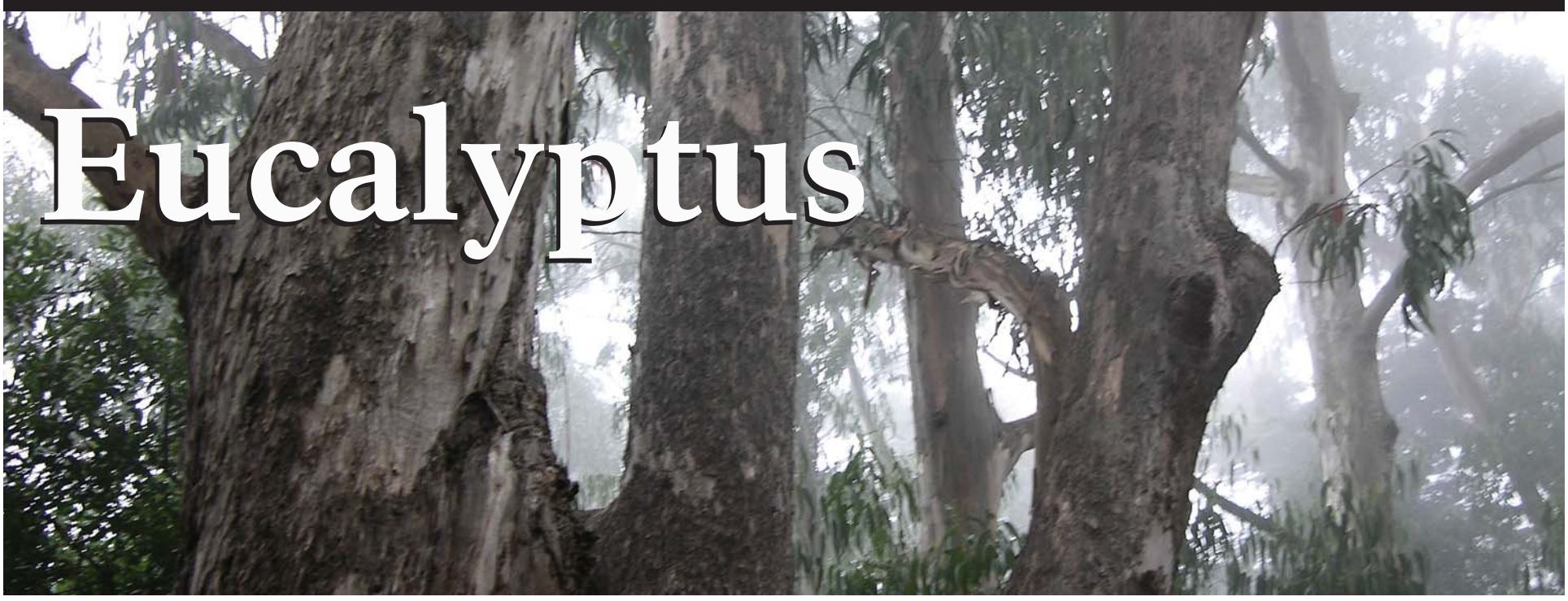


Eucalyptus

A Complex Challenge

FIRE MANAGEMENT, RESOURCE PROTECTION, AND THE LEGACY OF TASMANIAN BLUE GUM

DURING THE AGE OF EXPLORATION, CURIOUS SPECIES from around the world captured the imagination, desire and enterprising spirit of many different people. With fragrant oil and massive grandeur, eucalyptus trees were imported in great numbers from Australia to the Americas, and California became home to many of them.

Eucalyptus globulus, or Tasmanian blue gum, was first introduced to the San Francisco Bay Area in 1853 as an ornamental tree. Soon after, it was widely planted for timber production when domestic lumber sources were being depleted. Eucalyptus offered hope to the "Hardwood Famine", which the Bay Area was keenly aware of, after rebuilding from the 1906 earthquake.

Blue gum continues to be the most widespread species of eucalyptus found in California. Some of these trees were planted to create windbreaks or mark property boundaries on lands that are now in national parks and other natural areas. Most historic plantings have expanded far beyond their original scale, as blue gum thrives exceptionally well on the California coast.

ASTONISHING GROWTH RATE

Blue gum grows from 98 to 180 feet tall, reaching heights of 260 feet in California. As much as 60 to 70 percent of their total height is usually achieved by age 10. This rapid growth rate is one of the main reasons these trees were considered for commercial plantations. Rapid growth is accompanied by rapid water uptake, which is why eucalyptus plantings were also used to drain wetlands for development and agriculture.

BARK, LEAVES, AND FIRE ECOLOGY

The 700+ species of eucalyptus are divided into groups on the basis of their bark. The bark on the "gums", which include *Eucalyptus globulus*, is deciduous. Constant shedding of bark is part of what makes these trees a fire hazard. The bark catches fire readily, and the loose strips tend to carry fire up into the canopy, casting embers outward. Despite the presence of volatile oils that can produce a hot fire, leaves of blue gum eucalyptus are classed as intermediate in fire resistance when green, and juvenile leaves are highly resistant to flaming. It is the litter—the accumulation of dead, dry, oily leaves and debris—that is especially flammable. Carried by long swaying branches, fire spreads quickly in eucalyptus groves. When there is sufficient dead material in the canopy, fire moves easily through the tree tops.

Adaptations to fire include heat-resistant seed capsules which protect the seed for a critical short period when fire reaches the crowns. One study showed that seeds were protected from lethal heat penetration for about 4 minutes when capsules were exposed to 826º F. Following all types of fire, an accelerated seed shed occurs, even when the crowns are only subjected to intense heat without igniting. By reseeding when the litter is burned off, blue gum eucalyptus like many other species takes advantage of the freshly uncovered soil that is available after a fire.

MANAGING EUCALYPTUS

Once established without natural competitors, blue gum trees can spread rapidly, displacing native vegetation, and altering historic landscapes. They also have an uncanny ability to survive. Their response to cutting is to undergo mass-sprouting from the base or trunk, and even underground from the root system. This has led to experimentation with a variety of treatments. At some sites, historic eucalyptus trees are intensively managed to preserve a cultural resource. In other places, stands are completely removed, and the area is revegetated with native plants. Immediate fuel reduction can be accomplished by thinning tree stands and removing surface debris. Most projects have multiple objectives.

PURPOSE OF PUBLICATION

Since the inception of the National Fire Plan in 2001, the national parks in the San Francisco Bay Area have increased their hazardous fuel programs to reduce the threat of wildfire and restore ecosystem health. Projects involving blue gum eucalyptus have proven to be especially complex. These projects must balance fire management objectives with those of natural and cultural resource preservation. These same challenges have been faced by other land managers as well. The goal of this publication is to demonstrate the environmental considerations associated with eucalyptus treatments, and to give examples of some of the different strategies that have been used.

Upper map: Native *E. globulus* distribution. *From* Brooker and Kleinig, 1993. Field guide to eucalypts Volume 1: south-eastern Australia, second ed. Bloomings Books, Victoria, Australia.

Lower map: California counties where *E. globulus* has been confirmed. © 2005 Calflora. Berkeley, California, Calflora Database, www.calflora.org.

Decisions about eucalyptus are guided by a 1999 Presidential Executive Order on invasive species and the 1966 National Historic Preservation Act.

Hazardous Fuel

LITTER AND DUFF

Historic Sites

WIND BREAKS

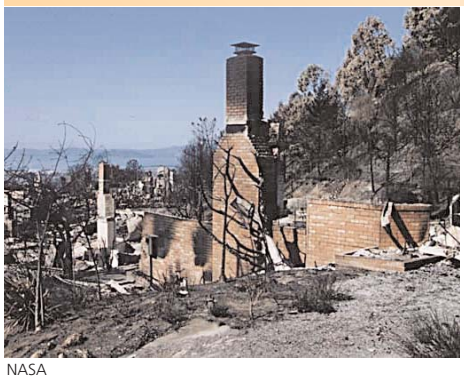
Treatment Options

NO EASY ANSWER

WHAT'S INSIDE

Eucalyptus —Hazard?

Lessons from the East Bay



NASA

1991 OAKLAND "TUNNEL" FIRE - On October 20, 1991, a combination of unseasonably high temperatures, low relative humidity, strong winds, and high levels of dry, overgrown vegetation resulted in a raging firestorm that became known as the worst wildfire in California's history. When it was all over, 25 people were killed, 150 others were injured, and 2,900 structures were destroyed, totaling $1.5 billion in damages. The fire burned over 3,000 acres. During the 10 hours the fire swept through the Oakland and Berkeley Hills, one building was ignited every 11 seconds.

What could have led to such devastation? Of course, no single variable is responsible. An accidental human-caused fire, which had been brought under control, was rekindled when an east wind set in. Dense vegetation was identified as a major contributor to the fire behavior, and in particular, dense eucalyptus forests. It was estimated that over 70% of the energy released through the combustion of vegetation was due to eucalyptus. In many cases, eucalyptus trees were adjacent to houses, with their canopy spreading over the roofs. The density of fuels immediately surrounding homes resulted in a continuous chain that spread the fire from structure to structure.

In the 1970's, a major freeze had left what seemed to be vast numbers of standing dead eucalyptus trees throughout the Oakland and Berkeley Hills. Many were cut, since the fire hazard of dead trees would be even more extreme than when they were alive. As it turned out, the trees were not dead, and resprouted into dense tree clusters. By 1991, the resprouts were well grown, and provided more fuel than then had existed before the freeze. Burning embers landed in some of these groves when the fire "jumped the freeway".

Since 1991, there has been a growing consensus that wildfires are difficult to contain in the East Bay Hills due to the rugged topography and extensive wildland-urban interface. Firefighters also now realize that wildfires are almost impossible to contain in eucalyptus forests. Approximately 1,500 acres of eucalyptus in the East Bay is managed by the East Bay Regional Park District (EBRPD), extending from Lake Chabot to Wildcat Canyon. About 500 acres have been removed or thinned over the last 30 years, with 80% of the work occurring after the 1991 fire.

The EBRPD has recommended treating an additional 900 acres, targeting regional parks such as Lake Chabot, Anthony Chabot, Redwood Regional, Sibley, Tilden and Claremont Canyon. The EBRPD obtained a 3-year FEMA (Federal Emergency Management Agency) Grant, for fire hazard mitigation, including over $1 million for eucalyptus treatment. By clearing the understory, and removing trees, the EBRPD hopes to minimize fire spread and intensity, when fire returns to the East Bay.

Agnes Farres
Student Conservation Association

Lessons from Southern Marin

2004 TAM FIRE - On May 9, 2004, a sunny Mother's Day Sunday, turned into an emergency situation, when a wildfire broke out in Golden Gate National Recreation Area. The exact circumstances of how the fire started remain unconfirmed, however the cause is unquestionably human and matches were determined to be the ignition source.

With a 7-minute response time, engines from Marin County Fire Department's Throckmorton Station were the first on scene, followed by other local fire agencies, and National Park Service firefighters. The fire quickly reached a 70 acre eucalyptus grove, where it burned rapidly and with great intensity, even though it was still spring. As the result of a highly successful initial attack, only 12 acres burned. No structures were lost, and no injuries were reported. The fire burned hot, consuming all surface fuels in the thick litter that had accumulated. Golden Gate National Recreation Area has managed the ongoing stabilization and rehabilitation of the burned area. Hundreds of unstable, scorched trees were felled and chipped. The chips were broadcast onsite to reduce erosion, and extensive revegetation with native species is planned.

Meanwhile, residents of Tamalpais Valley were suddenly confronted with questions about defensible space around their homes, escape routes, and evacuation plans. Community leaders stepped forward to organize two meetings which would lay the foundation for important wildfire planning in the future. Representing over 3,500 households, these neighborhoods are just some of the many scattered throughout the valleys of Mount Tamalpais, where the memory of devastation from a major fire in 1929 still looms. In some of these neighborhoods, fire insurance has been difficult to obtain.

Fuel Load Comparisons

Eucalyptus, California bay, and coast live oak forest types

FUEL ELEMENT	Live Component	Dead Component	Live Component	Dead Component	Live Component	Dead Component
Herbs and grasses	0.03	0.02	0.42	0.18	0.31	0.17
Shrubs and saplings	0.49	0.0	0.27	0.01	0.25	0.03
Fine twigs (1-hour)		1.33		0.69		1.18
Small branches (10-hour)		2.94		1.93		4.60
Medium branches (100 hour)		1.41		2.67		2.40
Logs (1,000 hour)		19.63		11.06		0.69
Litter (leaves, bark, needles, etc.)		4.99		1.70		2.19
TOTAL FUELS	Eucalyptus - 30.84 tons per acre		California Bay - 18.93 tons per acre		Coast Live Oak - 11.82 tons per acre	

Fuel in a vegetation community consists of both live and dead material measured in tons per acre. Eucalyptus typically displaces California Bay or Coast Live Oak communities which increases the fuel load. This comparison is based on fuels data collected from 7 Eucalyptus sites, 39 California Bay sites, and 11 Coast Live Oak sites within Point Reyes National Seashore and Golden Gate National Recreation Area. (*NPS Data*) "Total fuels" represents fuel available for wildland fire consumption, not total biomass. Most importantly, the mass of the live trees is not included. 1, 10, 100, and 1,000 hour fuels are classified by their diameter and take different amounts of time to dry out and become available for consumption.

***Below, top photo:* The thick litter on the floor of the eucalyptus grove was completely consumed in the Tam Fire. The live foliage proved fire resistant, so a potentially catastrophic crown fire was avoided. *Bottom photo:* The ridge in the background of a photo from the 1940s shows the grove that burned. The community of Tamalpais Valley has filled in the hillsides. Today this view would be blocked by other houses in the foreground.**

—or Habitat?

A Place for Wintering Monarchs

Monarch butterflies clustering in a eucalyptus grove at Andrew Molera State Park, near Big Sur, October 2003. This phenomenon occurs in some eucalyptus groves and Montery pine stands within the national parks in the S.F. Bay Area. *Photograph courtesy of Ventana Wildlife Society.*

AN IMPORTANT QUESTION WHEN managing eucalyptus groves is whether tree thinning or removal will affect monarch butterflies.

Every fall, monarch butterflies throughout North America migrate to overwintering sites in California or central Mexico. This long-distance migration is unique among insects. In fact, the North American monarch butterfly, *Danus plexippus*, is the only insect in the world known to make the same kind of annual, long-distance migration as birds or whales.

Most of the monarchs in the western states fly to the California coast to the same overwintering sites each year, while those east of the continental divide generally fly to the mountains of Mexico for the winter. In these relatively mild areas, they seek a specific protective microclimate where they hang in dense clusters waiting until the weather changes to return to their breeding ranges.

Monarchs cluster in California from October through February. In spring, they mate and the females depart, flying north and east to search for the milkweed plants on which they must lay their eggs. Generations of monarchs repopulate the west until the snap of autumn stimulates thier return migration to the coast.

Monarch butterflies are known to overwinter at more than 200 sites from Baja California to Sonoma County, with two of the "top ten" sites occurring in Marin County. The characteristics necessary to support overwintering Monarchs include the type of trees and other vegetation (such as ground covers), protection from wind and storms, proximity to water, and a microclimate of stable temperature, sunlight, calm and humidity.

Within the Bay Area national parks, monarchs have overwintered at Fort Mason, the Presidio, Fort Baker, Fort Barry, Tennessee Valley, and Palomarin. They have also overwintered adjacent to parklands in Muir Beach, Stinson Beach and Bolinas. The groves they use are usually eucalyptus or Monterey pine, because the stand structure is well-suited to the monarch's overwintering needs, and these trees are abundant in the coastal landscape. At two sites in Marin County, monarchs prefer Monterey pines.

There is no documentation of monarch butterfly presence or tree usage in Native American oral history, art work, or legends, nor in the post-contact descriptions. However, there are records from the late 1800s of Monarch butterfly migration and clustering in Monterey County. There is also anecdotal information from Marin County about monarchs overwintering in both pine and eucalyptus at Stinson Beach from the early 1900s. Other records indicate some monarch clustering in sycamore and oak in Santa Barbara County, and use of redwoods and cypress in Monterey County.

Today, many overwintering sites are endangered by modern land use activities. In 1983, the annual Monarch migration was declared a "threatened phenomena" by the International Union for Conservation of Nature and Natural Resources. Monarchs are also the only insect listed in the Bonn Convention on the Conservation of Migratory Species of Wild Animals, an international treaty protecting various animal taxa. Since so much contemporary Monarch overwintering habitat has been lost, some leading scientists believe this spectacular flight and clustering behavior may disappear in this century, and they advise protecting the remaining Monarch groves and important buffer zones.

The Monarch butterfly is a symbol of the seasons, the ebb and flow of life forms—a fragile and beautiful connection to the mysteries of nature.

Mia Monroe
Muir Woods National Monument

Above:* The "Five Sisters" planted at the original site of the old Lupton House is an example of historic eucalyptus used as a windbreak in the Olema Valley. *Photography by Phil Frank

Heritage Trees, Cultural Forests

Some eucalpytus trees in the San Francisco Bay Area have historic significance, associated with military posts and ranches established in the late 1800s and early 1900s. These trees are of special concern to cultural resource managers. Eucalyptus makes up a large component (42%) of the Presidio's 400-acre Historic Forest which has its origins in the 1883 "Plan for Cultivation of Trees upon the Presidio Reservation", developed by Army Major W. A. Jones. The perimeter plantings at Fort Baker, near Sausalito, are also important features. The old eucalyptus trees associated with ranches in the Olema Valley were planted for wind protection and privacy. Out on the Point Reyes Peninsula, a mile-long row of trees marks the Howard-Shafter boundary, between G and H Ranches. In all of these examples, the trees have expanded beyond their historic footprint. Careful plans to restore these features to their original proportions need to be developed. A program to replace old, dying trees with younger ones in order to maintain cultural landscapes may be necessary. The Presidio has embarked on a program to replace the blue gum on Rob Hill with an alternative, non-invasive species of eucalyptus.

Eucalyptus trees with historic significance in national parks are protected under the National Historic Preservation Act. Other eucalyptus trees may have protection under local ordinances as "Heritage Trees", due to their significance to a particular community.

Birds and Blue Gum

MANY DIFFERENT BIRDS USE EUCALYPTUS TREES FOR NESTING, ROOSTING AND FORAGING.
Research in the East Bay has shown that the number of species found in eucalpytus groves is similar to that in native woodlands, but the species themselves are different (Sax, 2002). Research in Santa Cruz County has shown that as many as 40 bird species regularly nest in eucalyptus. (Suddjian, 2004).

Although many birds do use eucalyptus trees, some scientists are concerned about the effects of eucalyptus on birds. Birds attracted to insects feeding on eucalyptus nectar may suffer higher rates of mortality or reproductive failure. For example, eucalyptus gum may cover the feathers and nostrils of insectivores such as the Ruby -crowned kinglet, potentially causing harm. (Stallcup, 1997) According to Geoff Geupel, Terrestrial Ecology Dirctor for PRBO Conservation Science, some birds that nest in eucalyptus, such as Anna's Hummingbirds, may have lower nest survivorship due to exposuse to high winds or storms, or other factors not present when nest-ing in native vegetation. Furthermore, eucalyptus groves often provide nesting for Great Horned Owls, Common Ravens, American Crows, and Red Shouldered Hawks, which are predators on smaller birds or their nests.

A study comparing wildife use of eucalyptus trees versus native vegetation on Angel Island found three times more arthopods, more small mammals, and more bird species in the native oak-bay woodland and grassland than in eucalyptus. The few bird species found to prefer eucalyptus were widespread species that occupy many different habitats throughout their range. (Keane and Morrison, 1990)

Eucalyptus specialists "down under" are larger and better equipped than North American species to forage flowering trees.

Top to Bottom:
Tasmania's Yellow Wattlebird,
Australia's New Holland Honeyeater,
Eastern Spinebill.

Top to Bottom:
Yellow-rumped Warbler,
Ruby-crowned Kinglet,
Anna's Hummingbird.

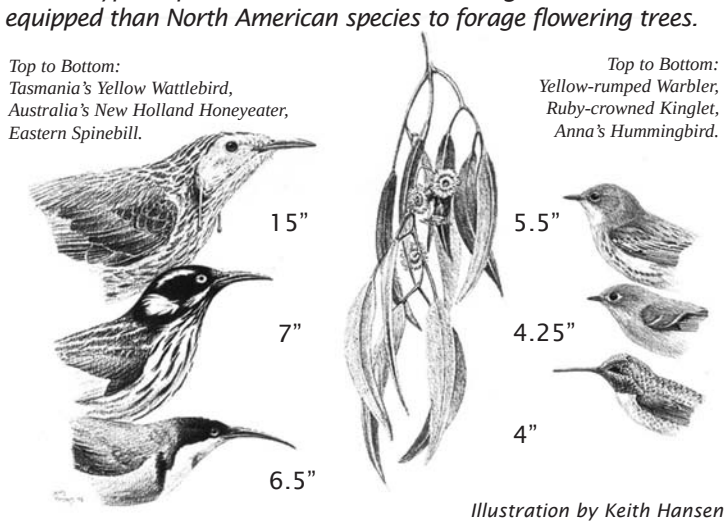


Illustration by Keith Hansen

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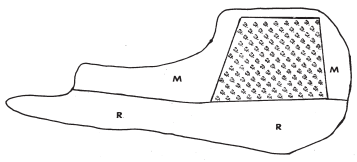
Eucalyptus in Coastal Parks and Open Space

GROVE EXPANSION EXAMPLE (Angel Island)



Shaded Area =
original planting 0.6 acres, 1915
Outer Area =
expansion to 2.2 acres, 1988

Reference: Focused Environmental Study, Restoration of Angel Island Natural Areas Affected by Eucalpytus, CA Dept of Parks and Rec, 1988.

The lands shown here include national parks, state parks, water districts, and privately owned natural areas. There are approximately 1,000 acres of blue gum eucalyptus on these lands today. Without treatment, this number will continue to increase.

Like eucalyptus, California bay trees have a pleasing fragrance, derived from natural oils. These oils can be useful to humans. California bay leaves were once used by Native Americans in their homes, under rugs, to keep insects away. Likewise, eucalyptus seed pods have proven to make effective flea collars for pets.

Once established, eucalyptus groves typically expand outward, displacing native plants. Coast live oak and California bay communities are especially threatened by invading eucalyptus. Fieldwork on Angel Island has shown that calcium can become concentrated in eucalyptus leaves, which raises soil pH as the leaf litter decays, potentially affecting soil organisms. Compared to native forest types, the soils in eucalyptus groves were shown to have significantly less carbon, more phosphorous, and more nitrogen. Additionally, water availability was reduced due to the extraordinary uptake of eucalyptus trees.

Photos: California bay (California Academy of Sciences) and coast live oak (NPS)

Key Concerns

Hazardous Fuels - ***eucalyptus groves produce large fuel loads***

Community Fire Protection - ***eucalyptus near residential areas can quickly carry fire to homes***

Natural Resource Preservation - ***as eucalyptus expands, it reduces native habitat***

Cultural Resource Preservation - ***some eucalyptus trees are historically significant***

Cost of Treatment - ***eucalyptus removal is very expensive***

Fuel Treatment Strategies

Trees

Established eucalyptus groves are usually thick with trees of many different ages. Removal strategies are complex as they involve falling very tall, dense trees, onto a forest floor littered with strips of bark, leaf debris, and often a field of stumps.

Cutting

Working with different sized trees requires different skills and equipment. Trees are sometimes removed in stages. The smaller trees may be cut first to make room for felling the larger ones. The largest eucalyptus trees are 72" (6 feet) or more in diameter. Harnesses may be required to lower the larger trees in sections.

The initial cut is usually at one to two feet off the ground. Taller stumps are later "flush cut" as close to the ground as possible. If chemical treatment is going to be applied to stumps, it must be done soon after cutting for maximum absorbtion.

There are two main approaches to cutting:

Stand thinning

Thinning can accomplish immediate fuel reduction objectives. It involves removing only select trees, usually the smaller ones, and leaving the remaining trees widely spaced.

Stand removal

This involves removing all trees and is done to achieve comprehensive site restoration.

Toppling

To avoid generating stumps,"toppling" has been used as an alternative to cutting. This method employs heavy equipment to knock over large trees, which causes the unearthing of their root systems as they fall.

Pros: No stumps are leftover so stump treatment costs are eliminated, and no chemicals are introduced to the site.
Cons: This technique involves significant soil disturbance and increased soil erosion potential.

Limbing

If cost prohibits tree removal, or historic or aesthetic values outweigh fire hazard or natural resource concerns, removal of lower limbs alone will reduce fuel and help keep fire from be carried into the tree tops.

Understory burning

Using a prescribed burn to remove litter and duff on the ground reduces fuel without removing trees. This is often done when costs prohibit cutting, when trees are critical habitat, or when historically significant trees are involved.

Stumps

When eucalyptus is cut, it vigorously resprouts unless the stumps are treated to prevent regrowth.This adds an extra phase of treatment to almost all eucalyptus removal projects.

Chemical application

Stumps may be treated by applying herbicide to a freshly cut surface. Garlon 4 and Round-up are widely used herbicides for eucalyptus and other weeds because they are very effective and break down quickly rather than continuuing to persist in the soil. Herbicide must be applied around the entire circumference of the cut where the actively growing cambium layer is. A dye is usually added to the herbicide to mark stumps that have been treated.

Light deprivation (tarping)

Experiments with "tarping" have used light deprivation and a physical barrier to prevent resprouting. This involves stapling heavy black plastic over the stump, and burying it with duff and mulch onsite.

Stump grinding

Physical destruction of stumps by grinding down to 2 feet below the surface, is another alternative to chemical treatment. When sensitve areas such as streams are nearby, the use of chemicals, even those which break down quickly, may be undesirable. Stump grinding may also be used if stump size or density will inhibit native plants from getting re-established. In some cases, however, resprouting has continued to occur even after grinding. This method is also labor intensive and costly.

Slash

Slash is the debris generated by vegetation management activities. It includes branches, tree trunks, and leaf litter. Removing eucalyptus generates an enormous amount of slash which also must be treated. This is usually the final phase of the project.

Hauling

The largest tree trunks can often be used as lumber or firewood, and are typically hauled away by truck. Trees 24" in diameter or smaller can be chipped, so hauling is typically used on diameters greater than 24". Eucalyptus removed near waterways may also be hauled by barge.

Aerial removal

In very rugged, inaccessible terrain, helicopters have been used to transport trees to staging areas where they can be safely loaded onto trucks for hauling.

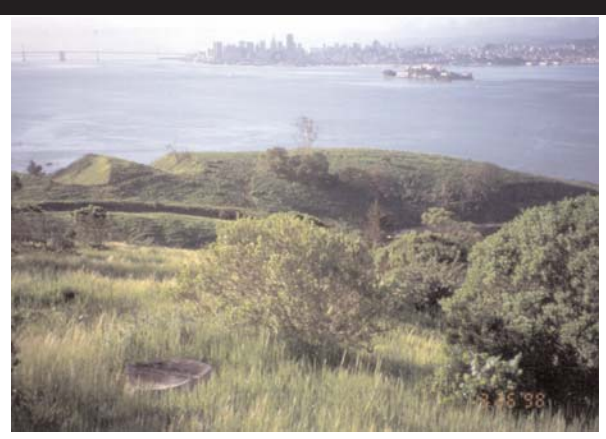
Pile burning

Pile burning involves stacking slash into piles and burning it under controlled conditions. This is a very cost-effective way of removing slash. In situations where the mulch generated by chipping cannot be used on the site, pile burning is the preferred slash treatment because removal of unwanted chips adds additional time and cost to the project.

Chipping

Chipping involves grinding vegetation debris into small pieces which are can be spread onsite as a mulch or transported offsite for other uses such as composting or burning to produce electricity. Mulching onsite often may also provide weed or erosion control by covering loose, recently disturbed soil. The largest chippers can easily process 24" diameter trees.

Project Case Studies



Angel Island
State Park

ANGEL ISLAND, OFTEN CALLED "the Ellis Island of the West", is historically significant as an immigration processing site, a WWII Prisoner of War camp, and a base for other military functions. Three thousand years ago, the island was a fishing and hunting site for the Coast Miwok people.

By the mid 1980s, there were approximately 86 acres of bluegum eucalyptus in the 740 acre park. From the 1870s to the 1930s, the military had planted small groves amounting to 24 acres. The original groves had expanded to more than three times their original size as new eucalyptus seedlings invaded native plant communities and began to dominate large portions of the landscape.

To preserve natural and cultural resources on Angel Island, the case for eucalyptus removal was strong, but the project was controversial. By 1996, after 10 years of planning for the project, 80 acres of eucalyptus removal was complete. An extensive environmental impact report had been prepared, and 6 acres of historically significant trees had been preserved. Active restoration work continues on the sites where trees were removed.

The first 16 acres of eucalyptus (3,800 tons) were removed by helicopter in 1990. With this method, ground disturbance was minimized and whole trees were removed, including limbs and branches. At the time, blue gum eucalyptus only had value for use in power generating plants, so the treatment costs were not subtantially offset by the value of the wood. After the trees were removed, the remaining woody debris and sections of tree butts resulting from stump lowering were piled and burned by Delta Conservation Camp inmate crews, under the supervision of California Department of Forestry and Fire Protection personnel.

There was no stable funding source to continue this expensive work. In 1993, however, California State Parks learned that a Japanese market for eucalyptus pulp chips was being developed which meant eucalyptus removal costs could be dramatically reduced. Under a contract with Planned Sierra Resources, tree removal resumed in the fall of 1995 using traditional logging methods. Skidding was done primarily with rubber-tired grapple skidders. Logs were transported from the island on a WWII Navy vessel equipped with a ramp for loading and unloading from a beach. This barge held 1,500 tons of logs. Unfortunately, it was damaged by contact with rocks on its first load. Bottom repairs allowed its continued use as a barge, but beach loading was not possible. Instead, loading was done with a derrick barge moored to a sea wall on the east side of the island. The derrick barge was moved by tugboat to the island. Only logs were barged. The slash was piled by a tractor-mounted brush rake into 235 large piles, an estimated 14,000 cubic yards of woody debris.

Special felling methods were used on trees growing near historic structures. These trees were climbed and figged, allowing the direction of the fall to be controlled by a tractor. Stumps were kept low and were generally cut at the same angle as the slope of the surrounding terrain. Garlon 4 herbicide (80% with oil) was applied to the outside circumference of the stumps. Trees less than 5 inches in diameter were felled by a separate contractor who reapplied the same herbicide mixture several times to stumps continuing to resprout.

In the final phase, approximately 24,000 tons of logs were removed, and slash piles were burned. Inmate crews from San Quentin State Prison stacked remaining slash, and the clean-up went on for several months. Expansive views of Golden Gate Bridge, San Francisco, and the East Bay are again available to park visitors, and the success of the restoration effort has been very encouraging Native grasses and shrubs have recolonized the sites and non-native plant control efforts have been effective. The changes have been dramatic and demonstrate that landscapes which have been converted to eucalyptus can be restored back to quality natural areas.

Dave Boyd
California State Parks

Highway One
Point Reyes National Seashore

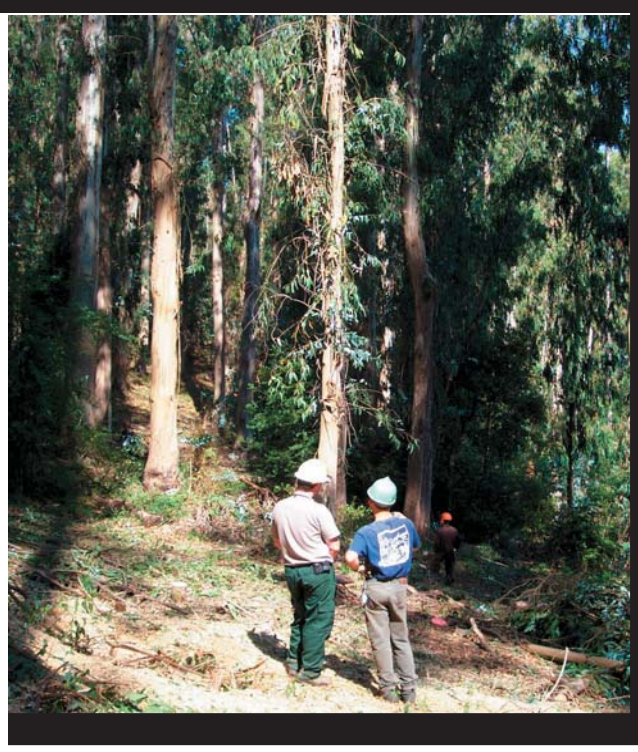
THE HIGHWAY ONE FIRE MANAGEMENT UNIT CONTAINS 2,874 ACRES, EXTENDING ALONG A BUSY traffic corridor between the communities of Olema and Bolinas, where the chance of vehicle related ignition is high. There are 94 acres of eucalyptus in this unit, 25 of which were treated in 2005 to reduce hazardous fuel.

The groves in the Olema Valley developed from individual trees which were historically planted in rows along roads and along property boundaries. The Highway One eucalyptus project involves thinning stands on both the east and west sides of the highway and is part of the more comprehensive Highway One Fuelbreak. Younger trees, 18" in diameter and less, are being removed in phases, beginning with the smallest (up to 5 inches in diameter) and progressing to larger trees. The cut trees are piled and chipped, and the stumps are chemically treated to prevent resprouting. During the first year of the project, 6,000 eucalyptus trees were removed in the area known as 13 Curves.

Crews from the Marin Conservation Corps, a local environmemtal service organization, cut the smaller trees. The larger trees were removed by the Point Reyes National Seashore Fuels Crew. The California Exotic Plant Management Team, a National Park Service task force dedicated to reducing the spread of invasive species, coordinated the application of herbicide to the cut stumps.

Work will be ongoing within the Highway One eucalyptus groves. The project site has also been used for training exercises by Marin County Fire Department and the National Park Service during the Wildland Fire Chainsaws class. This class is instructed as a refresher every year to ensure crew safety during tree removal operations.

Once ignited, a fire can spread quickly through a eucalyptus grove. Groves along roadways where many accidental fires start are a high priority for hazardous fuel reduction.



Tamalpais Valley
Golden Gate National Recreation Area

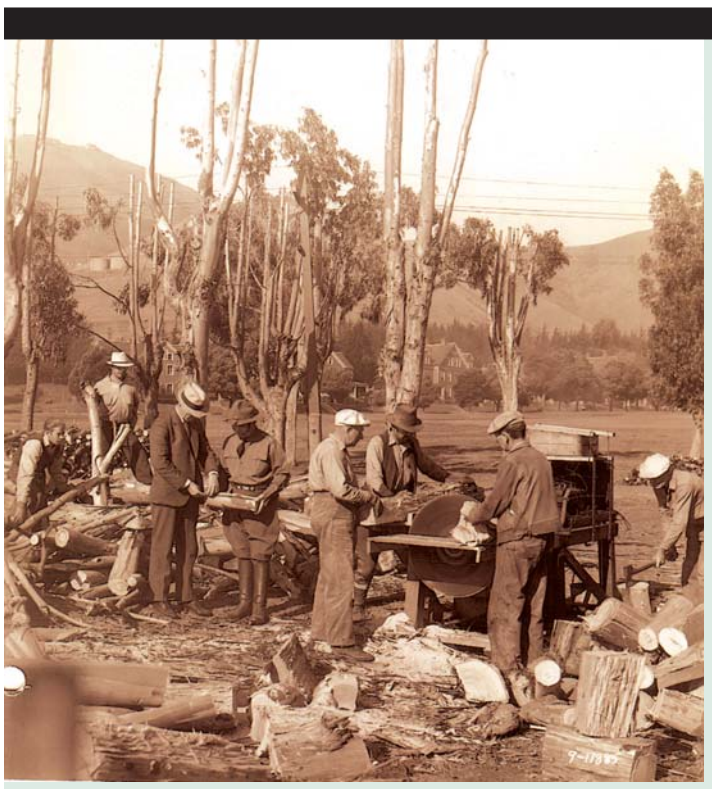
UNMANAGED EUCALYPTUS TREES, surrounding structures or within falling distance, are an accident waiting to happen. Two critical acres of eucalyptus were removed from Golden Gate National Recreation Area in Southern Marin, near the intersection of Marin Drive and Smith Road in Tamalpais Valley, during the fall of 2002. Soon afterwards, another 4 acres was removed near the Marinview subdivision, and two sites near Via Recodo and Vista de Valle, also in Tamalpais Valley.

These small, highly targeted projects, were done to create defensible space around homes adjacent to the park boundary. From the hundreds of acres of eucalyptus on GGNRA land, strategic areas in the wildland-urban interface are given the highest priority for removal.

Treatments on park land are often accompanied by a partnership project on private land, on the other side of the park boundary. Key partners include local fire departments, homeowners associations, and FIRESafe MARIN.

The new GGNRA Fire Management Plan identifies 4,926 acres of wildland-urban interface within GGNRA lands which will be targeted in future fuel reduction projects. This includes the 70 -acre eucalyptus grove adjacent to homes in Tamalpais Valley.

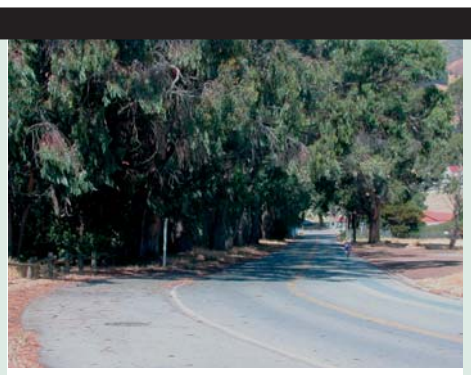
Flammable vegetation in immediate proximity to homes must be removed to create defensible space. Defensible space between structures and vegetation allows firefighters to safely defend a home from wildfire, and may also allow a home to survive on its own.



1936 tree trimming: "Improvements to Grounds" National Archives and Record Center, Fort Baker Construction Completion Reports 1917-1941

Management of the landscape was an ongoing concern during the historic period, as evidenced by this WPA work party, trimming trees on the Fort Baker parade ground.

Trimming branches and removing leaf litter preserves the historic condition of Fort Baker and is good fire safe practice.



BEFORE

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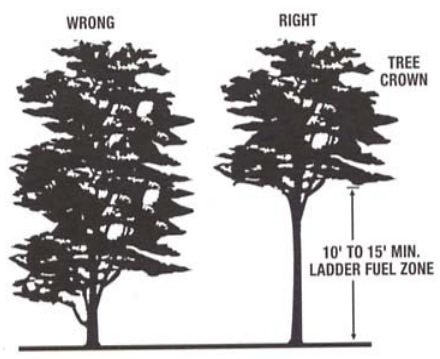


Fort Baker
Military Reservation GGNRA

FORT BAKER IS ONE OF THREE MILITARY RESERVATIONS that form the Forts Baker, Barry and Cronkhite Historic District, an area that is nationally significant for its coastal defense history.

In a 1888 reveiw of coastal defenses, Henry L. Abbot, a prominent military strategist wrote, *"... we must sacrifice neat crests and beautiful slopes, so far as the service of the guns and protection against washing by storms will permit; trees and bushes must be planted on the parapets and behind the batteries to prevent a clear definition of the guns... in a word, dispersion and concealment, as contrasted with concentration and armor..."*

In 1903, in conjunction with original building construction at Fort Baker, the post Quartermaster oversaw preparation of a planting program to reduce the discomfort caused by winds roaring through the Golden Gate into the site, as well as to enhance the appearance of the developing landscape. The Quartermaster's plan for Fort Baker proposed using 10,000 each of Monterey pine, cypress and eucalyptus trees to form a protective windbreak in a continuous arc along the semicircle of hills behind the post. It is not known exactly how many trees were planted, but it was far fewer than was proposed. In addition to windbreaks, windrows of trees were placed along the roads leading to the cantonement, where the living quarters and offices were.

At Fort Baker, blue gum eucalyptus trees are protected as part of a nationally significant cultural landscape.

Monitoring Treatments

To find out if treatments are achieving objectives, a variety of monitoring techniques are used to compare conditions before and after treatment. Examples of project objectives and monitoring strategies include:

Highway One Eucalyptus Thinning Project

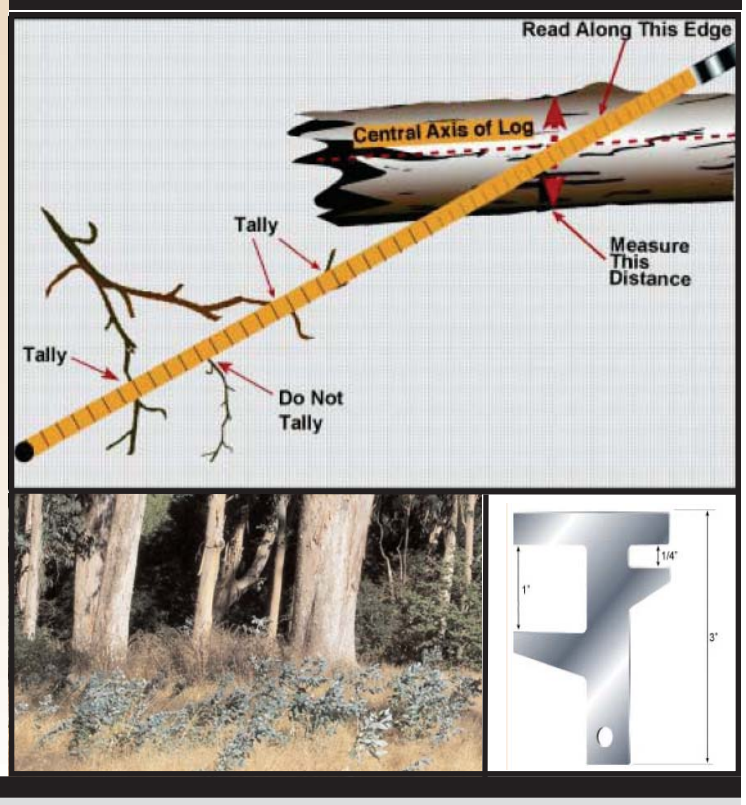
1. Decrease standing area of eucalyptus
   - *Measure how much of the ground is covered by the base of trees in a 25 x 4m plot*
2. Reduce the dead and downed fuel load
   - *Count how many times woody fuel of different sizes intersects a 50' transect*
   - *Measure how deep the duff is along a transect (*Duff is the decomposing vegetation below the freshly fallen leaf litter.)*
3. Minimize resprouting of stumps
   - *Count how many stumps are resprouting within a 25 x 4m plot*
4. Increase native shrub cover
   - *Count how many shrubs of each species are found in a 25 x 1m plot*
5. Detect and record overall changes in site
   - *Photographs are taken of the treatment area from several locations.*

Alta Avenue Eucalyptus Removal and Restoration Project

1. Identify and remove target invasive species
   - *Undesirable weed species will be removed from the site when observed*
2. Increase vegetation cover to 70% by 2006 and to 90% by 2008
   - *Measure vegetation in a quadrat, using checkpoints for additional revegetation action if needed*
3. Increase percentage of native vegetation
   - *Count and compare how many plants are native in relationship to how many are non-native*
4. Determine survival rate of replanted native species (coyotebrush, *Baccharis pilularis*)
   - *Measure how many native plant seedlings survive over time*
5. Determine if mulch from chipping is inhibits survival of native seedlings
   - *Measure depth of duff and relate this to seedling survival to determine if effect is significant*
6. Determine if wooden posts for bird perching increase seed dispersal by birds to site
   - *Compare rate of revegetation in areas with and without bird perch posts*

MONITORING TECHNIQUES

In a standard fuels transect, woody fuels on the ground are recorded by size on one side of a a 50-foot tape.
LOWER LEFT: Photomonitoring is used to record changes at a site, such as these new root shoots which developed after a tree thinning project.
LOWER RIGHT: A special guage is used to classify fuels by their diameter. 0- 1/4 in. (1-hour) , 1/4-1 in. (10-hour), and 1-3 in. (100-hour) are standard fuels categories. "Hours" refers to drying out time, or "time lag", which indicates how long it will take fuel to become available for combustion. The larger the diameter, the more time it will take for fuel to ignite.



Comments or Questions?

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1 Bear Valley Road, Point Reyes Station, CA 94956
415-464-5133

Let us know what you think about managing eucalyptus.

Eucalyptus Utilization

Wood products and energy from removed trees

ARE THERE PRACTICAL USES FOR EUCALYPTUS?

In the early 1900s, plans to develop eucalyptus as a lumber source proved unsuccessful because the wood cracks when dry.

In response to the oil embargo in the 1970s, a study for the U.S. Department of Energy looked at eucalytpus as a potential biomass fuel source which could be cultivated on "energy farms."

Today, land managers are seeking ways to recover costs from eucalyptus removal projects designed to reduce wildland fire hazards and preserve natural and cultural resources.

Chipped debris is hauled to co-generation plants and burned to create electricity. Boards have been cut to make wood flooring. Wood shavings are used as bedding in horse stalls. Eucalyptus trees have also been used for fences, furniture, and of course, the most traditional use of all, firewood.

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PRBO Conservation Science
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