

CITIZEN SCIENTIST PROGRAM

Southern California Oak Resource Assessment Reference Guide



Forest Health Protection, Region 5
and
University of California, Riverside

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New threats to forest health are commonly first diagnosed in urban environments and initially discovered by concerned citizens. Early detection of introduced/exotic pests can assist with mitigating these new threats. The southern oak woodlands of California represent crucial habitat for plants and wildlife, improve ecosystem services, and contribute to aesthetics. Observations by citizens can assist with protecting these valuable woodlands.

This reference guide was developed to provide an overview of common injury symptoms from insects and diseases to oaks in southern California. The guide is partitioned into feeding guilds and injury types with less emphasis on identifying specific insect and pathogen species. Injury symptoms can assist with identifying the specific problem and level of severity. This guide should be used jointly with the Southern California Citizen Scientist Survey Form.

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Common Oak Species

Coast live oak (*Quercus agrifolia*)



This is an evergreen oak species with a broad crown and smooth bark that is common in urban and forest settings. Leaves are leathery and cupped or flat shaped with margins spiny or round. Leaves are oval, oblong, or elliptically shaped and glossy green above. The underside of the leaf may be fuzzy or only possess hairs at vein crotches. Acorns are sharply pointed and elongated.

California black oak (*Quercus kelloggii*)



California black oak is a deciduous tree found at higher elevations (4,000-8,000 ft). The leaves are bright green and deeply lobed with spines on the tips. The bark is dark in color and ridged in older trees. Acorn cups are deeply cup-shaped with thin, paper-like scales. California black oak is prevalent throughout the mountains of southern California.

Canyon live oak (*Quercus chrysolepsis*)



This is an evergreen tree that is found in the higher elevation forests (4,000-8,000 ft) and commonly has multiple stems. Leaves are leathery, typically flat, and wedge-shaped with spiny or smooth margins. New leaves have fine red hairs on the underside of the leaf, whereas older leaves possess a gray color on the underside. Acorns have a wide, bulbous cap.

Common Oak Species

Blue oak (*Quercus douglasii*)



Blue oak is a deciduous tree with a rounded crown. The bark is light gray in color and shallowly checkered. Leaves are dull green possessing few shallow lobes or entire margins. Acorns are oval-shaped, have a sharply pointed tip, and shallow, warty cups. Blue oak is found in northern Los Angeles and Kern county in southern California.

Holly oak (*Quercus ilex*)



This is an evergreen tree species that is a common ornamental found throughout southern California. Bark is gray with checkered, scaly plates. Leaves are shiny dark green on the upper surface and pale green on the underside. Leaves can possess smooth margins or spiny margins. Acorns can be found on stalks with pointed tips and a deep cup.

Cork oak (*Quercus suber*)



Cork oak is a common ornamental tree species found in southern California. It is an evergreen tree with leaves that are shiny green on the upper surface and light green below. Leaf margins are mostly spiny. Bark is thick, furrowed, and very "corky." Outer bark can be easily chipped away. Acorns have a dimpled tip and the cup covers half the seed.

Common Oak Species

Interior live oak (*Quercus wislizenii*)



Interior live oak is an evergreen oak that can be tree or shrub form. Leaves are leathery, shiny, flat, and lack hairs on both surfaces. Stiff spines are found along the leaf margins. Bark is furrowed and gray when mature. Acorns possess a tapering tip and sit in a deep cup with thin and flat scales.

Engelmann oak (*Quercus engelmannii*)



This is a semi-deciduous tree species with a rounded crown. The bark is grayish and scaly. Leaves are a pale-green color, leathery, and flat. Leaves are rounded at the tip and mostly entire. Acorns have a rounded tip and the cups enclose nearly half of the seed. This species has a limited distribution in lower elevation oak woodlands in San Diego, Riverside, and Los Angeles Counties.

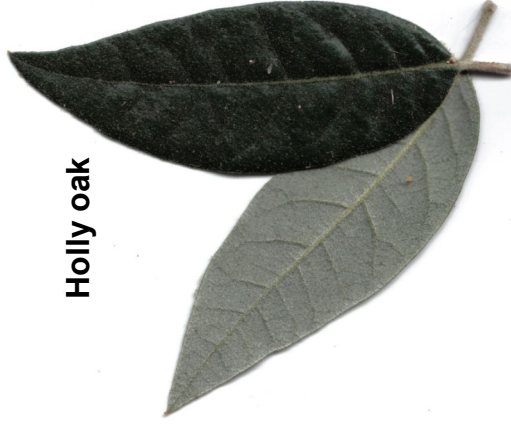
Valley oak (*Quercus lobata*)



Valley oak is a deciduous tree with thick, furrowed bark. Leaves are deeply lobed with 6-10 rounded lobes. The upper surface is a shiny dark green and paler green underneath possessing short, dense hairs. Acorns are long, conical with warty scales on the cup. Common in the Santa Monica Mountains and northwest of Los Angeles.

OAK SPECIES OF SOUTHERN CALIFORNIA

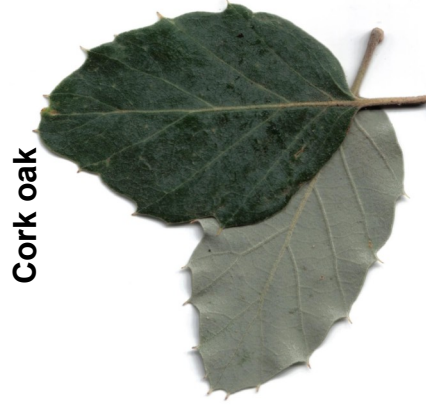
Common Oak Species



Holly oak



Coast live oak



Cork oak



Valley oak



California black oak

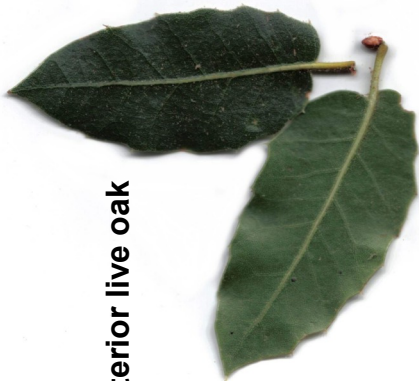


OAK SPECIES OF SOUTHERN CALIFORNIA

Common Oak Species



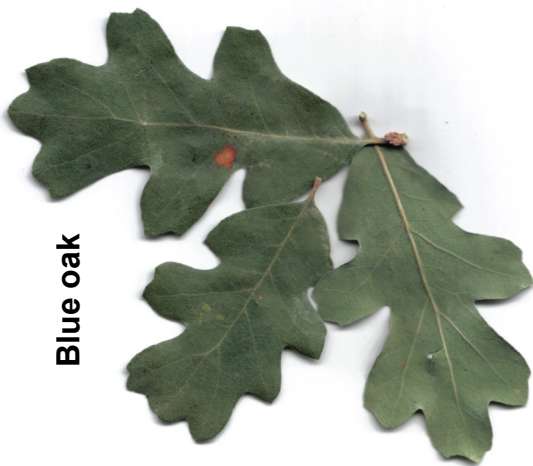
Engelmann oak



Interior live oak



Canyon live oak



Blue oak



Crown Health and Injury

INJURY RATINGS FOR OAK CANOPIES



Flagging: Distinct twigs/branches that turn brown and die; majority of canopy still green and living



Flagging: Dead branches can be found in direct sun or on shaded branches.



1-Healthy, full crown: large branches or the sky is hidden when the tree is healthy; crown is a deep green color



2-Minor thinning and/or twig die-back: twig tips are exposed; crown appears slightly grey; 10-25% leaf loss



3-Moderate thinning and branch dieback: crown appearing very gray; sky and branches very visible; 25-50% leaf loss



4-Severe thinning and branch die-back: Extensive leaf loss and dieback on large branches; resprouting from the larger branches; >50% leaf loss

Wood Boring Insects (insects and exterior signs)

COMMON INSECT INJURY CLASSES

Part of tree injured:

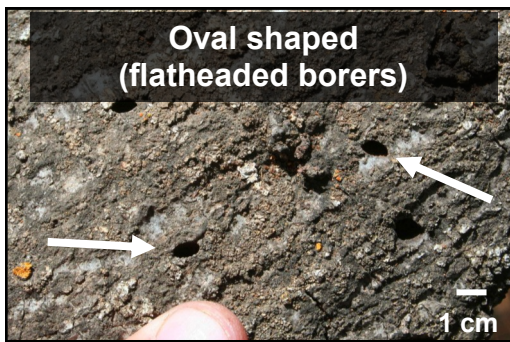
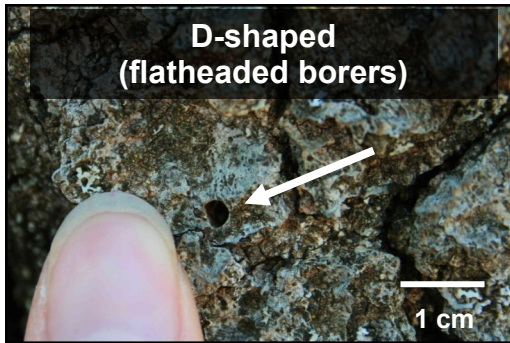
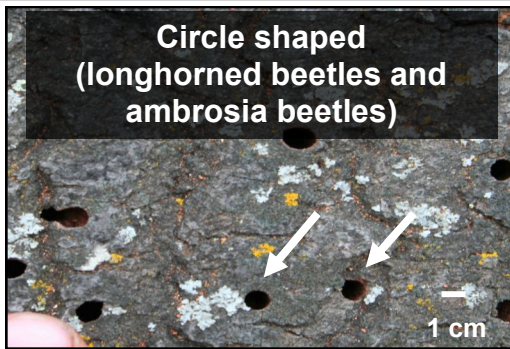
Main stem, branches, and twigs

Common wood borers:

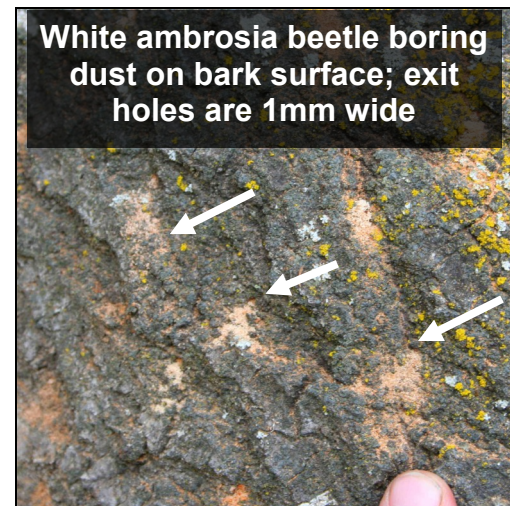
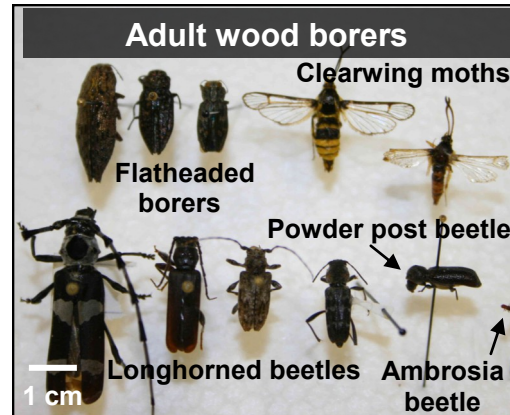
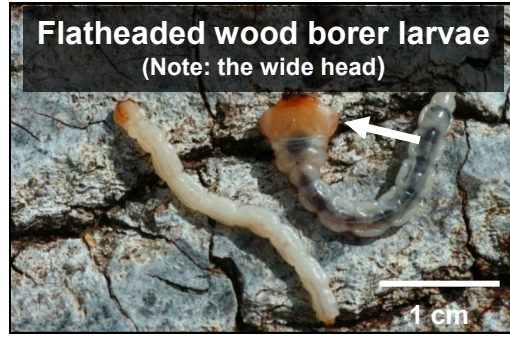
Longhorned beetles, flatheaded borers/metallic borers, ambrosia beetles, and clearwing borers

Common signs of injury:

Circle, oval, or D-shaped exit holes; irregular patterned larval galleries under the bark and in wood; and white boring dust



Adult exit holes

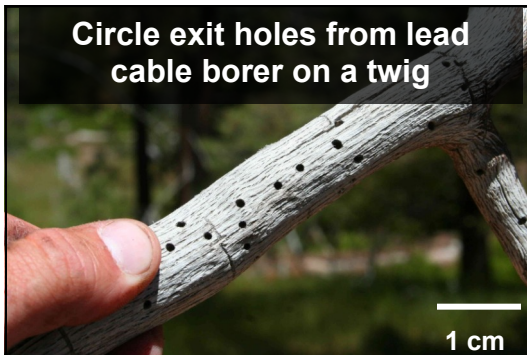


Wood Boring Insects (internal signs)

COMMON INSECT INJURY CLASSES



Wood Boring Insects (insects and exterior signs)



Biology:

Wood boring insects are a diverse group of insects that injure small twigs down to the main stem. Wood boring injury is commonly caused by beetle larvae, but a small group of caterpillars can injure the outer bark of oaks. Adult exit holes can be a distinct sign of wood boring feeding. Circle, oval, and D-shaped exit holes can be found on throughout the tree. Frass (insect excrement) and boring dust can also notify the presence of wood borer feeding under the bark or in wood. Tightly- or loosely-packed frass lines the irregular feeding galleries of beetle larvae under the bark or in the wood. White boring dust can be found in bark cracks and typically distinguish ambrosia beetle feeding. Dark-stained galleries (1 mm wide) in the wood are also characteristic of ambrosia beetles.

Common wood boring species:

flatheaded apple tree borer, oak cordwood borer, western sycamore borer, lead cable borer, oak twig girdler, ambrosia beetles (*Monarthrum* sp.), and oak twig borers

Damage caused/Importance:

Most of these species are secondary pests to oaks. Additional stress is required before these insects will attack trees. Death of twigs/branches (flagging) is a common symptom of wood borer injury. Tree mortality is rare for most of these species. However, some wood borers can aggressively kill trees over several years. The goldspotted oak borer is the only aggressive wood borer found in southern California that frequently kills oaks.

Bark Feeding Insects

Part of tree injured:

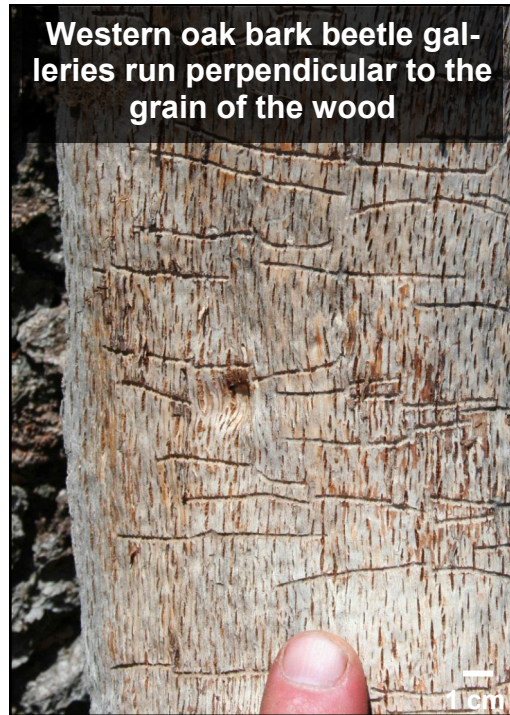
Primarily twigs and branches, but injury can be found on the main stem

Common bark feeding insects:

Oak bark beetles

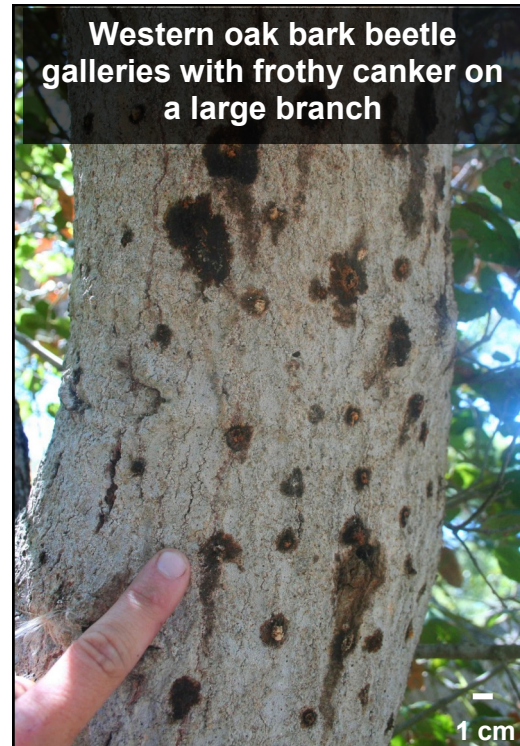
Common signs of injury:

Circle entrance and exit holes (1 mm); bark cracking, red boring dust in bark cracks; larval galleries on surface of wood or under bark, and twig/branch thinning



Bark Feeding Insects

COMMON INSECT INJURY CLASSES



Biology:

Oak bark beetles are brown in color and less than 2 mm in length. Oak bark beetles commonly attack twigs and smaller branches. However, the main stem can be attacked if populations are high or a tree is in severe decline. Oak bark beetle galleries can be found under the bark or on the wood surface. Galleries are etched into the wood and resemble a straight line that runs perpendicular to the grain of wood. Red boring dust can be found in the bark cracks to signify bark beetle attacks. Occasionally, bark beetle attacks are associated with a fungus (frothy canker), but does not always cause significant tree damage.

Common bark beetle species:

western oak bark beetles and bark beetles (*Pseudopityophthorus* species)

Damage caused/Importance:

This group of oak bark beetles are not aggressive as their pine counterparts (*Dendroctonus* species). Western oak bark beetles are considered a secondary pest to oaks and seldom cause tree mortality by themselves. Additional tree stress or predisposing factors are needed for this species to be associated with tree mortality. The bark beetles can kill twigs and smaller branches, which does not always result in tree mortality. Successful attack from these bark beetles does not always lead to tree mortality like most pine bark beetles.

Leaf Feeding Insects

Part of tree injured:

Leaves: feeding, mining, rolling, skeletonizing, and tiering

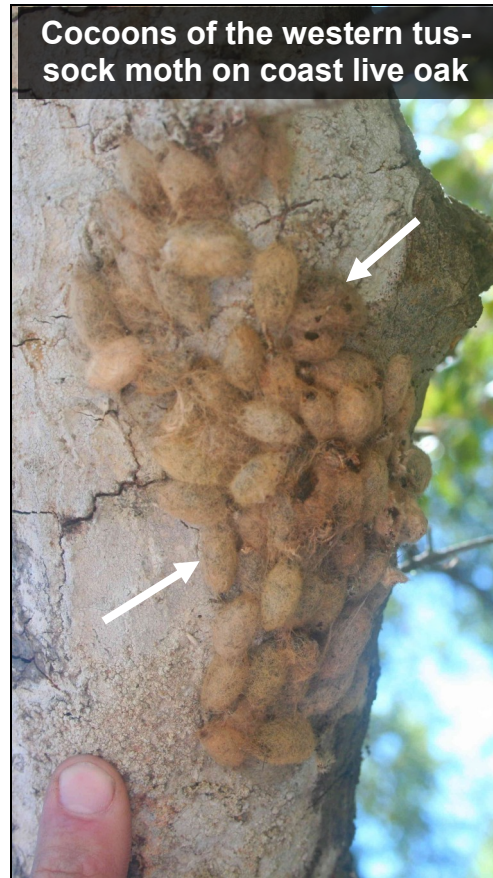
Common leaf feeding insects:

caterpillars, leaf beetles (adults and larvae)

Common signs of injury:

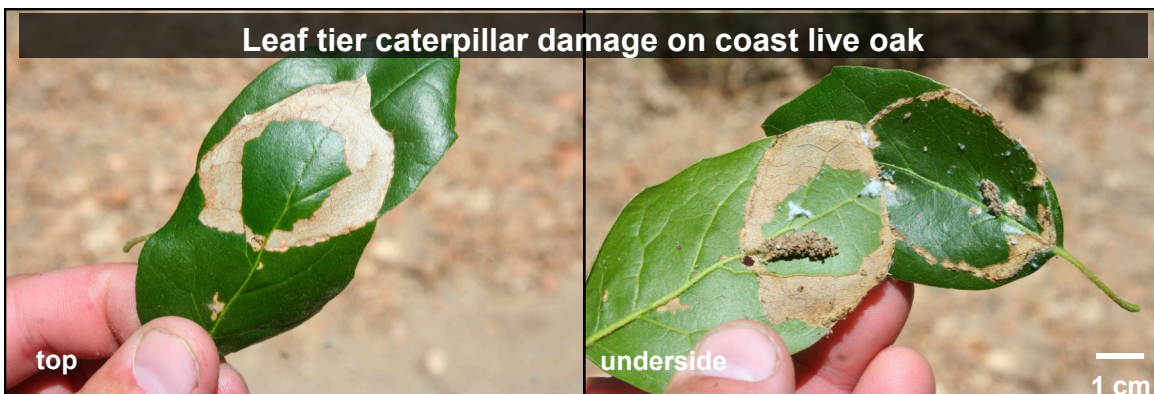
Loss of leaves; frass present on leaves, twigs, or on the ground; premature leaf loss; and yellowing/browning of leaves

Examples of leaf feeding on oaks



Leaf Feeding Insects

COMMON INSECT INJURY CLASSES



Biology:

Two major groups comprise the leaf feeding insects on oaks (caterpillars and leaf beetles). Caterpillars are commonly seen in early spring on the leaves. Leaf injury is typically visible after the leaves have turned brown at the feeding margins. At this time, the insect may be already gone. Additional evidence of caterpillars can be observed by the presence of cocoons on the main stem or on the underside of branches during the summer. Frass can also be found in the leaves and under the tree during heavy defoliation events.

Common leaf feeding species:

Western tussock moth, fruittree leaf roller, California oak moth, leaf beetles (Chrysomelidae)

Damage caused/Importance:

Minor defoliation from many of these species is not a concern. Minor leaf feeding does not seriously impact tree health. Tree mortality is uncommon from this group, but can occur when extensive defoliation events (entire leaf loss) are repeated for several years and additional stress factors are in concert (e.g. drought). Oaks can re-flush leaves following severe defoliation events.

Sucking Insects and Gall Makers

Part of tree injured:
Leaves and twigs

Common sucking insects and gall makers:
scales, whiteflies, true bugs, cicadas, and gall wasps

Common signs of injury:
Leaf curling; yellowing of leaves; and premature leaf loss

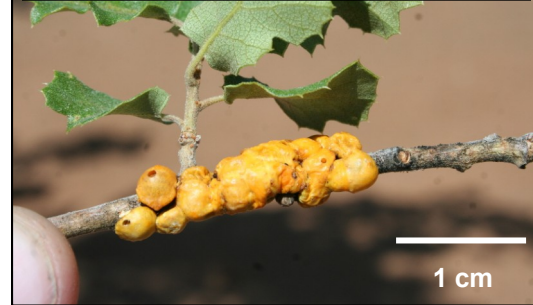
Crown whiteflies on the under-side of a coast live oak leaf



Oak lecanium scale on coast live oak twig



Scale insect on scrub oak



Oak apple gall on California black oak



Golden oak pit scale on Engelmann oak twig



Twig gall on canyon live oak

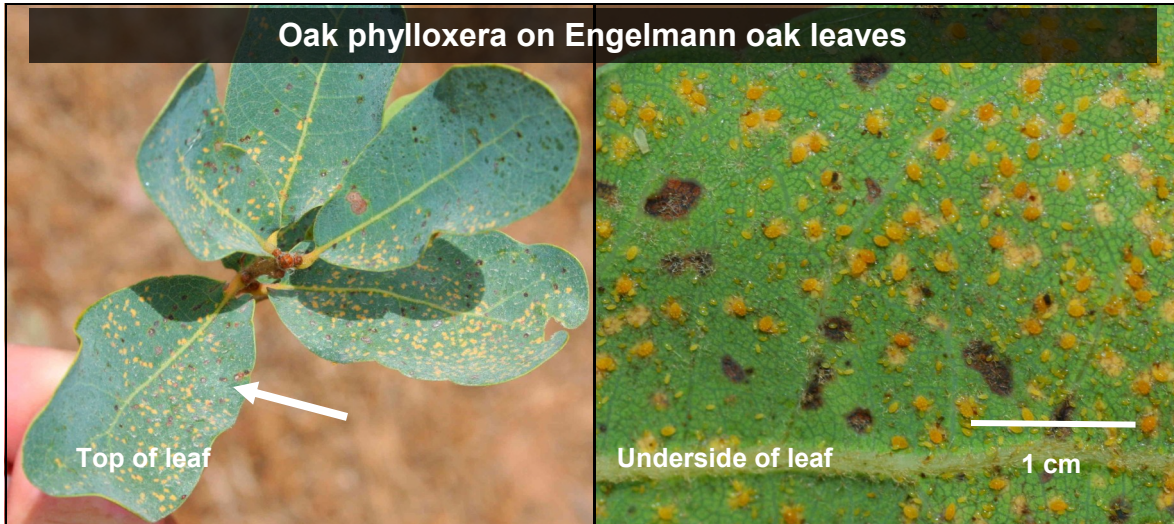


Leaf galls on scrub oaks



Sucking Insects and Gall Makers

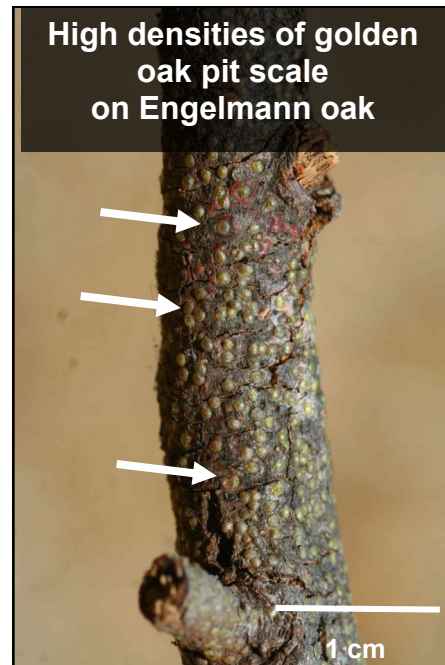
COMMON INSECT INJURY CLASSES



Biology:

Scales and whiteflies are tiny insects that feed on plant nutrients. These insects frequently produce a waxy secretion that is easily visible, but hides the insect. When densities of sucking insects are high, sooty-black mold is common on leaves, twigs, and the ground.

Gall insects are tiny wasps that feed in plant tissue. Galls are a result of irregular plant growth from immature wasp feeding. Leaf galls can come in various sizes, shapes, and colors. Galls are most frequently found on leaves, twigs, and branches.



Common sucking insects and gall maker species:

crown whiteflies, galling insects (oak apple gall), scales (oak lecanium, pit, and golden oak pit scales), and oak phylloxera

Damage caused/Importance:

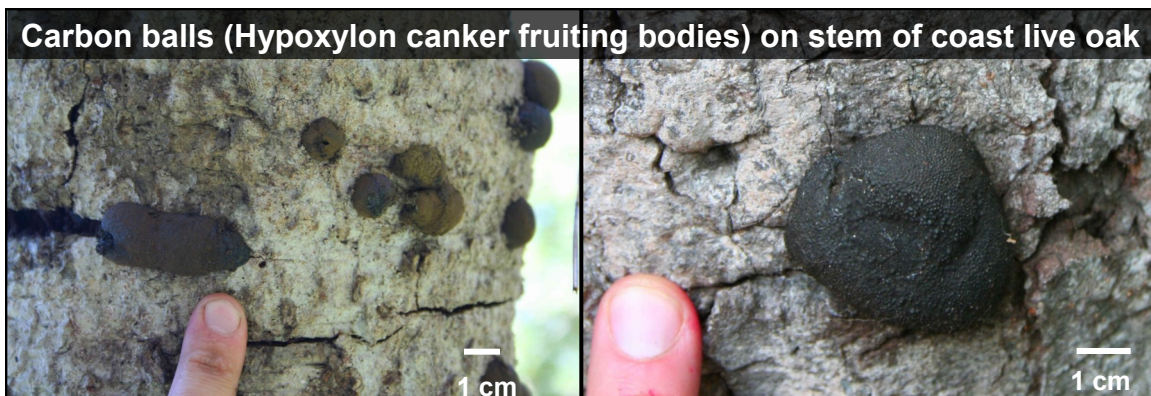
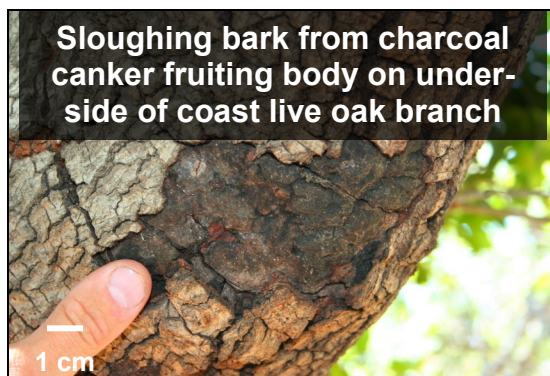
Premature leaf loss and twig/branch dieback is the most common type of injury associated with sucking insects and gall makers. Tree mortality is extremely uncommon from this group of insects. Additional stress factors (drought, insects, and disease) are usually required to cause tree death following several years of injury from these decline issues. Galls cause little problems to tree health (minor twig breakage on twig galls) and are more of a cosmetic nuisance than tree health concern.

Cankers, Wetwood, and Stem Decays

Part of tree injured:
Main stem and larger branches

Common fungus or disease:
Stem and branch cankers, *Phytophthora* species, and wetwood

Common signs of injury:
Fungi fruiting bodies (conks), staining on bark, bark bleeding, premature leaf loss, and sloughing of bark



Cankers, Wetwood, and Stem Decays



Biology:

Several fungi that cause stem cankers can be identified by bark staining and red bleeding/oozing. Common branch cankers can be identified by roughened, dark-colored fruiting bodies on the bark exterior and flaking-off of bark on the underside of branches. Hypoxylon cankers are easily identified by the circular, black fruiting bodies (carbon balls) on the bark of the main stem and larger branches. Wetwood is the result of a bacterial infection from the soil that forces fluid out of the affected wood through an opening or injury in the tree. Various stem decay fungi can be determined by the presence of conks on the main stem.

Common cankers, wetwood, and stem decays:

Charcoal canker, Hypoxylon canker, *Phytophthora cinnamomi*, *Phytophthora* species, and bacterial wetwood

Damage caused/Importance:

Some canker species are opportunistic on stressed hosts (Hypoxylon canker), whereas other canker species can be aggressive (*Phytophthora* species). Branch cankers are not normally a concern for tree health except during successive drought years. *Phytophthora* species can cause tree mortality or cause a reduction in tree health. Wetwood is not typically considered a threat to tree health. Decay conks commonly colonize dead or severely stressed stems where an increased likelihood of stem failure can occur.

Leaf and Twig Diseases and Mistletoe

Part of tree injured:

Leaves, twigs, and branches

Common diseases:

Anthracnose, twig blights, powdery mildew, and leafy mistletoes

Common signs of injury:

Loss of leaves, premature leaf loss, yellowing of leaf tips or entire leaves, twig death, and mistletoe

Spots and lesions from oak anthracnose on coast live oak



Oak anthracnose symptoms on coast live oak



Twig blight on a small twig of coast live oak



Powdery mildew fungus on California black oak



Leaf and Twig Diseases and Mistletoe

COMMON DISEASE INJURY CLASSES



Biology:

The fungi that causes oak anthracnose can be identified by necrotic yellow spots or lesions on leaves and twigs. Twig blight appears as small black flecking on the bark of twigs. Injury from twig blight is commonly scattered throughout the crown and frequently found on coast live oak. Powdery mildew is a parasitic fungi that has a whitish appearance on leaves. Oak mistletoe is also a parasitic plant that can cause significant water stress to host trees and is spread by bird droppings.

Common leaf diseases and twig blight:

Oak anthracnose, twig blight, powdery mildew, and oak mistletoe

Damage caused/Importance:

Oak anthracnose can cause premature leaf loss and kill young twigs. Twig blight commonly causes twig dieback (flagging) throughout the crown. Tree mortality is not regularly associated with both of these fungi, but significant leaf loss can occur following successive wet springs. Powdery mildew rarely impacts tree health of larger oaks and is not a significant concern to tree health. Severe mistletoe infections can slowly kill trees over several years, but can be pruned out before infection levels are high. Powdery mildew and mistletoe commonly impact aesthetics of ornamental tree more than tree health.

Light, Moderate, and Heavy Ratings

Rating injury symptoms for insects and disease as light, moderate, and heavy can provide additional insight into overall tree health. The immediate following descriptions provides general guidelines for severity ratings, whereas detailed descriptions of specific insect and disease injury classes are listed below.

Light: Injury symptom is visible, but not easily found and isolated to a single area.

Moderate: Symptoms are clumped or scattered, but impacting <50% of the tree.

Heavy: Symptoms are easily found throughout the affected areas (>50%).

Leaf injury and mistletoe

Light: Leaf injury is limited to small diameter twigs or a single branch, but injury symptoms are found on >25% of the crown.

Moderate: Injury can be found on several larger branches in the crown, but impacting 25-50% of the crown. Leaf injury can be scattered throughout the crown or clumped in one area.

Heavy: Leaves are showing signs of injury throughout the entire crown (>50% injury).

Heavy levels of leaf injury are commonly required for several years to significantly impact tree health or cause tree mortality. A crown rating of 4 (severe thinning) represents a tree under significant stress, which can lead to additional problems.

Bark staining/Canker fungi

Light: Bark staining is found in <5 areas on the stem or branches. Bark sloughing/flaking and fungi fruiting bodies are present on the stem or larger branches, but isolated to >10% of these areas.

Moderate: Bark staining is found in 5-10 areas (stained areas can be variable in size). Bark sloughing or fungi fruiting bodies is found across 10-25% of the stem or larger branches.

Heavy: Bark staining is found in >10 areas and/or bark is cracking off. Fungi symptoms are found on >25% on the stem and branches.

Moderate levels of bark staining/canker fungi can mean significant injury for trees and lead to additional problems. A crown rating for thinning/dieback can be an additional predictor of overall tree health.

Insect injury (emergence holes, boring dust, frass, larval galleries)

Light: These symptoms are present on the twigs or branches, or found in growth cracks on the lower part of the stem (<6 ft (2 m)).

Moderate: Emergence holes of any shape (<25) can be found on the lower stem. Frass, boring dust, and larval galleries are limited to <25% of the lower part of the stem (<6 ft). Active insect injury is clumped to a single area of the stem.

Heavy: Emergence hole densities of any size or shape (>25) can be found scattered across the lower stem (<6 ft). Boring dust, frass, and larval galleries from recent insect activity is found over the lower stem.

Presence of emergence holes, boring dust, frass, and larval galleries at moderate and severe levels can lead to a decline in tree health and possible tree mortality.

Contact information and References

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References and additional information:

Brown, L.R. and Eads, C.O. 1965. A Technical Study of Insects affecting the oak Tree in Southern California. California Agricultural Experiment Station. Agricultural Publications, University Hall, University of California, Berkeley 4, California.

Coleman, T.W. and Seybold, S.J. 2008. New pest in California: The goldspotted oak borer, *Agrilus coxalis* Waterhouse. USDA Forest Service, Pacific Southwest Region, State and Private Forestry. Pest Alert R5-RP-022. October 18, 2008.

Goldspotted Oak Borer Research, Education, and Outreach Website. 2010. University of California, Agriculture and Natural Resources. www.gsob.org

Pavik, B.M., P.C. Muick, S.G. Johnson, and M. Popper. 1991. Oaks in California. Cachuma Press. Oakland, CA. 184 p.

Swiecki, T.J. and E.A. Barnhardt. 2006. A Field Guide to Insects and Diseases of California Oaks. Gen. Tech. Rep. PSW-GTR-197. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, 151 p.

Roberts, F.M. 1995. The Oaks of the Southern California Floristic Province: The oaks of Coastal Southern California and Northwestern Baja California, Mexico. F.M. Roberts Publications. Encinitas, California

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