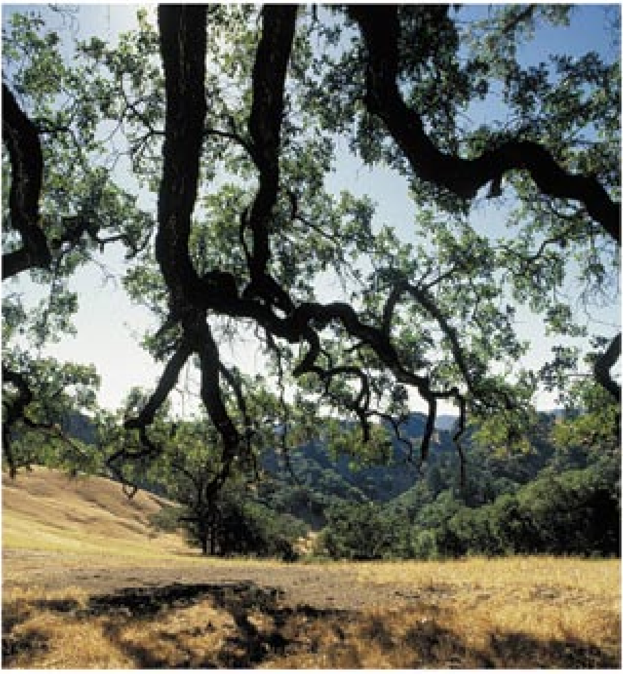

INTRODUCTION

Major Attributes of Trees

There are many kinds of trees in the world, and so there are many ways of sorting them. Some attributes of trees immediately call attention to themselves; other features may go unnoticed until you take a closer look or already know what to look for. Outstanding features include the tree's ultimate size and shape, leaf characteristics, bark patterns, and flowers, cones, or fruits. Let's examine each category in turn.

Size and Shape

Many trees are immediately singled out for their size, yet size can be misleading—especially height. The age of the tree and its environment play major roles in determining size. For the novice, it may be difficult to know whether a particular tree is a sapling or a full-grown specimen, although if you scrutinize the area where many of the same trees are present, the tree's age is usually obvious. Many young trees exhibit forms of foliage and overall shape that differ strikingly from their mature forms. Environment has an equally dramatic effect: strong winds, poor soils, and little water may severely limit the size of a tree. For example, the pygmy cypress *(Cupressus goveniana* subsp. *pygmaea)* is a stunted runt of a tree when it lives on the shallow, nutrient-deficient soils of ancient marine terraces. The same tree will grow to over 100 feet high on deep, rich soils. For these reasons, the overall size of a given tree may be a poor guide to identification.

Shape, by contrast, is often more reliable, at least when the approximate age of the tree is known. For example, a young incense-cedar exhibits a narrow, conical shape, whereas an old tree may bear an irregular, craggy crown. Many mature trees are quickly identified by the overall shape of their crown, often from some distance away. Practice makes perfect in applying this knowledge. Look for whether the crown is broader than tall, rounded, drooping, narrow, cone-shaped, irregular, or symmetrical.

Leaf Characteristics

When available, leaves are among the easiest means of identifying trees. Trees can be conveniently divided according to the major details of their leaves. A convenient starting point, for example, may be whether a tree is deciduous or evergreen. Most deciduous trees lose all their leaves in fall and remain leafless through the winter. Even in spring and summer, deciduous trees have rather thin, pliable leaves. Evergreen trees keep at least one or more sets of leaves through an entire year, so that they always have some leaves, even in winter. But no evergreen tree keeps all of its leaves for its entire life; the typical tenure of an evergreen leaf is between two and four years. Leaves of evergreen trees are often tough and leathery.

Another major criterion is whether leaves are needle- or scalelike. The majority of trees that bear seed cones rather than fruits—the conifers—have such leaves. By contrast, the majority of flowering trees have broader leaves, leading to the commonly used term *broadleaf tree.* Note that the term *hardwood tree* is synonymous with the term *broadleaf tree.* All softwood trees are conifers. The terms *softwood* and *hardwood* are not absolute: for example, balsa belongs to the hardwood group but has very soft, pliable wood. Rather, these terms are applied in a broad manner: flowering trees are hardwood, and coniferous trees are softwood.

Once you're past these major categories, many subtler leaf details readily separate one kind of tree from another. Here is a list of attributes to look for:

Leaf Arrangement

Are leaves found in pairs, whorls (three or more at a node), or singly on their twigs? Paired or whorled leaves are much less common than single (alternate) leaves.

Leaf Form

Are leaves simple, consisting of one piece, or are they compound, with two or more separate leaflets? Simple leaves may be further distinguished by whether they're deeply lobed or not.

Compound leaves are sometimes confused with a branch carrying several simple leaves. How can you tell the difference? Look for a tiny bud at the base of the leaf: a compound leaf has only one bud at its very base, and none at the base of each leaflet. If the leaf also has stipules (pairs of leaflike appendages) at its base, they will be found only at the base of the whole leaf, not the base of the leaflets.

Compound leaves are either pinnate—leaflets arranged ladderlike along a central stalk—or palmate—leaflets arrayed like fingers on a hand. Pinnately compound leaves are much more common than palmately compound leaves; but in general, there are far more trees with simple leaves than compound ones.

Leaf Shape

There are almost as many leaf shapes as there are kinds of leaves. The names of many shapes are intuitive, for example, oval, linear, lanceolate, and elliptical. Others are easily deduced: orbicular (round), for the shape of an orb; deltoid (triangular), for the shape of a river's delta. If in doubt, look up the meaning in the glossary in the back of this book. Some leaves may combine shapes of two different patterns: ovate-lanceolate, for example, which is a shape halfway between ovate and lanceolate.

Leaf Margin

The edges of leaves may be smooth (entire) or lined with jagged teeth or rounded scallops, or be wavy or curled under. There are many useful terms for describing these attributes.

Leaf Apex and Base

Some leaves with fundamentally the same shape may differ in the details of their tips. Leaf tips may be narrowly or broadly rounded or squared off, or may taper gradually or abruptly to a point.

Vein Pattern

Leaf veins often form intricate patterns, and each pattern can uniquely identify a particular tree. For example, close scrutiny of vein patterns may reveal that the primary pattern is pinnate, whereas the secondary pattern (the smaller veins) is reticulate. Often, leaves with the same overall shape have differing vein patterns, making this feature important in separating look-alikes.

Leaf Color

Although most leaves are green, there are many different tones of green. Some leaves also have a decided grayish, reddish, or bluish cast.

Leaf Coverings

Although it's not always obvious, many leaves are covered with special glands or hairs—protective structures that keep the leaves from drying out or from being chewed by insects. A good 10× hand lens is a useful adjunct for revealing details that to the untrained eye seem obscure. As you learn more about these minute coverings, it also becomes obvious that there are many different kinds of hairs—stiff, short, long, silky, straight, curled, starburstlike, interlaced, and more.

Leaf Size

Just as the overall size of a tree may be misleading, so, too, is leaf size. Typically, leaves at the top of a tree are smaller than leaves on the bottom branches. Shade leaves are generally larger because they need as broad a surface as possible to trap sunlight; sun leaves are smaller in order to conserve water.

Leaf Age

As trees grow to maturity, they lose their juvenile leaves, and the juvenile leaves on young trees may look entirely different from the adult leaves of the same tree. For example, blue gum has broadly oval, opposite juvenile leaves and vertically oriented, alternate, sickle-shaped adult leaves.

Bark Patterns

The bark of mature trees has its own distinctive pattern, but this pattern may be different or not be obvious when the tree is young. Tree bark may be brown, gray, whitish, reddish, or other colors. Bark texture may be stiff and tough, soft and spongy, or corky and flaky. Because old bark peels away every year and each tree has its own pattern of sloughing off its bark, bark shows distinctive designs. In some trees the bark is ribbed or ridged vertically; in others, it is crosshatched or checkered; in still others it is flaky or puzzlelike. Fissures between the raised areas of bark may be very shallow or well over an inch deep. Different layers of bark may exhibit different colors; for example, the western sycamore's *(Platanus racemosa)* oldest outer bark is gray, whereas its youngest inner bark is cream colored. Unfortunately, it is often difficult to describe the complexities of bark patterns in a few words: the eye is able to record these differences much more faithfully than language can.

Flowers, Cones, or Fruits

Broadleaf, or hardwood, trees usually produce flowers that ripen into fruits containing seeds. Coniferous, or softwood, trees usually bear cones—tiny pollen cones in spring, and seed cones that ripen into conspicuous papery, fleshy, or woody cones later in the year. Whether the tree is a conifer or has flowers, its reproductive parts are the most reliable means of identification, and botanists rely heavily on the characteristics of cones, flowers, and fruits for classifying trees. The biggest problem is that flowers and fruits are usually ephemeral—they may last only a few days or weeks. The more substantial fruits, such as acorns and samaras, may persist after they've fallen from the tree's branches. The same is true for the seed cones of conifers. But because bark and leaves are present most of the year, the keys in this book rely on them more than on the reproductive parts.

There are two general categories of broadleaf (flowering) trees: those with tiny, inconspicuous, wind-pollinated flowers, and those with showy, insect-pollinated flowers. In general, most of our native flowering trees belong to the first category. For example, oaks produce hanging chains (catkins) of tiny male flowers that turn yellow when they shed their pollen.

These male flowers have no colorful petals to attract insects. Oak female flowers are even less conspicuous—they're about the size of a pea and occur in the axils of new leaves. Each female flower is green and topped by three tiny red stigmas.

Generally, only the smaller trees, such as the California buckeye *(Aesculus californica)*, California fremontia *(Fremontodendron californicum)*, western redbud *(Cercis occidentalis)*, and service berries (*Amelanchier* spp.) produce colorful flowers with petals that are aimed at drawing bees, butterflies, or birds for pollination. Some of these, like the flowers of many of our native shrubs, are counted among the showiest and most beautiful components of native landscapes.

Successfully fertilized flowers (except exclusively male flowers) are followed by fruits—ripened ovaries that contain one or more seeds. Mature fruits may become fleshy and be brightly colored to attract mammals and birds, they may turn brown and papery and split open to shed their seeds, or they may harden into brown, thick-walled nuts, acorns, or small achenes (one-seeded fruits that remain closed) that animals gather for food and bury for later use. Throughout this book, you'll discover examples of each of these distinctive categories.

Conifers, by contrast, produce pollen and seed cones. Seed cones may take anywhere from six months to over two years to ripen and reach full size. Mature cones may be as short as an inch or as long as two feet in the case of the sugar pine. Typically, they consist of whorled or spirally arranged papery or woody scales. Each scale carries two or more seeds that, when ripe, generally fall out of the cone. Wings on the seeds help in dispersing the seeds on winds. A few are wingless and dispersed by animals.

Tree Habitats

In many places, trees dominate over smaller plants, and consequently, many ecologists accept the idea that trees represent the climax vegetation for any given area. But there are many mitigating circumstances, especially in California: coastal bluffs buffeted by constant wind; the unstable sandy soils of shifting sand dunes; constantly wet, boggy places; areas that are frequently burned; or dry habitats with nutrient-poor soils. To be sure, trees have adapted to some of these difficult situations, but there are definitely habitats where tree growth is untenable. One of the most dramatic of these is chaparral —a dense cover of evergreen shrubs adapted to steep, rocky, hot slopes that receive small amounts of annual precipitation. Human practices have also rendered many areas devoid of trees through burning, clearing, grazing, and plowing.

Despite these treeless places, there are many habitats that favor trees. A survey of Bay Area plant communities counts no fewer than seven kinds that support trees. Starting at the immediate coast, we find dense forests of closed-cone pines and cypresses clinging to rocky soils on promontories that receive heavy summer fog and ample winter rain. These forests consist of one or more species of wind-adapted conifers whose seed cones normally open only after fire sweeps through. These cones remain permanently attached to the trees. Typical of this community are Monterey pine *(Pinus radiata),* bishop pine *(P. muricata),* Monterey cypress *(Cupressus macrocarpa),* and Santa Cruz cypress *(C. abramsiana).* An unusual and extreme version of this vegetation occurs on ancient marine terraces whose soils have long been leached of nutrients and that have developed an underlying hardpan: the trees here are stunted. Several sites on the Mendocino coast are typified by pygmy cypress *(C. goveniana* subsp. *pygmaea),* bishop pines, and Bolander's beach pines *(P. contorta* subsp. *bolanderi),* none of which grow up to more than 10 feet tall on such sites.

A second kind of closed-cone pine forest can be found on inland, nutrient-poor soils where summer days often top 100 degrees F. Typical of the unusual soils that support these trees are serpentinites, developed from the slick bluish or reddish rocks that are toxically high in heavy metals. Here, look for knobcone pine *(P. attenuata)*, Sargent cypress *(C. sargentii)*, and Macnab cypress *(C. macnabiana)*.

Redwood forest is arguably California's most famous tree habitat. Although people typically think of redwoods as hugging the coast, they seldom occur closer than a half mile to the ocean because of their sensitivity to wind (redwood roots are shallow) and salt spray. Redwood forests reach their best development on flood plains within the heart of the summer fog belt. In old-growth forests, the coast redwood *(Sequoia sempervirens)* shades out other trees, although on slopes or in second-growth forests, the tanbark-oak *(Lithocarpus densiflorus)*, madrone *(Arbutus menziesii)*, Douglas-fir *(Pseudotsuga menziesii)*, California bay *(Umbellularia californica)*, and other trees mix with the redwoods.

These latter trees and others—mostly broadleaf evergreen trees—continue farther inland in a forest of their own called mixed-evergreen forest. Other trees to be expected in this community include the California-nutmeg *(Torreya californica)*, coast live oak *(Quercus agrifolia)*, and coast chinquapin *(Chrysolepis chrysophylla)*. Past fire history, duration or lack of coastal fogs, and elevation influence the mix of any given stand of this complex forest.

Mixed-evergreen forest often subtly merges with a higher-elevation forest that is uncommon in the Bay Area: mixed-conifer forest (aka ponderosa pine forest). This forest is extensive in California's mountainous regions, often occurring between 2,500 and 6,000 feet elevation. Look for patches of it on the Bay Area's highest mountains, especially on Mt. St. Helena in Napa County, and on Mt. Hamilton in Santa Clara County. It is much more characteristic in the rugged Santa Lucia Mountains of Monterey County. The dominant trees of this forest include ponderosa and sugar pines *(P. ponderosa* and *P. lambertiana)* and incense-cedar *(Calocedrus decurrens)*, as well as some of the trees from the mixed-evergreen forest, especially Douglas-fir. Broadleaf trees are also present where the taller conifers have not shaded them out and may include large stands of California black oak *(Q. kelloggii),* goldcup oak *(Q. chrysolepis),* and localized populations of flowering dogwood *(Cornus nuttallii).*

Inland at lower elevations and beyond the main fog belt, mixed-evergreen forest merges into a more open woodland dominated by oaks or oaks mixed with gray pine *(P. sabiniana)* and California buckeye *(Aesculus californica).* In many places, oak woodlands dominate on summer-hot, south-facing slopes, whereas mixed-evergreen forests cling to cooler, north-facing slopes.

Each area of oak woodland has its own mix of oaks, but the hottest, driest places are typified by blue oak *(Q. douglasii)* and interior live oak *(Q. wislizenii);* valley bottoms by valley oak *(Q. lobata)* and coast live oak *(Q. agrifolia);* places with higher rainfall by Garry oak *(Q. garryana)* and California black oak.

Finally, permanent water courses support their own version of a treeland referred to as riparian woodland. This exuberant and fast-growing plant community thrives because of its constant and reliable source of water, but it is normally only a few trees broad, and only large flood plains (parts of the Russian River, for example) have well-developed riparian areas. Within this woodland the trees grow in distinct layers and are often festooned by vines. The upper story may be overshadowed by Fremont cottonwood *(Populus fremontii),* western sycamore *(Platanus racemosa),* bigleaf maple *(Acer macrophyllum),* box elder *(A. negundo),* red and white alders *(Alnus rubra* and *A. rhombifolia),* and Oregon ash *(Fraxinus latifolia);* the lower strata feature one or more kinds of willow (*Salix* spp.), elderberries (*Sambucus* spp.), and a number of deciduous shrubs. Each area that supports riparian woodland has a different mix of these deciduous trees; usually only two or three species dominate any given place.

One last tree community deserves special comment: areas that have been planted with blue gum eucalyptus *(Eucalyptus globulus)* have maintained themselves and have sometimes expanded. Because of the intense competition of blue gum roots for water and because of the inhibitory nature of the oils produced by their leaves, few other species—woody or not—occur in these impoverished woodlands.

Threats to Tree Habitats

As urbanization expands, natural tree habitats are lost. But it's not just houses and their attendant roads, parking lots, and shopping malls that threaten trees. Air pollution seems to be an inevitable by-product of urbanization, and a number of conifers and other trees are adversely affected by it. Another of the myriad threats, and one of the most seemingly innocuous, is agriculture: monocultural stands of vegetables, fruit trees, and pastures for cows and sheep. Huge tracts of woodlands and forests have been altered and eliminated in order to grow food and raise livestock.

Other less obvious causes are also of concern. One is the alteration of our fauna; extirpation of most large predators, especially mountain lions, has led to overpopulation by deer. Deer browsing of young saplings becomes a major problem when old and dying trees are not replaced. The stress of drought—and we're now well aware of our drought cycles—exacerbates the situation: deer become so desperate for food that they'll even resort to supposedly deer-proof plants such as the California bay *(Umbellularia californica)*.

Yet another cause for worry is our sometimes accidental meddling with our flora. As noxious weeds have made their way into pastures, roadsides, and gardens so, too, aggressive nonnative trees have taken root in a variety of habitats. Some of these intruders—the English holly (*Ilex aquifolium*), maytens *(Maytenus boaria),* and plume albizia *(Albizia jubrissin),* for example—appear to cover a relatively small percentage of natural territory; however, even these have the potential to dominate an area by means of vigorous stump sprouting and suckering.

Other trees have invaded ecosystems in a much more aggressive manner and threaten not only the native trees but the habitats they create for other plants and animals. The blue gum eucalyptus *(E. globulus)* is a famous example, which is often taken for granted as native by many Bay Area residents. Not only are the blue gum's roots thirsty, but the leaves also carry on chemical warfare and suppress the growth of other plants. Another culprit is the salt-cedar, or tamarisk (*Tamarix* spp.), which threatens water courses by thirsty, deeply probing roots that not only use the water that native shrubs and trees would otherwise have used but also reduce the overall water flow of the stream itself.

Finally, some introduced trees can hybridize with our native trees. For example, *Crataegus monogyna* (a European hawthorn) is closely enough related to our native and rather uncommon western hawthorn *(C. suksdorfii)* that they hybridize. The resulting hybrids have the potential to be both invasive and better adapted to their potential home than either species by itself, and the gene pool of the native hawthorn may become seriously altered.

There is no easy solution to these and other dilemmas that affect native trees, but whatever measures can be taken to slow the process of habitat loss are important to maintaining the integrity of our unique tree communities. Let us remain aware of the problems and ready to do battle on behalf of the trees, which have no obvious defenses of their own. Our wild lands deserve to remain wild and diverse.

How to Use a Key

Although photographs promise easy identification, they are not always reliable. Seldom does any one image reveal enough details to make an identification certain. Hence the need for keys. Although keys may seem challenging, they can also be fun.

A key is a logical device that allows the reader to progressively narrow the choices until only one species remains. Each step in a key has two choices; in this book they're numbered similarly (1a versus 1b, for example). Each choice talks about one or two traits that can be compared—say, for example, whether flowers are red or yellow. After making the first choice, go to the next step and another pair of choices. You repeat this process until you've arrived at the name of your particular plant. Of course, if all choices were as easy as noting flower color, keys would be a breeze and everyone would use them without any special effort or practice. Sadly, there are many reasons why keys prove challenging and difficult.

It is of great importance to remember that nature is variable. Although a given species might usually have red flowers, it is not uncommon for flower color to vary, and yellow variants sometimes occur. No keys are comprehensive enough to take all possible exceptions into account. So, a first rule in keying is to look at more than one plant to see if your particular specimen is typical.

Second, keys often contain human errors. Inconsistencies may creep in even when the person making the key has been careful. This sort of problem may be hard to detect at first, but one check against taking a wrong turn—regardless of whose error it is—is to read the description and look at the photo(s) for the tree you've identified. If these don't match, something has gone wrong during the keying process.

Third, measuring things requires careful attention. I've tried to minimize the use of size in my keys. Remember, for example, when measuring leaves to choose a typical leaf. Always measure the broadest part of the leaf when width is given. Use only fresh leaves or flowers for measurements; dried material shrinks considerably.

Fourth, there are many specialized terms that are needed to describe important facets of leaves, twigs, bark, fruits, and flowers. Make frequent use of the glossary when you start. I've tried to minimize the use of technical terms, but sometimes a specific word for a specialized part is essential.

Finally, make careful notes about the tree you're identifying, especially if you don't have this book in hand while you're out in the field. What is the overall shape of the tree? Is it evergreen or deciduous? What are the leaves like? Does it have any obvious flowers, cones, or fruits? If so, what are the details? What color and pattern is the bark? Is there anything special about the branching pattern? What is the habitat like: shady, moist, dry, sunny, coastal, inland? What are some other obvious trees or shrubs growing with the tree? Is the tree growing on any especially distinctive soils such as those derived from blue serpentinite rocks?

Two aids that you may find useful to help identify trees, especially in the field, are a hand lens and a pair of binoculars. A good quality 10× hand lens is best, for it magnifies enough to reveal the details of hairs and other tiny structures, yet doesn't magnify so much that the image is dim. (The greater the magnification, the more light is required.) Binoculars are useful for seeing leaf patterns and other features of trees from a distance. You can also reverse the binoculars and use them as a sort of hand lens for seeing close-up details.

Here are some hints to help you get started with the keying process:

- Always start at the beginning and jot down the choices you make. If you come to a step where you're unsure of the choice, make a note of it.
- A wrong choice usually leads you to other choices that contradict what you see or are obviously wrong in some respect.
- Try working a key backward by starting with a tree whose name you already know. This will help give you insight into how the keys in this book work and will show you what I had in mind when I created the key.

- Always check the species accounts after making your identification. Helpful clues may be found there, such as where the tree occurs or the other trees that grow with it.
- Always check the photo(s) of the tree you've identified. If there is a discrepancy between the way the tree appears in the photograph and what you remember seeing, be suspicious that something went wrong with your choices during keying. (Also bear in mind that things such as tree shape may vary.)

Good luck. The more you practice with keys, the easier the process becomes.