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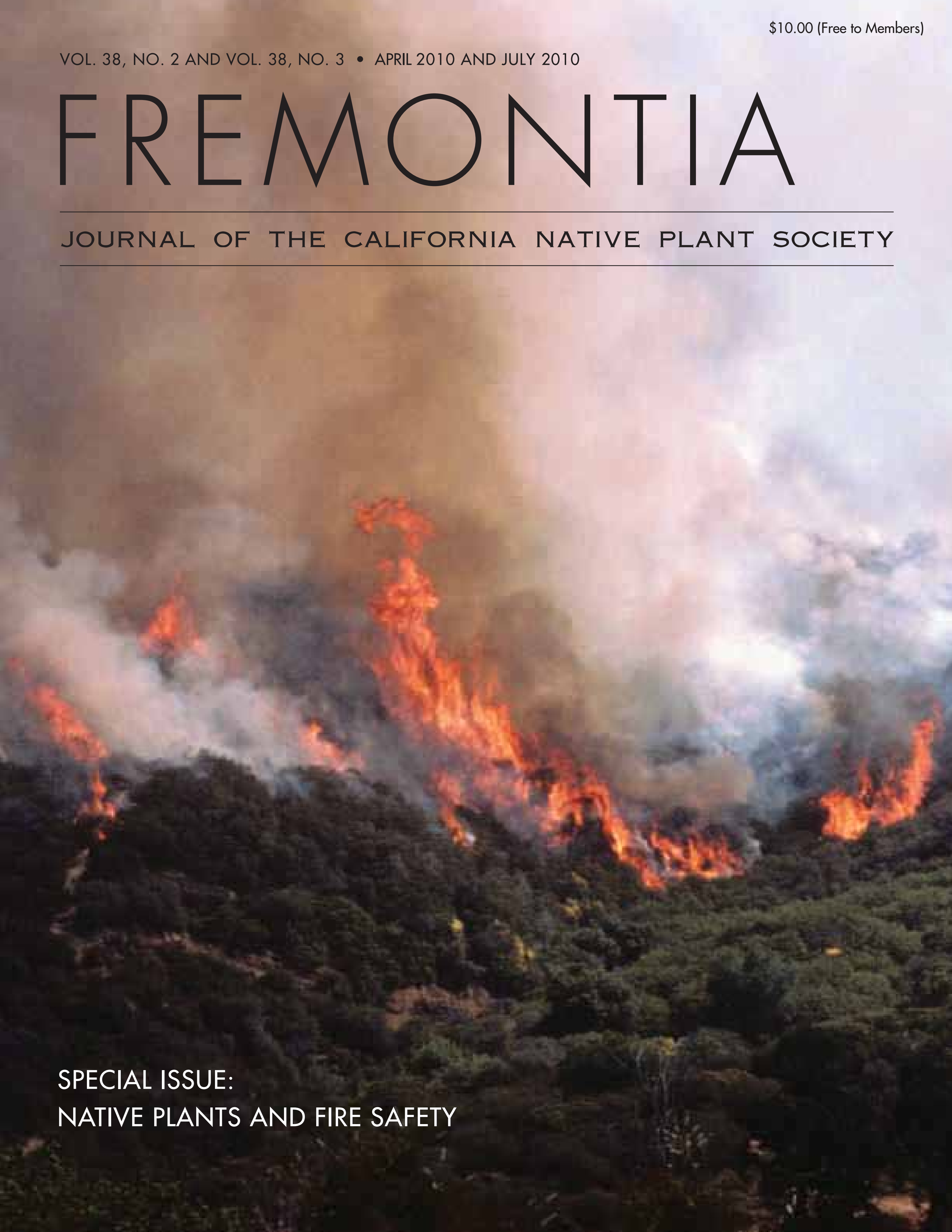
FREMONTIA

JOURNAL OF THE CALIFORNIA NATIVE PLANT SOCIETY



SPECIAL ISSUE:
NATIVE PLANTS AND FIRE SAFETY

FREMONTIA

VOL. 38, NO. 2, APRIL 2010 AND
VOL 38, NO. 3, JULY 2010

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CALIFORNIA NATIVE PLANT SOCIETY

Dedicated to the Preservation of the California Native Flora

The California Native Plant Society (CNPS) is a statewide nonprofit organization dedicated to increasing the understanding and appreciation of California's native plants, and to preserving them and their natural habitats for future generations.

CNPS carries out its mission through science, conservation advocacy, education, and horticulture at the local, state, and federal levels. It monitors rare and endangered plants and habitats; acts to save endangered areas through publicity, persuasion, and on occasion, legal action; provides expert testimony to government bodies; supports the establishment of native plant preserves; sponsors workdays to remove invasive plants; and offers a range of educational activities including speaker programs, field trips, native plant sales, horticultural workshops, and demonstration gardens.

Since its founding in 1965, the traditional strength of CNPS has been its dedicated volunteers. CNPS activities are organized at the local chapter level where members' varied interests influence what is done. Volunteers from the 33 CNPS chapters annually contribute in excess of 97,000 hours (equivalent to 46.5 full-time employees).

CNPS membership is open to all. Members receive the quarterly journal, *Fremontia,* the quarterly statewide *Bulletin,* and newsletters from their local CNPS chapter.

CALIFORNIA NATIVE PLANT SOCIETY

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THE COVER: Burning chaparral in Southern California. Photograph courtesy of the U.S. Forest Service.

Postfire regeneration of chaparral in the first spring after the 2007 Witch Fire in northern San Diego County. In addition to shrub resprouts, it is remarkable how many annual species with seed banks that have been dormant for decades are stimulated to germinate by smoke and heat. All photographs by J. Keeley.

FIRE ON CALIFORNIA LANDSCAPES

by Jon E. Keeley

This volume comprises a fine collection of papers that introduces a diversity of issues pertaining to wildfires. They illustrate well the difficulty of balancing protection of natural resources with threats to urban environments. Critical to understanding these issues is the recognition that there are distinct ecoregional differences in the natural role of fire and consequently in appropriate management practices, and nowhere is this more evident than in the very diverse state of California with its sharp contrasts between forested and non-forested ecosystems.

The California flora is well known for its resilience to periodic fires, and many species are characterized as being "fire-adapted" or having "fire-adaptive traits," which means they have characteristics that are deemed critical to success in fire-prone environments. However, in recent decades we have come to recognize that no species is adapted to fire *per se*, but rather is adapted to particular fire regimes. For example, fire-adaptive traits are very different between forest species and shrubland species, and historical impacts on fire regimes and contemporary fire management needs are very different between these biomes (Keeley et al. 2009). In this issue the novel approach of Keeler-Wolf, Evens, and Sawyer in applying fire responses to community associations is a first attempt at providing a framework for understanding fire regime differences that may prove useful to fire managers.

A state as diverse as California has many fire regimes, but the concept can be illustrated by contrasting surface fire regimes in forests with crown fire regimes in shrublands. Forests with historical fire regimes of surface fires that largely burned understory litter, or in more open forest savannah sites burned understory grasses, generally left most mature trees alive. The life history traits of the dominant mixed conifer trees reflect a strategy of outgrowing the surface fuels, maintaining the canopy well above the surface fuels, and evolving traits such as thick bark and self-pruning of dead branches as a means of providing separation between the fire and the live canopy. The trees in these forests depend on surviving, as they are the parent seed trees for subsequent recovery. Key to survival is the fuel load, and historically this was kept at a low level by frequent lightning-ignited fires. In these forest types, the landscape patterns of burning are critical to the speed of recovery, as seed dispersal is relatively localized and dependent on patches of seed trees surviving, interspersed with areas of high intensity burning that open gaps in the forest canopy.

Non-forested vegetation such as chaparral shrublands persist on more extreme sites where plant productivity is lower and the vegetation simply lacks the capacity to outgrow fire impacts. In these systems, crown fires periodically burn through entire canopies and leave very little above-ground living plants. On these landscapes lightning-ignited fires are far less frequent than in forested environments. Historically these shrublands burned perhaps once or twice a century, and fires profited from the massive landscape expanses of fuels. Most chaparral species recover endogenously (growing from within the site) by dormant seed banks and resprouting from basal burls or other below-ground vegetative structures. As a consequence of this endogenous regeneration system, fire size is seldom critical to vegetation recovery, although this is less true for the fauna.

This dichotomy of forest surface fire regimes and shrubland crown fire regimes of course only captures some extremes. In this issue, Lambert, D'Antonio, and Dudley describe Great Basin sage scrub, which experiences very frequent lightning-ignited fires, but due to the discontinuities in surface fuels, yields very patchy burn patterns. This is reflected in lack of resprouting and lack of dormant seed banks in many dominant shrubs (Keeley et al. 2009). The gaps are dependent on metapopulation dynamics, an ecological term that describes how landscapes recover by surviving populations recolonizing localized burned sites.

This community of chamise chaparral burned twice in three years and is now dominated by non-native species such as red brome (*Bromus madritensis* ssp. *rubens*).

Disturbance of course is a concern to all botanists who appreciate natural landscapes and conservation of the native flora. Disturbance from a human perspective is not the same as disturbance from a plant's perspective. On fire-prone landscapes where fire is considered a natural ecosystem process, humans disturb ecosystems by altering fire regimes, usually by either reducing fire frequency through fire suppression, or increasing fire frequency by increasing fire ignitions as well as by changing the seasonal distribution of ignitions. These alterations in the natural fire regime represent the real disturbances in these ecosystems and can have negative impacts on plant survival.

The introduction in Jack Cohen's article describes well the impact of humans on forested ecosystems. It is the long-standing story of fire suppression allowing unnatural fuel loads to accumulate, thus changing fire regimes from frequent low intensity surface fires to infrequent high intensity crown fires. These high intensity fires can result in large portions of the forest landscape being type converted to early seral stages of native chaparral that may persist for many decades, if not longer. These shrubs develop from dormant seed banks that were produced following similar high intensity crown fires sometime in the past, but in some cases there is no native shrub seed bank and, as discussed in Lambert, D'Antonio, and Dudley's article, these are likely to be invaded by non-native grasses.

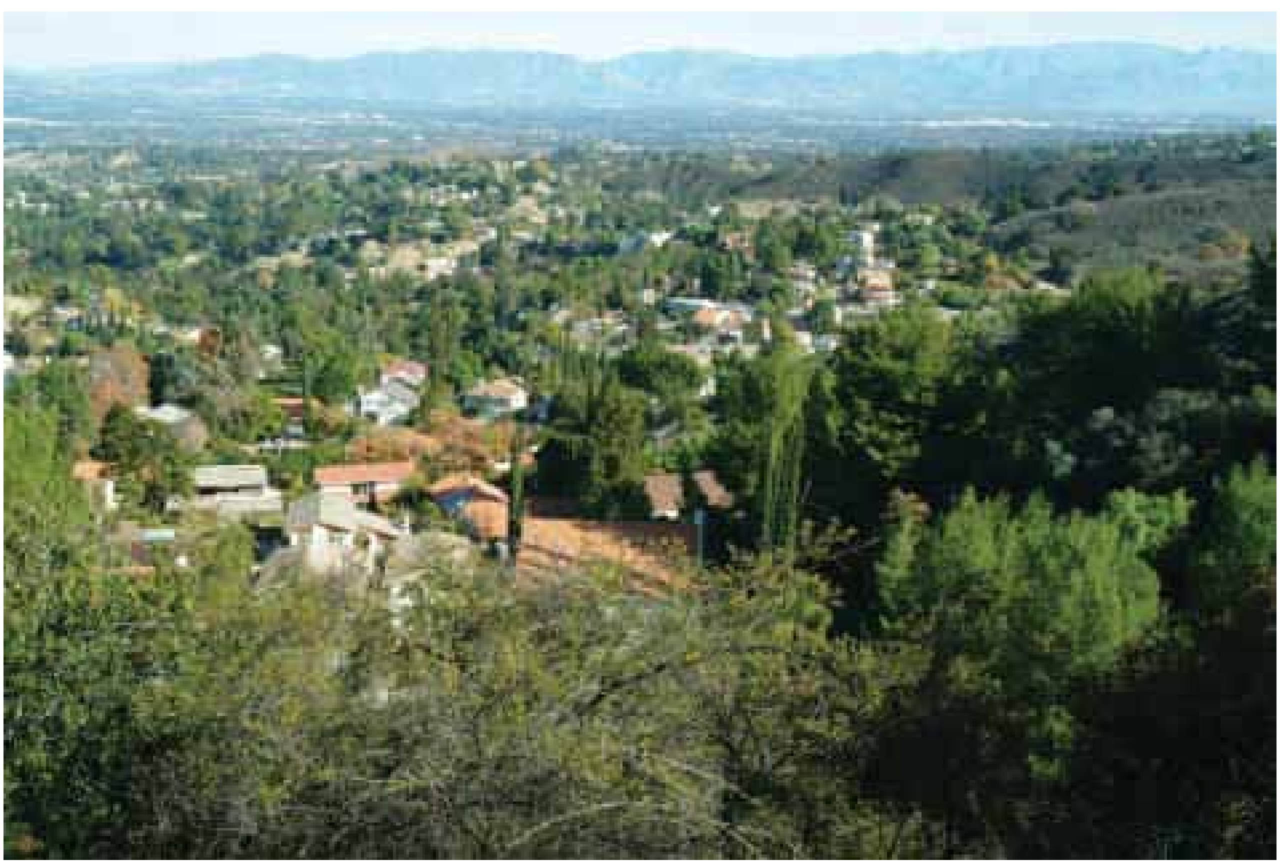
This however, represents only part of the California story. The majority of our landscape is not forested and humans have not reduced fire frequency, but rather have radically increased burning (Halsey 2004). In many places this has had the unfortunate impact of type converting native shrublands to non-native grass and forb lands as outlined by Lambert, D'Antonio, and Dudley in this issue. As a member of the California Native Plant Society, this type conversion concerns me because of the loss of both native flora and fauna. As an ecologist this concerns me because of the change in functional types from deep-rooted shrubs that can hold soils on steep slopes, to shallow-rooted herbs. As a fire scientist this concerns me because of the change in fire season from about 6 months in shrublands to 12 months in annual grasslands, and lastly as a scientist this is of concern due to the loss in the capacity for carbon storage and potential impacts on climate.

These two fire regimes have different implications for how we manage these landscapes. Most forests in our region have evolved along with frequent low intensity surface fires. As a consequence, the use of frequent prescription burning to reduce hazardous fuels is compatible with much of the flora and fauna. In short, fire-hazard reduction and resource protection are compatible. In contrast, chaparral shrublands have evolved with infrequent high intensity burning and many of the species are at risk when fire frequency increases. Consequently, fire-hazard reduction and resource protection are oftentimes at odds with one another.

No one concerned with our native flora can ignore the demands humans place on ecosystems, most directly by habitat destruction. Looking down the road this is even more important, as there is currently no effort to curb population growth in California. According to the California Department of Finance, by 2050 the population is projected to reach almost 60 million—about a 41% increase. This will place demands not only on habitat availability, but also on wildland fire activities that will undoubtedly impact native plants and urban environments. Of all the potential global changes threatening our state, population growth has to rank at the top of our list.

Historically, communities have viewed fire as something that state and federal fire agencies will control and prevent from impacting the urban environment. This may be accomplished through a combination of fire suppression tactics and concerted efforts at reducing wildland fuels. On non-forested landscapes this latter approach has often been very controversial because, depending on the methods used, it may involve the sacrifice of native flora, the introduction of non-native species, and the disruption of natural ecosystem processes. These are problems CNPS has been keenly aware of as documented in the article by Betsey Landis in this issue. These costs in and of themselves do not constitute reasons for avoiding such treatments, but they do put an added burden of proof on the managers for demonstrating a positive benefit. Over the past 100 years, wildland fire-fighting agencies have made great progress in managing the fire risk, but it seems unlikely they will ever be able to eliminate the threat of fires crossing the wildland-urban interface.

Dense urban fuels create hazardous conditions when wildfires burn across the wildland-urban interface.



Excessive clearance of chaparral around new home (top center) in San Diego County. A growing body of evidence indicates vegetation thinning rather than denuding the site is sufficient to provide defensible space for fire protection.

Jack Cohen's article provides us with a new frontier for dealing with the fire problem. In short, divert attention away from trying to prevent fires from reaching the urban environment and instead focus on making homes fire-proof and thus immune to fire. His call for better home construction is one very important part of the solution to the wildland-urban interface problem. In his view we could reach a point where uncontrolled wildfires were of minimal threat to urban environments because of fire-proof construction.

However, home construction is only one of the ways to make the urban environment fire-safe. Landscaping around homes often determines which homes burn and which survive. The U.S. Geological Survey has been studying this problem and found that landscaping decisions frequently are critical to home survival in wildfires, particularly for those homes at the immediate wildland-urban interface (Fotheringham 2010). This work should ultimately contribute to the SAFE Landscapes program outlined by Sabrina Drill in her article. Suzanne Schettler's fire-resistant landscaping paper provides further insights into this issue.

"Clearance" is an issue of critical importance, not just for solving wildland-urban impacts, but also of importance to botanists like myself and other CNPS members who are concerned about the impacts on natural resources. The term refers to the fuel management zone around homes, and unfortunately the word "clearance" has been institutionalized in statutes. There is plenty of evidence to show that actual clearance of all vegetation is not the proper approach to fuel management, as outlined by Greg Rubin's article. What is needed is breaking up the continuity of fuels, both vertically and spatially, and reducing the proportion of dead to live wood. In other words—thinning the vegetation. Complete clearance can actually enhance fire spread by both increasing alien weeds that comprise flashy fuels, and by eliminating important "ember catchers" such as oak trees that can dampen the fire threat around homes.

As Jack Cohen has shown, 100 feet of fuel modification surrounding a home seems to be sufficient to prevent homes from being destroyed during wildfires, especially in forested areas. However, as Cohen

Most fires ignite in grasses and other herbaceous material and spread to shrublands, as illustrated by this fire spreading into chamise chaparral. Photograph courtesy of the National Park Service.

points out, most homes are not destroyed by the radiant heat from the fire front. Rather it is common for homes to burn from embers entering vents or igniting piles of dead leaves on roofs or gutters. Since embers can travel a mile or more, clearance zones are not likely to be highly effective in altering housing losses in many instances.

In recent years we have seen a demand by insurance companies and legislators for increasing the clearance zone to 300 feet or more. In a recent analysis for San Diego County it was found that if all homes at the wildland-urban interface that could clear this distance did so, it would represent a clearance of one-third of the natural areas of the county (Keeley and Syphard, in press). To those concerned with resource protection, this looms as an ominous threat to future sustainability of our native flora and fauna.

Current conversation would make it seem as if there are two approaches to solving the wildland-urban interface fire problem: 1) stop fires from encroaching the urban environment, or 2) prevent fires from destroying homes. What has been missing from the debate is a third option: why not alter where we put homes?

Changes in planning decisions may have some of the greatest potential for reducing home losses in the future. By analogy with other hazards such as flooding—where development is restricted to sites outside flood plains—fire hazard planning needs a much more thorough examination than it has traditionally received. Roger Kennedy, historian and former National Park Service Director, has coined the concept of "Fire Zone Planning." This approach has not been ignored by fire agencies; for example, it is part of the reason for Cal Fire's intensive effort at fire hazard mapping in the state. The guidance this provides to planners, however, is largely a function of scale. The California Department of Forestry and Fire Protection maps are based in part on assumptions about the importance of natural wildland fuel loads, and in this respect they do appear to point out the most hazardous regions in the state. However, at community scales they may not be adequate. In a recent empirical study of home losses over the past 10 years in Los Angeles, Ventura, and San Diego counties, fire hazard maps did not predict actual property loss. Rather, location of homes relative to historical fires was of far greater predictive value (Syphard et al. in review).

Of course future changes in land planning will not necessarily solve the wildfire problem for many existing communities, although keeping new development from extending into currently rural areas may prevent further increases in human-caused ignitions and thus, future fire losses in general. To this end communities currently at the wildland-urban interface will need to deal with the problems they face being positioned near watersheds of highly flammable fuels. The federally supported Fire Safe Councils have an important role to play in these cases as described by two articles, one by Yvonne Everett and one by Julie Rogers.

REFERENCES

California Department of Finance. 2007. New state projections show 25 million more Californians by 2050. Press release. http://www.dof.ca.gov/html/demograp/reportspapers/projections/p1/documents/p1_press_release_7-07.pdf (accessed June 2, 2011).

Fotheringham, C.J. 2010. Landscape fuels and the management of natural systems. Station Fire Symposium, Altadena, CA, December 16, 2010. Los Angeles Watershed Council.

Halsey, R.H. 2004. Fire, chaparral, and survival in southern California. Sunbelt Publications, San Diego, CA.

Keeley, J.E., et al. 2009. Ecological foundations for fire management in North American forest and shrubland ecosystems. USDA Forest Service, Pacific Northwest Research Station, General Technical Report, PNW-GTR-779.

Keeley, J.E. and A.D. Syphard. The 2003 and 2007 wildfires in southern California. In *Natural Disasters and Adaptation to Climate Change,* ed. J. Palutikof and D.J. Karoly. Cambridge University Press, Cambridge, UK. In press.

Syphard, A.D, J.E. Keeley, A. Bar Massada, T.J. Brennan, and V.C. Radeloff. Housing location and arrangement increase wildfire risk in southern California. *Science. In review.*

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HOW CNPS DEVELOPED A POLICY ON NATIVE PLANTS AND FIRE SAFETY

by Betsey Landis

The CNPS policy on Native Plants and Fire Safety, adopted March 13, 2010, is the culmination of years of discussions among CNPS members about reports of increasing wildfire frequency, extensive urban encroachment into native plant habitat, flagrant clearing of native vegetation, including into public parklands, and the consequent invasion of these bare, eroded areas by highly flammable weeds.

The policy process began September 8, 2007 at the annual CNPS Conservation Conference. Sue Britting had organized a session on chaparral management issues. Max Moritz, assistant cooperative extension specialist in wildland fire and adjunct assistant professor at UC Berkeley, spoke about his research in chaparral ecology and fire. Ernylee Chamlee, chief of wildland fire prevention engineering for the California Department of Forestry and Fire Protection, presented the State regulatory aspects on fuel management in chaparral. The last speaker, Betsey Landis, Los Angeles/Santa Monica Mountains Chapter of CNPS, discussed the chapter perspective on the impacts of current fuel reduction practices on maintenance of healthy chaparral habitat.

In her presentation, Ernylee Chamlee reported that about five million people live in a wildland-urban interface (WUI) in California. She indicated that the management of these lands for fuels, plants, vegetation types, and safety will be an enormous issue for our state. Notably, all general plans (specifically those sections addressing fire issues) needed to be updated by 2010, and it was emphasized that this process allows organizations and individuals to get involved. The question was then posed as to whether we, CNPS, should have a policy statement regarding fuels management and "living with fire." The discussion that ensued involved what that policy might include, how specific it should be, how it would be disseminated, and who would be responsible for bringing it to fruition.[1]

In 2008 a fire policy subcommittee of the Chapter Council Policy Committee was formally constituted with Celia Kutcher (Orange County) as chair, Betsey Landis (Los Angeles /Santa Monica Mountains) as vice chair, Jim Bishop (Mt. Lassen) as Chapter Council Policy Committee advisor, and Chuck Williams (Sanhedrin). Frank Landis (San Diego) and Kevin Bryant (Santa Clara) joined the committee in 2009.

As a fire precaution, native vegetation was cleared to bare dirt and sparse annual grass cover out to 100 feet from this house. The result? Serious erosion, including slumping, soil liquefaction, and sliding during the rainy season. Photograph by M. Witter.

As many as 100 people contributed comments and information as the policy evolved into a document applicable to the whole state. Every chapter was sent drafts for review, and revisions were discussed at Chapter Council meetings. A special session on fire-management topics was held at the January 2009 CNPS Conference.

Jim Bishop then sent out a survey to all chapters asking three questions: 1) What are the fire risk reduction practices in your area

SOME PLANTS TO AVOID WHEN LANDSCAPING IN FIRE-PRONE AREAS

The following plants are either flammable, invasive, or both, and should not be used in areas of high fire danger.

Scientific Name	Common Name
Acacia species	acacia (trees and shrubs)
Ageratina adenophora	eupatory
Ailanthus altissima	tree of heaven
Bougainvillea	bougainvillea
Cedrus species	cedar
Cortaderia selloana, Cortaderia jubata	pampas grass
Cupressus species	cypress
Delairea odorata	cape ivy, German ivy
Dimorphotheca sinuata	African daisy
Dodonea viscosa	hopseed bush
Eucalyptus species	eucalyptus, gum tree
Fraxinus uhdei	Shamel ash
Gelsemium sempervirens	Carolina jessamine
Hakea suaveolens	hakea
Hedera species	ivy
Juniperus species	juniper
Lobularia maritima	sweet alyssum
Myoporum laetum	myoporum
Pennisetum species	fountain grass
Phoenix canariensis	Canary Island date palm
Picea species	spruce
Pinus species	pine
Ricinus communis	castor bean
Schinus molle	Peruvian pepper tree (or "California" pepper tree)
Schinus terebinthifolius	Brazilian pepper tree
Spartium junceum	Spanish broom
Taxus species	yew
Thuja species	arborvitae
Tropaeolum majus	nasturtium
Vinca major, Vinca minor	periwinkle
Washingtonia spp.	Californian and Mexican fan palms

Sources: Santa Monica Mountains Community Wildfire Protection Plan, ForEverGreen Forestry. Recommended List of Native Plants for Landscaping in the Santa Monica Mountains, Los Angeles/Santa Monica Mountains Chapter, CNPS.

that are most detrimental to native plants and habitats? 2) What are better approaches, ones that will reduce fire risk without hurting native plants? 3) What agencies are the key to getting practices implemented?

The answers revealed layers of inconsistent, often contradictory, regulations about fire and fuel management practices, as well as a lot of confusion around the state about which level of regulatory authority was responsible for which regulation.

Finally in February 2009, the draft policy was submitted to the Chapter Council Policy Committee, which made a few editorial changes. The fire policy subcommittee and the Chapter Council Policy Committee then approved the final draft. The Native Plants and Fire Safety Policy was presented to the Chapter Council March 13, 2010 and was adopted by unanimous vote.

NEGATIVE IMPACTS AND POSSIBLE SOLUTIONS:

FEDERAL LEVEL

At the federal level, southern California Chapters reported problems with the prescribed burns that are an integral part of fuel management in the Healthy Forests Restoration Act of 2003 (HFRA). Fuel management plans utilizing prescribed burns in the southern California National Forests, which have large areas of chaparral, have resulted in uncontrolled wildfires, too frequent burning, and conversion to weedy, flammable, erodable slopes. The HFRA allows fuel reduction in the WUI (wildlands/urban interface) of up to 1 1/2 miles from structures. Other fuel management methods include mastication, crushing, and building fuel breaks, all of which destroy the intricate root matrix native plant communities create to knit the fragile watersheds together. In heavy rainfalls, mudslides are inevitable. Loss of healthy topsoil leads to non-native shallow-rooted grasslands, which in turn lead to more frequent early season wildfires.

Suggestions for preventing further damage to these chaparral forests ranged from rewriting the Healthy Forests Restoration Act to excluding its application to southern California National Forests.

STATE LEVEL

At the state level, there were no general complaints about the State Fire Code (PRC 4291, CCR 1299, General Guidelines, or Chapter 7

Building Code for Wildfire Areas, except that the definition of "Brush Clearance" needs to be removed and replaced with a new term, perhaps "Fuel Management." Currently State Cal Fire rarely uses the term "Brush Clearance," although fire authorities at the county or city level still do. The Code requires 100 feet of fuel reduction around structures, with the most rigorous fuel reduction and vegetation control occurring in the first 30 feet from the structures.

California FAIR Plan (CFP) is a state-mandated pool of private insurance companies. All insurance companies insuring properties in California in high-risk (high fire hazard) areas must belong to this pool. Chapters have received complaints from members and others owning homes in fire areas about the unreasonable requirements placed on them for clearing vegetation around their homes. CFP requires 200 feet minimum of clearance and may require more (3,000 feet clearance was reported in one instance in Riverside County!). If the property owner cannot clear that far due to property lines, CFP will insist that the property owner somehow compel the adjacent owner to clear the land.

TOP: **A former fuel break has turned into a major weed-infested area that is now more susceptible to wildfire than it was before the native vegetation was removed. Photograph by R.S. Taylor. •** BOTTOM: **An example of excessive vegetation clearance around a house in the wildland-urban interface near San Diego. Photograph by R. Halsey.**

The penalty for not clearing land to CFP's satisfaction is a large surcharge on the first property owner. CFP does not show as much concern about proper fuel clearance of ornamental trees, shrubs, and vines in the first 30 feet from the home, which is considered by experts to be the more important defensible area. Since the adjacent property owner is often the public (i.e., parks and preserves), political pressure by property owners and homeowner associations results in park authorities clearing protected natural resources on a yearly basis, resulting in losses of native habitat and major erosion in natural watershed areas. The suggested recourse is to work with the State Insurance Commissioner and the State Legislature to require the insurance pool to adhere to the State Fire Code, and to supply mudslide insurance along with the fire insurance.

CalTrans has its own fuel modification regulations that seem to work better in some counties than others. Problems are in protecting rare native plants that may grow along roads, especially in areas where farmlands have removed much of the usual habitat for these native plants. It needs better management oversight, as does the Transportation Corridor Authority.

Each California state park has its own management plan, which may or may not consider protection of native habitat as a major concern. Their maintenance plans for trails and recreation areas should contain location data of any rare native plants and how to avoid damaging their habitats or causing weed invasions at those locations. All parks should have regulations promoting fire-safe construction of all structures and adjacent landscapes.

The building of fire/fuel breaks, at whatever level of government, is a statewide problem. Some are necessary, having been built during a wildfire, but others are not. In state parks, biologists may be present at the fire command post during a wildfire. A biologist will go out with the bulldozer operator if a fuel break is required in an area known to have rare plants. The biologist will direct the bulldozer operator around larger plants or will request that the operator lift the blade as the machine moves over smaller plants. Often the bulldozers are sent out to carve a fuel break straight up and down slopes. This usually results in heavy infestations of weeds after the fire is over. Recovery of the area may take years.

Some developments on flat land use large, bulldozed fuel breaks to protect structures from fire. Questions were posed by CNPS members about the wisdom and value of such fuel breaks.

TOP: The downslope area adjacent to this residence has been denuded of all vegetation and is eroding. Meanwhile, fire hazards including a wooden fence and pine trees remain next to the house. • BOTTOM: Typical of many new developments in wild areas of Southern California, these houses were built too close to each other, and are surrounded by flammable trees. Their risk for damage from a wildfire is high. Photographs by R. Halsey.

COUNTY LEVEL

At the county level, fire authorities may be County Fire Departments or Fire Districts, and may include paid staff, volunteers, or a combination of both. Many of these fire authorities require more than 100 feet clearance of all native vegetation from the structures in fire areas while allowing non-native, ornamental, often highly flammable plants to remain around the houses. Many county codes do not require fire-safe construction for fire areas. Due to water restrictions, irrigation may be allowed in the first 30 feet from the house, but prohibited beyond

LAYERS OF AUTHORITY FOR FIRE AND FUEL MANAGEMENT REGULATIONS

LEVEL OF JURISDICTION	RESPONSIBLE ENTITY
Federal	*Congress (Acts)*
Federal	Dept. of Interior: Natl. Parks, BLM, Natl. Cooperative Land & Wildlife Area USDA: Natl. Forests
Indian Reservations	Dept. of Indian Affairs, Tribal Councils
State of California	Legislature (Codes)
State of California	CalFire, State Fire Marshal's Office
State of California	State Insurance Commissioner
State of California	State Parks & Wilderness Areas
State of California	Dept. of Fish and Game, DFG Preserves
State of California	Caltrans
State of California	UC Reserves
Counties	Boards of Supervisors, Planning Depts., Commissions
Counties	County Fire Departments or Fire Districts
Counties	County Water Districts
Counties	NCCP, HCP, MCP
Counties	Transportation Corridors, Road Depts.
Counties	Weed Management Areas
Counties	County Parks and Recreation Areas
Cities	City Councils, Planning Depts., Building & Safety Depts., Commissions
Cities	City Parks and Recreation Areas
Cities	Municipal Water and Power Depts.
Private	Lumber Companies, Mining Companies
Private	Land Trusts
Private	Utilities (Water, Power, Gas, Communications)
Private	Homeowner Associations

Source: CNPS Chapter Council Fire Policy Subcommittee, CNPS conservation chairs, other CNPS members, and Web searches.

that point, even in times of drought. The cost of wildfires is greater than the cost to the homeowner for fire-safe construction and the cost to maintain a healthy landscape to the property line, even if occasional watering beyond the first 30 feet is necessitated by dry winters.

A continuing problem—especially when volunteer fire departments are involved—is the lack of coordination between rural fire districts, or between adjacent cities, counties, and perhaps other landowners—when fighting a large wildfire covering several jurisdictions. The people concerned with good fire response need to step forward and organize communications and resources in these jurisdictions.

Many of the same concerns apply at both the county and city level, where CNPS members comment in public hearings on General Plans about environmental issues involving native plants and invasive weeds, and in CEQA processes that involve impacts on native vegetation. With human activity in natural areas comes a greater chance of wildfire ignition. General Plans should reflect the increased hazards of increasing populations living in fire areas: to the residents and rate payers, in the economic costs of fighting fires, in the resulting losses in natural resources (especially in watershed and percolation areas), and in damage caused by erosion. Local jurisdictions should require fire-safe building codes for homes, power networks and grids, transmission towers, and for fire-safe landscaping, and require enforcement of those codes.

WHAT CNPS CHAPTERS CAN DO

Below are some suggestions of things CNPS chapters and members can do to protect both native habitat and homes.

- Join the local County Weed Management Area to assist in identifying best management practices for protecting native plant resources, by removing invasive non-native plants from native habitat areas or in the vicinity of rare plant populations.
- If the CNPS chapter has members living in wildfire areas, those members may be involved in a local Fire Safe Council. If not, encourage members to explore the concept of Fire Safe Councils. Either assist a Fire Safe Council to design a plan that protects native plant resources and properly manages those resources, or organize a new Fire Safe Council, utilizing chapter native plant expertise to create a plan that protects both human residents and native habitats.

[1] Conference proceedings link: http://www.cnps.org/cnps/conservation/conference/2007/index.php

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NATIVE PLANTS AND FIRE SAFETY POLICY

Adopted by CNPS Chapter Council March 13, 2010

THE POLICY

Statement:

The California Native Plant Society opposes the unnecessary destruction of California's native plant heritage for the purpose of wildfire fuel management. The California Native Plant Society supports protecting human lives, property, and California's native plants from poor fuel management practices. California's superbly diverse native plants are its most valuable resource for erosion control and water conservation, and are vital to the long-term health of California.

Intent:

To provide an authoritative policy that California Native Plant Society and others can use to persuade legislators and regulators to approve fire-safe practices that maximize conservation of native plants and native plant ecosystems, while protecting citizens, firefighters, and property.

SUPPORTING MATERIALS

Rationale:

Siting development in or adjacent to native plant communities increases the risk to structures from wildfire, the potential for additional human-caused ignitions, and the need for more fuel management. The best land-use planning practices minimize placing development in locations that increase the risk of property exposure or of ignitions. The best fire-safe building codes reduce the risk of the structure being ignited, or spreading fire, during a wildfire.

Fuel management practices to protect urban development generally have been ineffective and/or counter-productive, severely impacting that native vegetation. Public ordinances and bureaucratic regulations often require fuel-removal practices in excess of 2006 California Public Resource Code 4291, causing severe damage to native plant ecosystems without reducing wildfire risk. These requirements should be replaced with proven fuel-management practices that minimize the wildfire threat and do not devastate native plant ecosystems.

California is large and diverse, and different fuel systems require different solutions for minimizing the impacts of fuel management and fire control practices on native vegetation. That diversity, as exemplified in two cases noted here, requires the development of implementation guidelines that fit the affected area.

Examples:

- In some areas, especially shrublands, shortened fire-return cycles have converted native plant communities into non-native grasslands. These faster-burning invasive non-native plant species in turn fuel early-season wildfires, preventing regrowth of native vegetation and diminishing resource value.
- In certain forested areas, wildfire suppression has caused a lengthened fire-return cycle, which can allow an accumulation of dead material and an increased likelihood of high-intensity wildfires. This modification of natural cycles has led to losses in native forest species diversity, erosion, increased wildfire management costs, and greater risks to property and people.

Implementation:

The California Native Plant Society supports:

- Fuel management plans that minimize the risk to human life and property while maximizing protection of native plants and their habitats. These plans should be locally adapted and account for all combustible materials, including building materials, ornamental vegetation, other landscaping materials, and adjacent native plant ecosystems.
- Building codes and ordinances that require structures and landscaping in high-fire-risk areas to be situated, constructed, retrofitted, and maintained using materials and practices that minimize the ignition and spread of wildfires.

- The creation of laws, regulations, and land-use policies that discourage new development in areas of high-fire danger.

There are many different fire environments and property-development settings throughout the state. The California Native Plant Society will develop specific guidelines for implementation, supported by current applicable fire science and botanical knowledge, to fit the particular wildfire environment and property-development patterns of a given area. These detailed guidelines will be supplemental to this policy, and can be created, modified, or removed by approval of the California Native Plant Society Chapter Council.

DEFINITIONS CODIFIED IN STATE LAW OR LOCAL ORDINANCES

Brush—All native vegetation (especially shrubs), all vegetation in undeveloped lands. ***Sources***: California FAIR Plan 2010; Los Angeles City Fire Department 2010.

Brush areas—Wildlands, undeveloped lands. ***Synonyms***: Brush hazard areas, brush/wildfire areas. ***Source***: California FAIR Plan 2010.

Brush clearance—Treatments or thinning of vegetation to reduce fire hazards. ***Synonyms***: Fire clearance, fuel clearance. ***Source***: Los Angeles City Fire Department 2000.

California FAIR Plan—"The California Fair Access to Insurance Requirements (FAIR) Plan was created by state legislation in July 1968 following the 1960s brush fires and riots. It is an insurance pool established to assure the availability of basic property insurance to people who own insurable property in the State of California and who, beyond their control, have been unable to obtain insurance in the voluntary insurance market. The FAIR Plan is a private association based in Los Angeles comprised of all insurers licensed to write property insurance in California. The FAIR Plan is not a state agency." ***Source***: California FAIR Plan 2010.

Defensible space—An area extending 100 feet from a structure in which "Fuels shall be maintained in a condition so that a wildfire burning under average weather conditions would be unlikely to ignite the structure" (PRC 4291). The defensible space zone consists of an innermost 30 feet in which the fuels are maintained as "lean and green," and an outermost 70 feet as the "reduced fuel zone" in which fuels are reduced, limbed up, and thinned. ***Source***: Cal Fire 2010a.

GENERAL GUIDELINES

Public Resource Code 4291, Excerpt from General Guidelines (pages 5-6):

C. Fuel Treatment Guidelines

The following fuel treatment guidelines comply with the requirements of 14 CCR 1299 and PRC 4291. All persons using these guidelines to comply with CCR 1299 and PRC 4291 shall implement General Guidelines 1, 2, 3, and either 4a or 4b, as described below.

1. Maintain a firebreak by removing and clearing away all flammable vegetation and other combustible growth within 30 feet of each building or structure, with certain exceptions pursuant to PRC 4291(a). Single specimens of trees or other vegetation may be retained provided they are well spaced, well pruned, and create a condition that avoids spread of fire to other vegetation or to a building or structure.
2. Dead and dying woody surface fuels and aerial fuels within the Reduced Fuel Zone shall be removed. Loose surface litter, normally consisting of fallen leaves or needles, twigs, bark, cones, and small branches, shall be permitted to a depth of 3 inches. This guideline is primarily intended to eliminate trees, bushes, shrubs, and surface debris that are completely dead, or with substantial amounts of dead branches or leaves/needles that would readily burn.
3. Down logs or stumps anywhere within 100 feet from the building or structure, when embedded in the soil, may be retained when isolated from other vegetation. Occasional (approximately one per acre) standing dead trees (snags) that are well-spaced from other vegetation and which will not fall on buildings or structures or on roadways/driveways may be retained.
4. Within the Reduced Fuel Zone, one of the following fuel treatments (4a or 4b) shall be implemented. Properties with greater fire hazards will require greater clearing treatments. Combinations of the methods may be acceptable under 1299(c) as long as the intent of these guidelines is met.

4a. Reduced Fuel Zone: Fuel Separation

In conjunction with General Guidelines 1, 2, and 3, above, minimum clearance between fuels surrounding each building or structure will range from 4 feet to 40 feet in all directions, both horizontally and vertically. Clearance distances between vegetation will depend on the slope, vegetation size, vegetation type (brush, grass, trees), and other fuel characteristics (fuel compaction, chemical content, etc.). Properties with greater fire hazards will require greater separation between fuels. For example, properties on steep slopes having large-sized vegetation will require greater spacing between individual trees and bushes. Groups of vegetation (numerous plants growing together less than 10 feet in total foliage width) may be treated as a single plant. For example, three individual manzanita plants growing together with a total foliage width of 8 feet can be "grouped" and considered as one plant, and spaced according to the Plant Spacing Guidelines in this document.

4b. Reduced Fuel Zone: Defensible Space with Continuous Tree Canopy

To achieve defensible space while retaining a stand of larger trees with a continuous tree canopy, apply the following treatments:

- Generally, remove all surface fuels greater than 4 inches in height. Single specimens of trees or other vegetation may be retained, provided they are well-spaced, well-pruned, and create a condition that avoids spread of fire to other vegetation or to a building or structure.
- Remove lower limbs of trees (prune) to at least 6 feet up to 15 feet (or the lower 1/3 branches for small trees). Properties with greater fire hazards, such as steeper slopes or more severe fire danger, will require pruning heights in the upper end of this range.

Source: Cal Fire. 2006

GLOSSARY OF TERMS

Community—Any ecologically integrated group of species of microorganisms, plants, and animals inhabiting a given area. ***Source***: Purves, Orians, Heller, Sadava (1998).

Ecosystem—The organisms of a particular habitat, together with the physical environment in which they live. ***Source***: Purves, Orians, Heller, Sadava (1998).

Environment—An organism's surroundings, both living and nonliving; includes temperature, light intensity, and all other species that influence the focal organism. ***Source***: Purves, Orians, Heller, Sadava (1998).

Fire management—Strategies for controlling and extinguishing fires/wildfires. ***Source***: Carle (2008).

Fire-safe landscaping—Designing a defensible space by using well-spaced fire-resistant plants and hardscape elements such as brick or stone walls to prevent heat and flames from reaching the structure. ***Source***: SAFE Landscapes (2009).

Fuel—Any combustible material, both man-made—such as wood fences, lumber, furniture, plastic, awnings, and cloth—and vegetative—such as grass, leaves, ground litter, plants, shrubs, and trees—that feeds a fire. ***Sources***: For vegetation: Carle (2008); for man-made materials as fuel: Los Angeles City Fire Department (2000).

Fuel management—Manipulating fuels to reduce the likelihood of ignition, reduce fire behavior, and/or lessen potential damage and resistance to control. ***Synonyms***: fuel modification, fuel reduction, wildfire fuel management. ***Source***: Carle (2008).

Habitat—The environment in which an organism lives. ***Source***: Purves, Orians, Heller, Sadava (1998).

Native—Occurring naturally in an area, not as either a direct or indirect consequence of human activity; indigenous; not alien. ***Source***: Hickman (1993). Note: Plants documented or assumed to have been in California at the advent of European exploration of the west coast of North America—around 1500 A.D.—are generally considered to be "native plants."

Plant community—An assemblage of individuals of one to many plant species distinct in structure and composition from other adjacent such groupings. ***Source***: Sawyer, Keeler-Wolf, and Evens (2009).

Vegetation—All the plant species in a region and the way they are arranged. ***Source***: Sawyer, Keeler-Wolf, and Evens (2009).

Vegetation management—Manipulation of plant species by humans to attain a goal or goals such as esthetics, economics, maintenance, restoration, pest/weed eradication, and/or fuel modification. ***Sources***: Carle (2008); Sawyer, Keeler-Wolf, and Evens (2009).

Wildland-urban interface (WUI)—The area where structures and other human development meet undeveloped wildlands and their fuels.

Source: Carle (2008). Note: WUI is easy to define qualitatively but it is so site-specific that WUI cannot be used to create quantitative regulations defining the width of fuel clearance zones in general.

SOURCE REFERENCES FOR LEGAL DEFINITIONS AND GLOSSARY OF TERMS

Cal Fire 2010a. Why 100 Feet? http://www.fire.ca.gov/communications/communications_firesafety_100feet.php (accessed January, 2010)

California FAIR Plan. 2010. California FAIR plan website. http://www.cfpnet.com/ (accessed January, 2010)

Carle, David 2008. *An Introduction to Fire in California.* University of California Press, Berkeley.

Hickman, James C. (ed.). 1993. *The Jepson Manual: Higher Plants of California.* University of California Press, Berkeley.

Los Angeles City Fire Department, 2000. Los Angeles Fire Department Fire Hazard Reduction and Safety Guidelines. LAFD Bureau of Fire Prevention and Public Safety, Brush Clearance Unit. Van Nuys, CA.

Purves, W.K., G.H. Orians, H.C. Heller, and D. Sadava. 1998. *Life: The Science of Biology*, 5th ed. Sinauer Associates, Inc. 23 Plumtree Road, Sunderland, MA. W.H. Freeman and Company, Salt Lake City, UT.

SAFE Landscapes. 2010. SAFE Landscapes, Sustainable and Fire Safe Website. http://groups.ucanr.org/SAFE/ (accessed February, 2010).

Sawyer, J.O., T. Keeler-Wolf, and J.M. Evens. 2009. *A Manual of California Vegetation,* 2d ed. California Native Plant Society, Sacramento CA.

Cal Fire 2006. Cal Fire Clearance Code: General Guidelines for Creating Defensible Space, February 8, 2006. http://www.fire.ca.gov/cdfbofdb/PDFS/4291 guidelines2_23_06.pdf (accessed January, 2010)

Cal Fire 2010a. Why 100 Feet? http://www.fire.ca.gov/communications/communications_firesafety_100feet.php (accessed January, 2010)

GENERAL REFERENCES

Cal Fire 2010b. The Wildland Urban Interface Building Code Information. http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_codes.php (accessed February, 2010).

California Codes, Public Resources Code (PRC) section 4291. http://www.leginfo.ca.gov/cgi-bin/displaycode?section+prc&group+04001-05000&file4291-4299 (accessed March, 2010)

California Fire Safe Council. 2010 Homeowner's Guide to Firewise Landscaping. http://www.firesafecouncil.org/homeowner/index.cfm (accessed February, 2010)

California Department of Forestry and Fire Protection, Office of the State Fire Marshal. 2010. Wildland Urban Interface Products. http://www.osfm.fire.ca.gov/strucfireengineer/pdf/bml/wuiproducts.pdf (accessed February, 2010)

Halsey, Richard W. 2008. *Fire, Chaparral, and Survival in Southern California,* 2d ed. Sunbelt Publications, Inc., San Diego, CA.

Keeley, J.E. 1981. Reproductive cycles and fire regimes. In *Proceedings of the Conference on Fire Regimes and Ecosystem Properties,* ed. H.A. Mooney, T.M. Bonnicksen, N.L. Christensen, J.E. Lotan, and W.A. Reiners, pp. 231-277. USDA Forest Service, General Technical Report WO-26.

Keeley, J.E. 1991. Resilience to fire does not imply adaptation to fire: an example from the California chaparral. *Proceedings of the Tall Timbers Fire Ecology Conference* 17:113-120.

Keeley, J.E., P.H. Zedler, C.A. Zammit, and T.J. Stohlgren. 1989. Fire and demography. In *The California Chaparral: Paradigms Re-Examined,* ed. S.C. Keeley, pp. 151-153. Science Series No. 34. Natural History Museum of Los Angeles County, Los Angeles, CA.

Los Angeles City Fire Department, 2000. Los Angeles Fire Department Fire Hazard Reduction and Safety Guidelines. LAFD Bureau of Fire Prevention and Public Safety, Brush Clearance Unit, Van Nuys, CA.

SAFE Landscapes. 2010. SAFE Landscapes, Sustainable, and Fire Safe Website. http://groups.ucanr.org/SAFE/ (accessed February, 2010).

Taylor, Alan H., and C.N. Skinner. 1995. Fire regimes and management of old-growth Douglas fir forests in the Klamath Mountains of northwestern California. In *Proceedings: Fire Effects on Rare and Endangered Species and Habitats Conference,* Nov. 13-16, 1995, ed. J.M. Greenlee, pp. 203-208. International Association of Wildland Fire, Fairfield, WA.

THE WILDLAND-URBAN INTERFACE FIRE PROBLEM

by Jack Cohen

The fire destruction of hundreds of homes associated with wildfires has occurred in the United States for more than a century. From 1870 to 1920, massive wildfires occurred principally in the Lake States but also elsewhere. Wildfires such as Peshtigo (Wisconsin, 1871), Michigan (1881), Hinckley (Minnesota, 1894), Adirondack (New York, 1903), the Big Blowup (Idaho-Montana, 1910), and Cloquet (Minnesota, 1918) extended across millions of acres, destroying towns and causing several thousand civilian fatalities (Pyne 1982). This period produced significantly greater destruction of property and lives than has occurred in the past 50 years.

More recently, the home destruction problem related to wildfires became nationally recognized in 1985 and has become known as the wildland-urban interface (WUI) fire problem. The initial fire management response to the WUI fire problem, principally organized by the U.S. Forest Service and the National Fire Protection Association, resulted in the 1986 Wildfire Strikes Home conference (Laughlin and Page 1986). The current national Firewise program developed out of that initiative (*www.firewise.org*). Since 2000, federal and state wildland fire management policy has recognized the WUI fire problem as a principal issue in a number of documents including the National Fire Plan (2000), Federal Wildland Fire Management Policy (2001), 10-Year Comprehensive Strategy (2001), and the Healthy Forests Restoration Act (2003).

Wildfire exclusion started as a prime directive in the early years of the U.S. Forest Service and became a broad national perspective. Chief Forester Henry Graves stated in 1913 that "the necessity of preventing losses from forest fires requires no discussion. It is the fundamental obligation of the Forest Service and takes precedence over all other duties and activities" (Pyne 1982). Although several prominent foresters and researchers, like Coert DuBois of the Forest Service and H.H. Chapman of Yale University, promoted the benefits of wildland burning in the 1920s and 1930s, the questioning of fire control policies was considered a threat to nationally organized forestry programs (Pyne 1982). For the next four decades the federal public land management policy largely addressed wildfires as unwanted—to be prevented, and if not prevented, to be suppressed at the smallest area possible (the fire exclusion paradigm).

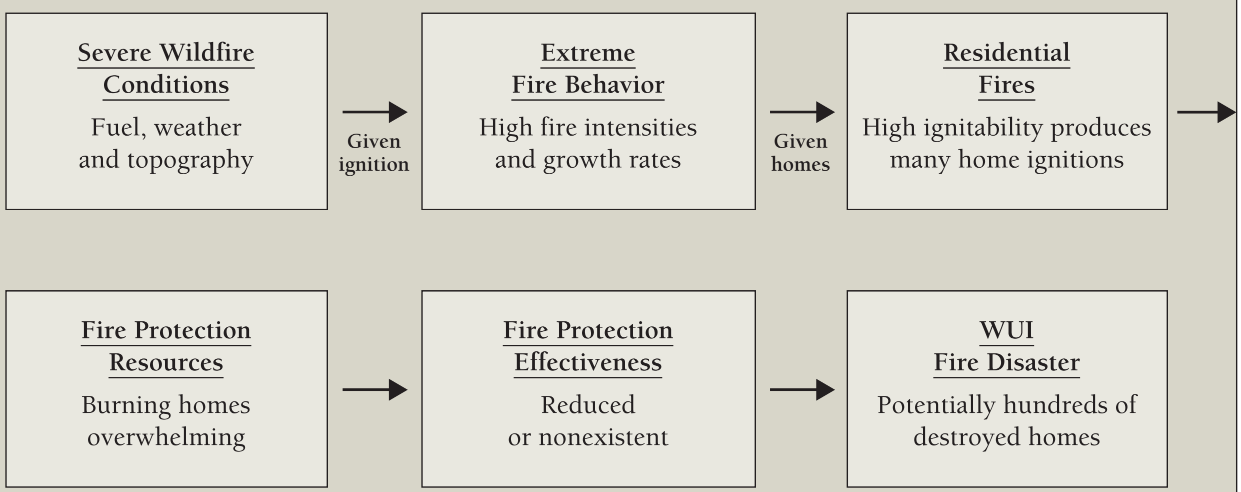
Federal policy began to recognize wildland fire as a historical, ecological factor in the late 1960s and early 1970s (Pyne 1982). Current policy recognizes that wildland fire can be an important ecological process and provides latitude for planned burning (prescribed fire) and designating unplanned fires as desirable. In practice, however, the nationwide total number of wildland fires suppressed as wildfires overwhelmingly dominates the fire occurrence statistics. For example, on federal lands the ten-year (1998–2007) average number of total wildland fires per year designated for suppression is approximately 80,000 occurrences, compared with 327 designated as desirable (National Interagency Fire Center).

Although some agencies have more management latitude in principle, the proportion of fires suppressed suggests that an exclusion

TABLE 1. WILDLAND-URBAN INTERFACE DISASTERS DURING EXTREME WILDFIRES (1990–2007)

Year	Incident	Location	Homes destroyed (approx.)
1990	Painted Cave	Santa Barbara, CA	479
1991	Spokane "Firestorm"	Spokane, WA	108
	Tunnel/Oakland	Oakland, CA	2900
1993	Laguna Hills Old Topanga	Laguna and Malibu, CA	634
1996	Millers Reach	Big Lake, AK	344
1998	Florida Fires	Flagler and Volusia Counties, FL	300
2000	Cerro Grande	Los Alamos, NM	235
2002	Hayman	Lake George, CO	132
	Rodeo-Chediski	Heber-Overgaard, AZ	426
2003	Aspen	Summerhaven, AZ	340
	Old, Cedar, etc.	Southern CA	3640
2006	Texas-Oklahoma Fires	Texas and Oklahoma	723
2007	Angora	Lake Tahoe, CA	245
	Witch, Slide, Grass Valley, etc.	Southern CA	2180

FIGURE 1. WILDLAND-URBAN INTERFACE FIRE SEQUENCE.



WUI fire disasters depend on the exposure of ignitable homes to the flames and firebrands of uncontrollable, extreme wildfires. Many burning and highly ignitable homes overwhelm firefighters, resulting in many homes without protection. If homes exposed to wildfire are ignition-resistant, then an extreme wildfire can occur without a WUI fire disaster.

approach largely continues. The term "fire exclusion paradigm" refers to this organizational culture and operational practice of preventing and suppressing nearly all wildland fires.

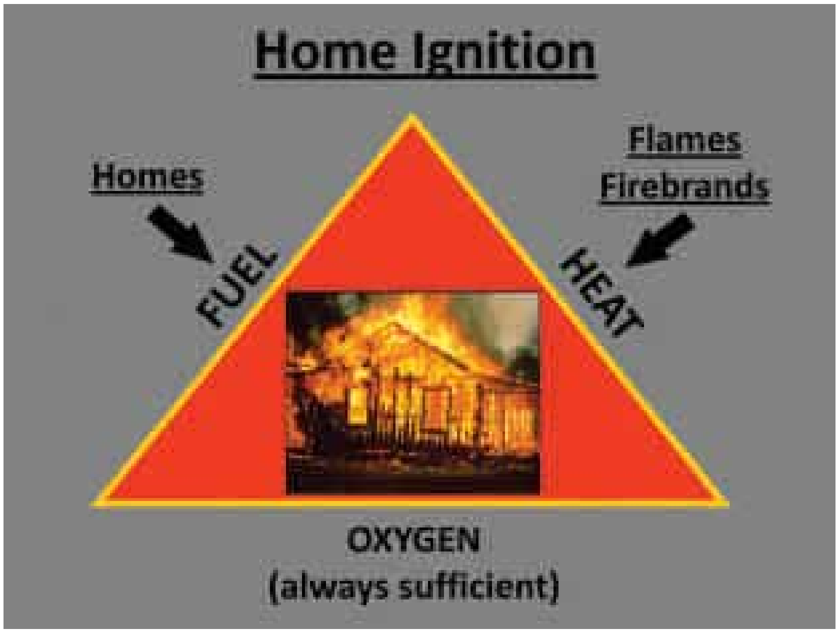
As a consequence of these practices, fire suppression has significantly contributed to the reduction of fire occurrence in most areas of the United States. The National Fire Plan report states, "As a result of the all-out effort to suppress fires, the annual acreage consumed by wildfires in the lower 48 states dropped from 40 to 50 million acres (16 to 20 million hectares) a year in the early 1930s to about 5 million acres (2 million hectares) in the 1970s" (USDA and USDI 2000). In some ecosystems, such as the ponderosa pine (*Pinus ponderosa*) forests in the western U.S., the reduction of fire occurrence has resulted in significant changes to the species composition and increases in the amount of live and dead vegetation (Arno and Brown 1991; Finney and Cohen 2003). Furthermore, it has been shown that in many areas aggressive fire suppression over many years has contributed to reduced fire occurrence that has led to increased fuels and changed fuel composition and arrangements. In turn, that has contributed to the extensive areas of high intensity wildfires experienced in recent years (USDA and USDI 2000).

DEFINING DISASTER

One might assume there is an unbreakable link between increasing wildfire extent and intensity and increasing WUI residential fire destruction. However, we cannot assume extreme wildfires directly cause WUI fire disasters; these disasters depend on homes igniting during wildfires. Certainly extreme wildfires initiate ignitions within residential areas, but if homes do not ignite and burn during wildfires, then the WUI fire problem largely does not exist.

Widespread WUI home destruction during wildfires does not occur when normal wildfire control and structure protection capabilities limit the fire spread. Wildland fire suppression operations successfully control 97–99% of all wildfires with the initial response (Stephens and Ruth 2005), and firefighters typically limit a fire to a single structure or prevent the fire from spreading beyond that structure. However, big flames and extensive showers of burning embers (firebrands) resulting from high intensity fires over broad areas (referred to as "extreme wildfire conditions") is not a typical situation. When residential development is exposed to extreme wildfire conditions numerous houses can ignite and burn simultaneously, overwhelming firefighters and reducing fire protection effectiveness. WUI fire disasters principally occur during these extreme wildfire conditions that account for the one to three percent of wildfires that escape control (Menakis et al. 2003). Table 1 lists WUI fire disasters between 1990 and 2007. Every one of these disasters occurred because extreme wildfire conditions overwhelmed firefighters attempting wildfire control and firefighters attempting to protect structures.

FIGURE 2. THE FIRE TRIANGLE



Home ignitions depend on a sufficiency of FUEL, the flammable parts of a home, and HEAT, the flames and firebrands of all objects burning around a home. OXYGEN will always be sufficient for home ignitions.

The WUI fire disaster context can be generally described as a set of contingencies (Figure 1). The disaster sequence starts when a wildfire or multiple wildfires burn during extreme fire conditions. The combination of extreme vegetation, weather, and topographic conditions given a fire start produces fast-spreading, intensely burning fires that overwhelm wildfire suppression efforts. If extreme wildfire spreads close enough to residential development with its flames and firebrands, hundreds of ignitable homes can be simultaneously exposed.

Although protection may be effective for some homes, an extreme wildfire's high intensities and rapid spread combine to produce broad residential fire exposures that potentially ignite many houses and jeopardize firefighters' safety. This prevents fire protection for many structures. With homeowners likely evacuated and firefighters unable to protect every house, small, easy-to-extinguish ignitions can result in total home destruction.

If homes are sufficiently resistant to ignition and do not ignite when exposed to extreme wildfire, the homes survive with little to no firefighter protection; we have an extreme wildfire but not a WUI fire disaster. Thus, the occurrence of WUI fire disasters principally depends on home ignition potential.

Homes ignite and burn by meeting and sustaining the requirements for combustion. Fire is a process that requires a sufficiency of fuel, heat, and oxygen to continue. The fire process is graphically represented by the "fire triangle" (Figure 2). For the WUI fire context, the house is the "fuel" and all burning objects surrounding the house (vegetation and other structures) are the "heat." In this context oxygen will always be sufficient. During extreme WUI fires the requirements for combustion can be met, resulting in home (fuel) ignitions in two principal ways: 1) direct flame heating—radiation and

This historical photo series from western Montana (Smith and Arno 1999) shows how an initially open forest (with management activity) dominated by ponderosa pine (*Pinus ponderosa*) became increasingly vegetated by predominantly Douglas fir (*Pseudotsuga menziesii*), a

convection (flame contact), and 2) firebrands collecting on flammable house surfaces (burning ember spot ignitions) (Cohen and Wilson 1995; Cohen 2000a).

Research indicates that WUI fire destruction occurs principally due to conditions local to destroyed homes. Computational modeling and laboratory and field experiments that describe the heat transfer required for ignition have shown that the large flames of burning shrubs and tree canopies (crown fires) must be within 100 feet to ignite a home's wood exterior (Cohen and Wilson 1995; Cohen 2000a; Cohen 2004). Actual case examinations find that extreme wildfire behavior does not occur within most residential areas (Cohen 2000b; Cohen and Stratton 2003; Cohen and Stratton 2008). Unconsumed vegetation surrounding most destroyed homes and generally throughout burned residential areas indicates home ignitions occur from lower intensity surface fires spreading to contact a home and from firebrands contacting the flammable surfaces of a house.

Computations, experiments, and disaster examinations show that a home's ignition potential during extreme wildfire is principally determined by the characteristics of a home's exterior materials, design, and associated flammable debris related to surrounding burning objects within 100 feet (30 meters) and firebrands (lofted burning embers). I call this area—a home and its immediate surroundings—*the home ignition zone* (HIZ). Thus, given an extreme wildfire, the HIZ principally determines the potential for home ignition and this reveals opportunities for preventing WUI fire disasters.

PREVENTING DISASTER

The above research suggests an alternative for preventing disastrous home destruction without the necessity of controlling wildfires under extreme conditions. Addressing conditions within the HIZ can significantly reduce the home ignition potential. Thus, given ignition-resistant homes, extreme wildfires can spread to residential areas without incurring WUI fire disasters. To date, however, WUI ignition resistance has not been the primary approach used by most federal, state, and local fire agencies to prevent disastrous WUI fire destruction. Although the HIZ approach for preventing WUI fire disasters has been adopted by the national Firewise program (*www.firewise.org*), fire suppression with a focus on the wildfire and fuel treatment outside the home ignition zone still remains the principal approach.

For example, the U.S. Departments of Agriculture and Interior produced a report in response to the home destruction (principally at Los Alamos, NM) and wildfires of 2000 that became known as the National Fire Plan (USDA and USDI 2000). This report designated fire suppression at the federal, state, and local levels as the first priority. Several years later a multiagency plan was developed called the 10-Year Comprehensive Strategy (Western Governors Association 2006). This plan is currently in effect and promotes multi-agency collaboration for reducing wildfire risks, including the risk of WUI fire disasters. The first goal of the strategy directs the improvement of wildfire prevention and suppression. In general, the 10-Year Comprehensive Strategy promotes a fire suppression approach for preventing WUI fire disasters without consideration for home ignition potential and the HIZ as a key component (Western Governors Association 2006).

Vegetation fuel reduction treatments, as reported in the Healthy Forests Report of May 2007, also

change in forest type and density. Historically, such a site had frequent fire occurrence every decade or so that maintained ponderosa pine in a more open condition. All photographs courtesy of U.S. Forest Service, Rocky Mountain Research Station.

ABOVE: **Unconsumed vegetation adjacent to four destroyed homes in this view indicates ignitions from lower intensity surfaces fires and/ or firebrands directly igniting homes.** • TOP RIGHT: **This condition typically prevails across entire residential areas of WUI fire destruction. The areas of consumed canopy vegetation in this scene are related to homes burning.** • BOTTOM RIGHT: **High intensity fire spread in the tree canopy (crown fire) stopped at this residential street and did not continue as crown fire. However, all of the structures for several more blocks burned.**

point to the widespread use of a wildfire modification and control approach that does not address a home's ignition potential, but rather focuses on areas outside the HIZ (USDA and USDI 2008). Fuel treatments in the vicinity are expected to protect homes by creating conditions that enable successful fire suppression. Wildfire operations appear to be consistent with the above policy as indicated by the significant U.S. Forest Service expenditure of suppression resources for WUI protection. A November 2006 Office of Inspector General report (USDA 2006) on large wildfire suppression costs documents this practice:

> FS managers and staff stated that WUI protection was the major driver of FS suppression costs, with some staff estimating that between 50 to 95 percent of large wildfire suppression expenditures were directly related to protecting private property and homes in the WUI….When FS protection responsibilities are directly adjacent to WUI development, FS line officers feel compelled to aggressively suppress wildfires because the fires threaten privately-owned structures, even if the fires pose no threat to FS resources.

These findings are consistent with Forest Service Manual directives regarding WUI fire protection. Section 5137 of the manual defines Forest Service structure protection measures in terms of wildfire control (USFS 2004). "The Forest Service's primary responsibility and objective for structure fire protection is to suppress wildfire before it reaches structures." The evidence from policy documents, fire management operations, and manual directives indicates that wildfire suppression and activities in support of suppression constitute the principal approach for preventing disastrous residential fire destruction. Yet the evidence of disastrous WUI fire occurrence suggests that reasonable levels of fire suppression cannot prevent these disasters.

The inevitability of wildfires—including the extreme wildfires that account for the one to three percent of the fires that escape control—is axiomatic. But WUI fire disasters occur during this one to three percent of uncontrollable wildfires. This might suggest the inevitability of WUI fire disasters; however, research shows it is the HIZ that principally determines the potential for WUI fire disasters. The continued focus on fire suppression largely to the

exclusion of alternatives that address home ignition potential suggests a persistent inappropriate framing of the WUI fire problem in terms of the fire exclusion paradigm.

Preventing WUI fire disasters requires that the problem be framed in terms of home ignition potential and not fire exclusion. Because this principally involves the HIZ, and the HIZ primarily falls within private ownership, the responsibility for preventing home ignitions largely falls within the authority of the property owner. If we are to prevent extensive home destruction within the WUI, property owners must become engaged, matching their authority over the HIZ with the responsibility to create ignition resistant homes. Fire agencies can reinforce the necessity of property owner engagement as well as facilitate property owners in reducing the ignition vulnerability of their homes.

REFERENCES

Arno S.F., and J.K. Brown. 1991. Overcoming the paradox in managing wildland fire. *Western Wildlands* 17(1): 40-46.

Cohen J.D., and P. Wilson. 1995. Current results from structure ignition assessment model (SIAM) research. In Proc. of the Fire Management in the Wildland/Urban Interface: Sharing solutions Symposium, Oct. 2-5, 1994, Kananaskis, AB, ed. C. Tymstra C. Partners in Protection, Edmonton, AB.

Cohen J.D. 2000a. Preventing disaster: Home ignitability in the wildland-urban interface. *Journal of Forestry* 98(3): 15-21.

——. 2000b. A brief summary of my Los Alamos fire destruction examination. *Wildfire* 9(4): 16-18.

Cohen J.D., and R.D. Stratton. 2003. Home destruction. In Hayman Fire Case Study. Gen. Tech. Rep. RMRS-GTR-114, ed. R.T. Graham. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT.

Cohen J.D. 2004. Relating flame radiation to home ignition using modeling and experimental crown fires. *Canadian Journal of Forest Research* 34: 1616-1626.

Cohen J.D., and R.D. Stratton. 2008. Home destruction examination: Grass Valley Fire. Technical Paper, R5-TP-026b. USDA Forest Service, Region 5, Vallejo, CA.

Finney M.A., and J.D. Cohen. 2003. Expectation and evaluation of fuel management objectives. RMRS-P-29, USDA Forest Service.

Laughlin J., and C. Page, eds. 1987. Wildfire strikes home! Report of the national wildfire/urban fire protection conference. NFPA SPP-86. National Fire Protection Association, Quincy, MA.

Menakis J.P., J.D. Cohen, and L. Bradshaw. 2003. Mapping wildland fire risk to flammable structures for the conterminous United States. In Proc. of fire conference 2000: The first national congress on fire ecology, prevention, and management, ed. K.E.M Galley, R.C. Klinger, and N.G. Sugihara. Misc. pub. 13. Tall Timbers Research Station, Tallahassee, FL.

National Interagency Fire Center. Wildland fire statistics. http://www.nifc.gov/fire_info.

Pyne, S.J. 1982. *Fire in America.* University of Washington Press, Seattle, WA.

Smith H.Y., and S.F. Arno, eds. 1999. Eighty-eight years of change in a managed ponderosa pine forest. Gen. Tech. Rep. RMRS-GTR-23. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT.

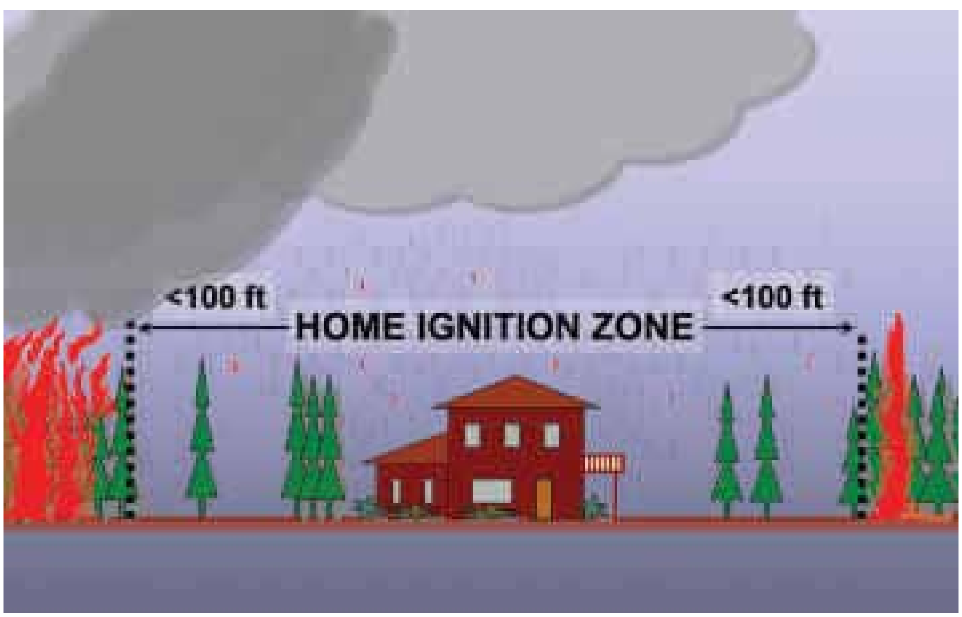
Stephens S.L., and L.W. Ruth. 2005. Federal forest fire policy in the United States. *Ecological Applications* 15(2): 532-542.

U.S. Department of Agriculture. 2006. Office of Inspector General audit report: Forest Service large fire suppression costs. Report no. 08601-44-SF.

U.S. Department of Agriculture, U.S. Department of Interior. 2000. Managing impact of wildfires on communities and the environment: A report to the president in response to the wildfires of 2000.

U.S. Department of Agriculture, U.S. Department of Interior. 2008. Healthy forests and rangelands, Healthy Forests Report.

U.S. Department of Agriculture. 2004. Forest Service Manual, Title 5100, Fire Management, Sections 5137 and 5137.02. Western Governors Association. 2006. A collaborative approach for reducing wildland fire risks to communities and the environment: 10-year comprehensive strategy implementation plan. Western Governors Association.



The home ignition zone (HIZ) is the area that principally determines a home's ignition potential during extreme wildfires when active fire protection is unlikely. It is the fire behavior within the HIZ, about 100 feet or less in relation to a home's ignition vulnerability, that principally determines ignition potential. Firebrands, regardless of travel distance, are a significant ignition factor, but only based on the HIZ characteristics. The firebrand ignition threat depends on spot ignitions within the HIZ that can burn to contact a house or collect on a home's flammable surfaces, all HIZ conditions.

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Two contrasting vegetation alliances with chamise (*Adenostoma fasciculatum*) and whiteleaf manzanita (*Arctostaphylos viscida*). Chamise will both resprout from the base and germinate from seeds while this manzanita only germinates from seeds following fires. Photograph by T. Keeler-Wolf.

INTERPRETING FIRE AND LIFE HISTORY INFORMATION IN *THE MANUAL OF CALIFORNIA VEGETATION*

by Todd Keeler-Wolf, Julie M. Evens, and John O. Sawyer

Fire is a pervasive force impacting the composition and structure of vegetation throughout most of California. As discussed throughout this issue of *Fremontia,* fire has shaped our state's flora and is one of the major natural processes regularly affecting our ability to coexist with nature. Here we consider changes in *The Manual of California Vegetation* (MCV2) as they relate to fire.

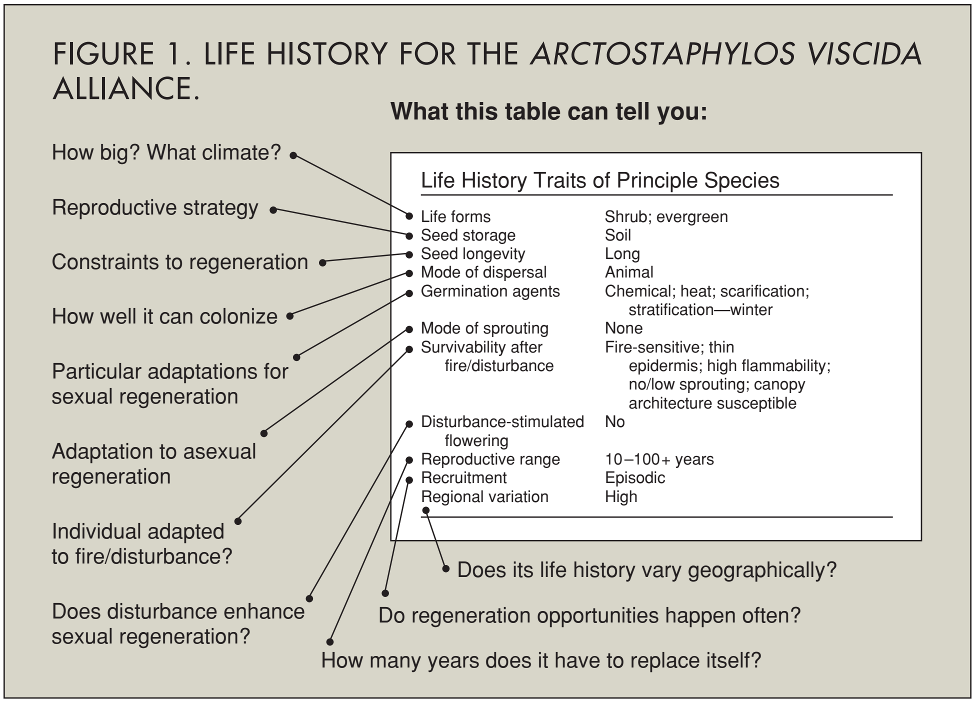

FIGURE 1. LIFE HISTORY FOR THE *ARCTOSTAPHYLOS VISCIDA* ALLIANCE.

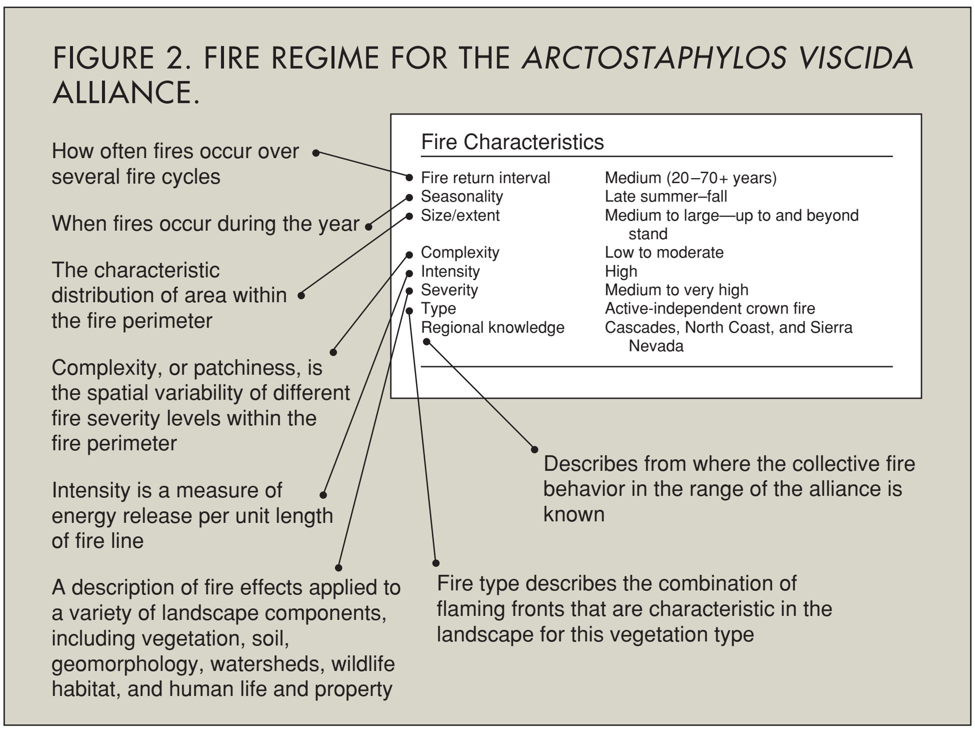

FIGURE 2. FIRE REGIME FOR THE *ARCTOSTAPHYLOS VISCIDA* ALLIANCE.

A major reason for preparing a second edition was to provide more useful descriptions of the state's natural vegetation so that we can better preserve it. Principally, we thought to improve the book's utility by including life history and fire behavior characteristics for each of the more than 380 main California vegetation types, which are known formally as "alliances." The life history of the main distinguishing plant species (bolded in the first line of an alliance's description), coupled with a summary of the natural processes affecting it, explain the conditions that enable the alliance to exist. In a sense, it is akin to having a general "recipe" for sustaining each alliance listed in the book, although this "recipe" must be thought of as broadly defined and not subject to precise measurements.

In each full alliance description there are two separate tables with accompanying text—one for the life history traits of the distinguishing plant species and another for the associated fire regime for that alliance. The logic behind the two tables addresses the tendency of distinguishing plant species of an alliance to have specific abilities that are adapted to a set of specific environmental and ecological conditions. For example, a desert scrub type defined by creosote bush (*Larrea tridentata*) will respond very differently to fire than a chaparral type defined by chamise (*Adenostoma fasciculatum*), even though both shrubs are similar in size and have small evergreen leaves.

The conditions under which an alliance can persist depend, to a great degree, on adaptations of the distinguishing species (its longevity, germination requirements, general morphology, and other genetically controlled traits) **plus** the type, frequency, and intensity of the natural processes associated with that vegetation over time. If conditions change sufficiently beyond the distinguishing species' general range of tolerance, then the vegetation will also change as a reaction

Open stand of Creosote Bush (*Larrea tridentata*) Alliance with an understory including red brome (*Bromus madritensis* ssp. *rubens*) and Mediterranean grass (*Schismus* spp.). Recent invasion by non-native grasses increase the risk of this vegetation burning. Photograph by T. Keeler-Wolf.

to the new processes. Taken more broadly, by comparing characteristics of multiple vegetation types within a large parcel of land or watershed, we can begin to understand how its diversity has changed, or has not, under current conditions. In addition, we can better understand how to conserve its diversity by grasping the role of fire and other natural processes at the landscape level.

HOW WE PRESENT THE INFORMATION

With help from members of the U.S. Forest Service's Joint Fire Sciences Program, we held a series of five regional workshops around the state between 2000 and 2003. At these meetings, we collectively considered the longevity, germination requirements, general morphology, and other genetically controlled traits for each distinguishing plant species and the type, frequency, and intensity of fire or other natural processes associated with a set of alliances in that region. We used this information, together with literature surveys and detailed interviews with other fire ecologists, in developing the two tables for each alliance. All told, over 50 professional ecologists, land managers, and other scientists contributed to the information in these tables, in addition to information derived from scores of publications.

The categories in the Life History Table (Figure 1) summarize essential traits for distinguishing species that define an alliance. These traits comprise the "code" or the basic set of advantages and constraints of plants that allow them to interact with their current environment. Some of these traits are evolutionarily conservative and unvarying, while others are more pliable and may vary throughout the range of the species. This last notion is captured in the category "regional variation."

The concept behind the Fire Regime Table (Figure 2) is to describe the fire characteristics for each alliance with respect to temporal (fire return, seasonality), spatial (fire size, complexity), and magnitude (fire intensity, severity, type) attributes using the currently authoritative book on California fire ecology (Sugihara et al. 2006). The resulting fire regime information describes fire conditions favorable to the plant species that define the alliance.

It is important to note that wildfires can burn across whole landscapes. Fires are often impartial to biologically defined boundaries; one fire often impacts several adjacent stands of many other alliances in the burned areas. However, the biological and physical characteristics of each stand of vegetation can *also* affect how the fire burns; in some cases a fire may burn only portions of a single stand or lots of stands of many alliances. Fire is also not a completely regular and predictable event, and it may occur at different times of the year, and at different frequencies, affected by seasonal weather, topography, geography, yearly variances in plant productivity, and human influences.

However, we cannot determine exact fire return intervals (e.g., how frequently fire affects a particular stand of vegetation) for each alliance for two main reasons. We often do not have enough data on plant responses to fire to arrive at precise fire return intervals. More importantly, natural processes such as fire influence the character of the vegetation depending on the time between events (whether a relatively short or long interval), and the pattern of the events (whether a mild understory surface or an intense crown fire). These two variables, in turn, affect the composition and structure of the resulting vegetation. So, we assign general terms (e.g., short, medium, long) in the tables. These are often

LEFT: **Fires significantly reduce the shrub cover, and species such as the matchweed (*Gutierrezia* spp.) and non-native grasses that thrive following disturbances dominate for many years afterwards before creosote can recover. • BELOW: Bigpod ceanothus (*Ceanothus megacarpus*) occurs in a patchwork with other chaparral in the Santa Monica Mountains in Ventura County, where fire and other disturbance modify the nature of stands. Photographs by J. Evens.**

supplemented by a range of years for the shorter and the longer averages of time between fires, when this information is known from observations. The fire types listed (defined in Appendix 2 of MCV2) also may vary depending on the character of the vegetation and its geographic location.

It is important to note that the statements on fire return intervals should not be taken out of context, particularly since they may be used to make decisions about land management. For example, when interpreting these parenthetical ranges in a fire return interval, one should not strictly select an upper or lower value or the calculated mean between the extremes. We present these ranges as broad guides, not as stringent and literal rules. A good case in point can be illustrated by chaparral stands containing species with different adaptive strategies, such as white leaf manzanita (*Arctostaphylos viscida*), an obligate seeding shrub, and birch leaf mountain mahogany (*Cercocarpus montanus*), a resprouting shrub. Keeley et al. (2005) have found that stands of these species are tolerant of long fire-free periods, and even 100+ year-old stands show no perceptible reduction in their ability to recover following fire.

With the standardized attributes presented in the life history and fire regime tables, users may apply the information in the book to a given patch or stand of vegetation to help answer a series of questions. For example, are the factors that influence its effective reproduction, recruitment, and regeneration being met in this stand, so there is a high likelihood of the vegetation's persistence (Figure 1)? Such questions are relative to the recent history of the particular stand. Since fire history is a principal influential natural process that impacts the viability of vegetation stands in California, the fire regime table (Figure 2) is also helpful in answering these questions.

FIGURE 3. THE LIFE HISTORY AND FIRE REGIME TABLES OF *LARREA TRIDENTATA–AMBROSIA DUMOSA* ALLIANCE.

Life History Traits of Principle Species

	Larrea tridentata	*Ambrosia dumosa*
Life forms	Shrub; drought deciduous	Shrub; drought deciduous; clonal
Seed storage	Soil	Soil
Seed longevity	Medium	Medium
Mode of dispersal	Animal; gravity wind	Animal; tumbling
Germination agents	Chemical; heat	None
Mode of sprouting	Underground structures	Underground structures
Survivability after fire/disturbance	Fire-sensitive; no/low sprouter	Fire-sensitive; no/low sprouter

Fire Characteristics

Fire return interval	Truncated long
Seasonality	Spring–summer–fall
Size/extent	Small to moderate
Complexity	Low
Intensity	High
Severity	Moderate
Type	Passive-active crown fire

Note: Additional information in these tables can be found in the MCV2

For example, the life form (tree, shrub, herbaceous plant) and the particular genetic traits of the species (e.g., seed storage, mode of sprouting, and survivability after fire) clearly influence the species' perseverance under certain fire characteristics. Fire type, the interval between fires, fire intensity, and the other characteristics synthesized in each fire regime table expresses the physical, temporal, and spatial effects of fire on the vegetation of each alliance. Taken together, these tables can be used to interpret the ecological status of any stand of vegetation and understand how it has been impacted by fire.

It is also important to remember that many stands in California have persisted for thousands of years without regular influence by fire. Only relatively recently has fire become frequent in some areas with the introduction of nonnative weedy plants along with human-instigated fires. For example, increased fire frequencies have altered much of the vegetation in California's warm deserts. A classic example involves a widespread alliance, the *Larrea tridentata–Ambrosia dumosa* Alliance. A quick look at the life history and fire regime tables for this alliance will tell you how troublesome frequent fire can be (Figure 3).

The fire characteristics found in Figure 3 are from page 567 in the *Manual*. Both *Ambrosia dumosa* and *Larrea tridentata* exhibit limited sprouting ability after fire, and *L. tridentata* has resinous foliage that is highly flammable (Vasek 1979, 1983, Marshall 1995b). Low-intensity fires can cause up to 100% mortality in both *L. tridentata* and *A. dumosa*, but some shrubs can survive if crowns are only partially consumed. Mortality rates are probably related to rainfall conditions during the immediate post-fire years, and both species may colonize successfully by seed from offsite sources in high rainfall years following a fire (Brooks and Minnich 2006). However, *A. dumosa* can colonize more rapidly after fire and may dominate alone for a number of years before both *L. tridentata* and *A. dumosa* regain similar pre-fire dominance.

ANOTHER EXAMPLE

Big pod ceanothus (*Ceanothus megacarpus*) is a classic obligate seeding chaparral shrub of southern California. It typically dies after the normally intense fires of the region. Yet as with *Arctostaphylos viscida* (Figure 1), seeds of the ceanothus are stored in the soil. Seedlings germinate within a few years after fire under natural fire regimes, and grow quickly to replace previously burned stands, sometimes preceded by short-lived stands of disturbance followers like deer weed (*Lotus scoparius*).

Large acreages of big pod ceanothus (pp. 452-543 in MCV2) have covered the Santa Ynez, Santa Monica, and other coastal mountains in the past, yet stands are less extensive today, even in areas that still are covered with natural vegetation. Why? A likely reason is that human-initiated fires are occurring more frequently than *C. megacarpus* stands can build up the necessary banks of soil-stored seeds for stands to regenerate. As with other chaparral shrubs, larger ceanothus plants can produce many seeds. While ceanothus may start producing some seeds from small young shrubs, if fires occur when the shrubs are relatively young, fewer seeds are likely to be stored in the soil. If fires occur every few years, just after young ceanothus are first producing seeds, it may only take a few successive close-interval fires to deplete the seed bank.

By properly interpreting the MCV2, readers will notice that while this ceanothus' fire return interval is estimated to average between 25 and 55 years, the plant is reproductively viable from 10 to 100+ years. Thus, a fluctuating fire return interval between the youngest reproductive age (about 10 yrs.) and oldest age (100+ yrs.) is reasonable. Repeat fires at the short end of the reported range (ex., between 10 and 25 yrs.) are much less likely to ensure stand regeneration than longer intervals (> 25 yrs.). Thus, understanding the natural history of diagnostic vegetation species and the effects of unnatural fire regimes on native vegetation is extremely important to long-term ecosystem viability.

SUMMARY AND CONCLUSIONS

We include the new tables and text in the *Manual* as guides for conservationists, natural historians, and land managers, so that mosaics of natural vegetation can be interpreted and information can be used appropriately within an ecological context. This information, in many cases, has been summarized for the first time in our book, and was assembled from a wide variety of sources including published and peer-reviewed literature and interviews with knowledgeable experts. Fire ecology is a rapidly expanding field and much new information is coming to light even since the publication of the MCV2.

Sometimes older assertions in the literature are in direct conflict with recent findings. For example, chemicals that accumulate in the soil from chamise chaparral (*Adenostoma fasciculatum* Alliance) do not appear to negatively impact the community of plants as once thought. Furthermore, these chemicals do not cause stand stagnation, but rather can increase after fire (Keeley et al. 1985, Halsey 2004, and summarized in McMurray 1990). As research of life history and fire regime characteristics continues to expand, our tables and descriptions must be updated. We seek any information that will improve our descriptions, and are planning to produce an online version of the *Manual* so it can be updated periodically.

SELECTED REFERENCES

Keeley, J.E., B.A. Morton, A. Pedrosa, and P. Trotter. 1985. Role of allelopathy, heat, and charred wood in the germination of chaparral herbs and suffrutescents. *Journal of Ecology* 73: 445-458.

Halsey, R.W. 2004. In search of allelopathy: An eco-historical view of the investigation of chemical inhibition in California coastal sage scrub and chamise chaparral. *Journal of the Torrey Botanical Society* 131: 343-367.

Keeley, J.E., A.H. Pfaff, and H.D. Safford. 2005. Fire suppression impacts on postfire recovery of Sierra Nevada chaparral shrublands. *International Journal of Wildland Fire* 14: 255-265.

McMurray, N. 1990. *Adenostoma fasciculatum.* In *Fire Effects Information System*. USDA, Forest Service, Rocky Mountain Research Station. http://www.fs.fed.us/database/feis/

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Invasive grasses and forbs have invaded this fuel break in the Santa Ynez Mountains above Santa Barbara. Photograph by C. D'Antonio.

INVASIVE SPECIES AND FIRE IN CALIFORNIA ECOSYSTEMS

by Adam M. Lambert, Carla M. D'Antonio, and Tom L. Dudley

Invasive plant species occur throughout all floristic regions of California, but their spatial extent, diversity, and impacts within these regions vary considerably. Alterations of natural disturbance regimes have made communities more susceptible to these invasions (Brooks et al. 2004). Fire is a natural and chronic disturbance in many California plant communities and has been observed to promote and be promoted by invasive species in several of the communities.

Fire regimes—the type, frequency, intensity and timing of fire—have played an important role in the evolution of California plant communities, but human influences have changed fire regimes, sometimes in ways that shift the relative dominance of native and non-native species. Invasive plants may be directly responsible for changes in fire regimes through increased biomass, changes in the distribution of flammable biomass, increased flammability, and altered timing of fuel drying, while others may be "fire followers" whose abundances increase as a result of shortening of fire return intervals.

California's shrublands, woodlands, grasslands, wetlands, and forests occupy different elevation and moisture zones, creating unique fire regimes that have benefitted particular invasive species. Plant associations that differ in physiognomy, fire regimes, and fuel types may vary in their resistance and resilience to fire. Fire regimes have been best studied in conifer forests and shrublands, but are poorly understood in California's grasslands. The role of fire in riparian or other wetland systems is particularly poorly known, presumably because these habitats have long been considered barriers to fire due to the high moisture content of soil and vegetation.

Most evidence indicates that the strongest impacts of invasive plants on fire regimes in California occur in coastal sage scrub, deserts, and riparian areas. The subject of how fire regimes are being changed in these systems will be addressed later on. In general, one of the least reversible and most significant impacts on native species occurs when introduced plant species alter the frequency of fire. In the intermountain west, cheatgrass (*Bromus tectorum*) has affected more areas than any other invasive plant. Plant ecologists observed in the mid-1900s that invasion by cheatgrass increased fire frequencies by creating continuous standing fuel between shrubs in these lightning-prone habitats. This, in turn, has led to a decline in native species and increased invasion by cheatgrass, setting in motion a cycle that is difficult to break.

For example, work by Steve Whisenant, now at Texas A&M University, quantified alterations in fire frequency and the dramatic loss of native species in Idaho's Snake River Plains as a result of lightning-caused summer fires fueled by dead cheatgrass. Could this happen in California? Red brome (*Bromus madritensis* ssp. *rubens*) and other invasive annual grasses increase fire frequencies in the western Mojave Desert in California, and cheatgrass has been part of the fuel in sagebrush fires in the Owens Valley. But so far, few sites have burned multiple times and it is not yet clear if a grass/fire cycle as has developed in the central Great Basin will develop in the California deserts.

The California Invasive Plant Council plant inventory lists 104 species that have the potential to alter fire dynamics or whose abundance is increased following fire. However, for many of these species, there is little published evidence to corroborate these accounts. Some of these species most likely influ-

Purple veldtgrass (*Ehrharta calycina*) in burned coastal sage scrub site at Vandenberg Air Force Base, approximately 15 years after fire. Fire is a natural disturbance in these ecosystems, but *Ehrharta* regenerates very rapidly after fire and appears to suppress the recovery of native species. Photograph by C. D'Antonio.

Abundant invasive, nonnative annual grasses growing between and within a stand of native species at a recently burned chaparral site in Ronald W. Caspers Wilderness Park, Orange County. Photograph by C. D'Antonio.

ence some aspect of fire regimes, but many may not. Here, we focus on the invasive plants that are well known for their interaction with fire, and provide case histories of invasion by the most problematic of these plants in the major upland and wetland ecosystems of California. We primarily address those invasive species that appear to alter fire regimes, rather than focusing on the many more non-native species that appear to opportunistically benefit from the presence of fire in our landscapes.

SHRUBLANDS

When one thinks of fire in California, one immediately thinks of the massive conflagrations that occur in central and southern California chaparral and sage-scrub ecosystems, particularly because of their close proximity to dense population centers. These closed-canopy shrublands—particularly intact chaparral—are in fact relatively resistant to invasion by non-native species. However, non-native plants are increasingly closely tied to fire dynamics and to ecosystem responses to fire in some regions.

Under natural conditions, chaparral communities retain most fuels in the canopy layer and have relatively long fire intervals (greater than 20 years). Contrary to common perception, foliar tissue does not easily ignite except under super-heated conditions or when leaf tissue moisture is low. However, several weedy forbs and grasses tend to thrive at the disturbed edges of these shrublands along roads, power lines, and fuel breaks where shrubs are removed. The invasive, annual grasses that often colonize these areas dry out much earlier in the spring than the native shrubs, and with their high surface area to volume ratio, are more prone to ignition than the native vegetation. Mediterranean grasses such as *Bromus* species and slender oats (*Avena barbata*) are particularly implicated since they act as wicks, spreading fast-moving fire into the canopies of larger shrub vegetation.

Monotypic giant reed stand (*Arundo donax*) in the Santa Clara River, Ventura County. A human-initiated fire burned through several kilometers of the riparian zone, fueled primarily by giant reed. The dead trees remaining are cottonwoods and willows. Photograph by A. Lambert.

Human activity also tends to be focused on these edges, making ignition far more likely to occur. (Lightning is uncommon in these systems and is rarely implicated in ignitions except at high elevations.) Jon Keeley and others have noted that the frequency of ignition has dramatically increased as a consequence of human activity, and the presence of these weedy plants exacerbates this interaction. In essence, the widespread presence of annual grasses—both because of their earlier seasonal drying compared to shrubs and their high surface area to volume ratio—has enhanced the volume of readily ignitable fuel and increased the seasonal duration when fuels are readily susceptible to ignition.

At historic fire frequencies, shrublands are generally resilient to fire. Chaparral species are well-known to regenerate from both resprouting of perennial root crowns and germination of seeds in the soil when heated and/or exposed to smoke. But increasing fire frequencies in these systems, especially near urban centers, has led to a loss in native species that rely on seed regeneration due to insufficient recovery time between fires for shrubs to reach reproductive age. For example, researcher Anna Jacobsen, who studied repeated short-interval fire in the Santa Monica Mountains, has found that return intervals of less than 12 years cause substantial reductions in shrub densities, including loss of obligate seeding shrubs and a decline in some of the resprouter species. The eventual result is a habitat that contains an open mosaic of exotic annual grasses and a few resprouting shrubs. Thus, increased fire frequency results in a conversion of native shrublands to a more open, grass-invaded system with scattered woody plants. The application of prescribed fire for "brush removal" in wildlands similarly contributes to counterproductive vegetation type conversion.

Shrublands along California's

Tamarisk resprouting following a fire at the Cibola National Wildlife along the lower Colorado River. Photograph by A. Lambert.

foggy central coast are also affected by an increase in the abundance of the fire-responsive African perennial veldtgrass (*Ehrharta calycina*). This species was introduced at least 40 years ago for erosion control in sandy soils. It produces relatively continuous fuel that promotes the spread of fire through coastal chaparral and sage scrub, but it also responds rapidly to fire. This species also promotes fire and it increases in density following fire in similar Mediterranean climate areas of Southwest Australia. The result in California is that many habitats which burned either in accidental or prescribed fires are becoming heavily dominated by low diversity stands of veldtgrass. This conversion is most apparent on Vandenberg Air Force base where *Ehrharta* was widely planted in the 1900s and has spread widely. Such coastal chaparral and shrublands on unique marine terrace soils (in this case, sands) are well known for their high endemism (being unique to a particular geographic region). So an increase in fire occurrence and an increase in the growth of highly competitive grasses after fire could lead to the decline of endemic species.

DESERTS

Invasive grasses have played an even more fundamental role in altering fire dynamics and causing native plant declines in desert ecosystems. In general, deserts are among the least invaded ecosystems in North America, in terms of the number of non-native species that have become established and the proportion of the flora they represent (Rejmanek and Richardson 1994). Roughly 5% of the flora is comprised of exotic species, presumably owing to physiological stresses caused by the harsh climate and moisture conditions. However, a few ecosystem-changing grass species are increasing the frequency of fires in California deserts. The exact species differ in each desert, but all threaten the future sustainability of these fragile ecosystems.

In the Great Basin systems east of the Sierra Nevada, cheatgrass (*Bromus tectorum*) is the primary species of concern, thriving where soil disturbance from historic livestock grazing has promoted its establishment in the interspaces between shrubs like sagebrush (*Artemisia tridentata*), bitter brush (*Purshia tridentata*), and rabbit brush (*Chrysothamnus spp.*). Lightning strikes often ignite fires in the region, but whereas historically these would have burned short distances and then died out because of the discontinuous fuels, cheatgrass now provides a continuous fuelbed between senescent (end of aging process when plant tissues become dormant, dry, or are dropped) sagebrush, resulting in very large fires.

In the Mojave Desert, the same impact is caused by low-growing Mediterranean grasses (*Schismus barbatus* and *S. arabicus*), as well as by red brome. All are annual grasses that fill in the space between shrubs. In the Sonora/Colorado Desert, senesced red brome is implicated in supporting fast moving surface fires and shortening fire intervals (Rogers and Steele 1980, Phillips 1992). Many desert plant species are not adapted to fire, so are gradually being replaced by monotypic stands of annual grasses. Large-scale type conversion of endemic desert plant communities is more prevalent in Arizona and Nevada to-date, but recent fires in the Owens Valley and areas of the Mojave show that our desert ecosystems are not immune to such irreversible impacts.

Sahara mustard (*Brassica tournefortii*) is a short-lived forb that poses a serious threat to desert ecosystems. While it has not yet caused serious fire events in sand-dominated sections of the Mojave, this large, multi-branched plant is forming nearly continuous stands and is already crowding out annual wildflowers. It will almost certainly become fuel for destructive wildfire in the future.

GRASSLANDS

California's grasslands have a history of human management that has impeded accurate documentation of fire cycles. Early human inhabitants used fire to reduce woody plant cover and maintain grassland habitats for hunting, and to promote growth of particular species. After Euro-American colonization, grasslands were maintained by intensive livestock grazing, and fire was used to convert shrublands to grasslands. Today fire frequencies are low in these ecosystems, likely lower than prior to European settlement.

California grasslands are dominated by European annual grasses, even in regions that have not burned for decades. Prescribed fire has been used as a tool in some invaded grasslands to try to manage against non-native grasses, but results have been mixed as demonstrated in a meta-analysis conducted by D'Antonio and Bainbridge (Corbin et al. 2004). While it appears that a single fire can reduce non-native grasses, this effect is short-lived, and only recurrent fire or fire combined with grazing can keep down non-native grasses. At the same time, some non-native forbs such as species in the genus *Erodium* and black mustard (*Brassica nigra*) are promoted by fire. Thus, the use of fire in grasslands to enhance native species must be carefully done, and consideration of what non-native species are in the local seedbank is a key element. But overall, fire is not considered a key factor in the maintenance of invasive plant dominance, nor an appropriate management tool for eliminating non-native species in most California grasslands.

FORESTS

In California, there is a general pattern of decreasing numbers of non-native plant species with increasing elevation (Keeley et al. 2011). Fuel management practices in coniferous forest ecosystems have generally decreased fire frequency, but at the same time have increased the severity of wildfires compared with other fire-prone systems. Woody fuel accumulation (of native species), livestock grazing, and logging—which creates even-aged stands replete with ladder fuels—have altered fire regimes from historical low- or mixed-severity understory fires to larger, more intense crown fires. These high-intensity fires create crown gaps and appear to occur more frequently than in the past. Montane coniferous forests in California generally have a lower diversity of invasive species and a different composition of invasive species than lower elevation woodlands and grasslands. Many of the invasive species problems in forest ecosystems have been attributed to management practices that reduce fire frequency.

Cheatgrass (*Bromus tectorum*) appears to be one invasive plant that is an increasingly common invader of some of the drier coniferous forest ecosystems in California such as Ponderosa pine woodlands. Keeley has documented its occurrence in the understory of Ponderosa-dominated sites where it becomes abundant after fire. However, it is not clear that cheatgrass has any long-term impact on these ecosystems. Abundant cheatgrass growth during the early years after fire when tree seedlings are small could result in an increased probability of fire occurrence, to the detriment of the young woody plants, but data to support this is lacking.

RIPARIAN SYSTEMS

Riparian ecosystems encompass a wide variety of habitats, from small springs and vernal pools to large rivers, coastal marshlands, and natural and man-made lakes, and support much of the biodiversity found in California. Riparian vegetation is defined by plants with regular access to groundwater or soil moisture, so typically, riparian plants have higher foliar moisture than upland plants. Higher moisture content imparts greater resistance to and reduced damage from fire, so riparian areas are often considered to be functional barriers to the spread of wildfire (Pettit and Naiman 2007). However, several invasive plants in California riparian systems are changing these dynamics. For example, giant reed (*Arundo donax*) and tamarisk (*Tamarix* spp.) are well known to be highly flammable, yet both species recover rapidly from fire by regrowth from below-ground plant parts. By contrast, cottonwoods, willows, and other native woody plants are much less tolerant of direct exposure to fire. Recent studies suggest that the invasive plants mentioned above are making riparian systems fire-prone.

Giant reed is a large, bamboo-like grass from southern Eurasia that is altering the diversity and function of riparian corridors throughout coastal California. In Southern

TABLE 1. NON-NATIVE, INVASIVE PLANTS POTENTIALLY ASSOCIATED WITH CHANGE IN FIRE REGIME OR FUEL CONDITIONS IN CALIFORNIA

Common Name	Scientific Name	Habitat*	Habitats of Concern and Comments
ANNUAL GRASSES			
barbed goatgrass	*Aegilops triuncialis*	G, C, W	Spreading into serpentine grasslands where it could promote fire in otherwise sparse vegetation
wild oats	*Avena fatua, A. barbata*	G	Ignition on trails, roads, disturbance corridors
ripgut brome	*Bromus diandrus*	G, C, W	Widespread and abundant, particularly in nitrogen-rich soils
red brome	*Bromus madritensis* ssp. *rubens*	G, D	Desert and desert washes in Mojave
cheat grass, downy brome	*Bromus tectorum*	D	Primarily high desert, but also in parts of lower Mojave and Sierra Nevada
foxtail barley	*Hordeum murinum* ssp. *leporinum*	G	Widespread, could change fuel continuity in some sites
Mediterranean grass	*Schismus arabicus, S. barbatus*	D	Produces continuous fine fuels in arid shrublands, esp. Mojave desert
medusahead	*Taeniatherum caput-medusae*	G, D	Common in grasslands of North Coast ranges and north Central Valley, spreading into high desert
PERENNIAL GRASSES			
beach grass	*Ammophila arenaria, A. breviligulata*	[1]	Creates dense fine fuels in coastal dunes, where fire typically would not burn
giant reed	*Arundo donax*	R	Low gradient floodplains; drought tolerant, highly fire-promoting
jubata grass, pampas grass	*Cortaderia jubata, C. selloana*	G, C	Primarily coastal habitats; could influence fuel continuity
veldt grass	*Ehrharta calycina*	G	Sandy soils, especially dune shrublands on central coast
smilo grass	*Piptatherum miliaceum*	G, C, W, R	Expanding range; can invade into disturbed chaparral. Future significance unclear, but could change chaparral fire regime.
ravenna grass	*Saccharum ravennae*	D, R	Emerging concern in North Coast riparian scrub; considered fire hazard in Arizona
fountain grass	*Pennisetum setaceum*	G, C	Roadsides, also coastal dunes. Some horticultural cultivars sterile. Highly invasive and fire promoting in Hawaii.
FORBS			
fivehook bassia, forage kochia	*Bassia hyssopifolia, B. scoparia* (*formerly Kochia*)	D, R	Alkaline habitats and disturbed areas where it forms continuous stands
black mustard	*Brassica nigra*	G, C, R	Widespread in disturbed sites and coastal shrublands; high standing biomass. Flammability poorly known.

Sahara mustard	*Brassica tournefortii*	D	Favors sandy substrates and dunes
thistles	*Carduus spp., Cirsium* spp., *Cynara cardunculus, Silybum marianum*	G, C, W, R	Could be ladder fuels in open woodlands; disturbed soils
yellow starthistle	*Centaurea solstitialis*	G, R	Large stands provide continuous fuel, but flammability poorly known
tumble or tansy mustard	*Descurainia sophia*	D, R	Impacts appear to be minor, but locally more invasive in northeast CA
perennial pepperweed, tall whitetop	*Lepidium latifolium*	R	Dense stands of standing biomass in wetland margins; range expanding
Russian thistle	*Salsola tragus*	D, R	Forms dense stands in disturbed alkaline sites; tumbleweeds can accumulate along fence lines and structures, causing a build-up of fuels
SHRUBS			
Scotch broom	*Cytisus scoparius*	C	Coastal scrub, oak woodland, perennial grasslands; could enhance fuel accumulation
French broom	*Genista monspessulana*	C, R	Coastal scrub, oak woodlands, grasslands, particularly in understory, creating additional dry biomass
Spanish broom	*Spartium junceum*	C, R	Coastal scrub, grasslands, wetlands, oak woodland, forests; mostly found in open canopy
gorse	*Ulex europaeus*	G, C	Coastal bluffs and grasslands; may not be highly flammable but adds substantial biomass to grasslands
TREES			
tree-of-heaven	*Ailanthus altissima*	C, W, R	Fire tolerant, litter burns
Tasmanian blue gum	*Eucalyptus globulus*	W, R	Coastal habitats; spreads from plantations and can enhance fire intensity; source of firebrands near urban areas
Peruvian peppertree	*Schinus molle*	C	Southern CA coastal hillsides; promoted by fire
athel	*Tamarix aphylla*	D, R	Limited distribution; evergreen species; lower fire risk than deciduous congeners
tamarisk, saltcedar	*Tamarix ramosissima, T. chinensis, T. parviflora,* etc.	D, R	Major fire hazard throughout western states; replaces less flammable riparian vegetation
fan palms	*Washingtonia robusta, W. filifera*	R	Native to isolated desert springs; spreads from ornamental plantings; source of firebrands near urban areas
VINE			
cape ivy	*Delairea odorata*	R	Coastal, both riparian and fog-affected chaparral; hanging dry biomass could be fuel, esp. when killed back by frost

The plants listed above have known impacts or greatest potential to influence fire regimes, or to become fire hazards as their populations increase. Other invasive plants with little or no available fire-related information were not included.
*G = grassland, C = chaparral, W = woodlands, D = desert, R = riparian
[1] Occurs only in coastal beach dunes

California, giant reed has fueled fires around urban areas and facilitated fire spread to natural areas, and is alleged to reduce the ability of river courses to act as natural barriers to fire. Coffman and her collaborators at UCLA examined the regrowth rates of giant reed and nearby native woody vegetation following a 300-hectare fire in the Santa Clara River (Ventura and Los Angeles Counties) in 2005. Giant reed grew three to four times faster following fire, and within one year its density was 20 times greater than native species. This suggests that rapid regrowth of the highly flammable biomass creates an invasive plant-fire cycle that ultimately leads to a decline in native species in these ecosystems.

In more arid regions, tamarisk or saltcedar (*Tamarix* spp.) is considered to be one of the most destructive invaders of the southwestern U.S. This shrubby tree was introduced from Eurasia in the 1800s for erosion control, windbreaks, and other horticultural uses. It now dominates desert riparian corridors such as the lower Colorado River and parts of the Owens River where water and land management have degraded conditions for native cottonwood, willow, and/or mesquite vegetation. Tamarisk has also displaced some native riparian woodlands in relatively healthy watersheds such as Coyote Creek in Anza-Borrego State Park. The relatively long intervals between flood events allow tamarisk seedlings to reach maturity, and subsequently to inhibit establishment of native plants.

In these locations, wildfires have become frequent. For example, on the Colorado River bordering California and Arizona, Bureau of Reclamation researcher David Busch has shown that over a third (approximately 37%) of riparian vegetation burned during a 12-year period. Such fires occur in the fall/winter period when the deciduous plants drop foliage which builds up into a flammable litter layer. They also occur during the growing season when tamarisk is also susceptible to ignition and may burn with greater intensity owing to volatile compounds in live, green foliage. In a cooperative study of tamarisk-fueled fires by the University of California and the U.S. Geological Survey, Gail Drus found that across the desert regions there is a correlation between the relative abundance of tamarisk and extent of native plant mortality. In other words, as tamarisk becomes more abundant, there is a greater loss of native vegetation during fire and acceleration toward eventual monocultures of this widespread invader. Interestingly, the introduction of the tamarisk leaf beetle (*Diorhabda* spp.) for biological control of tamarisk may protect native plants because, even in the absence of tamarisk mortality, by reducing tamarisk canopy density, the threat of fire to native plants is reduced (Brooks et al. 2008).

Comparatively little is known about most invasive plants in California and their relationship to wildfire. The above examples are the best observed cases of invasive plants changing the dynamics of fire in California ecosystems, although some are still anecdotal. Further scientific evaluation is necessary to accurately identify the mechanisms that lead to these changes or to determine whether changes are reversible. Current evidence suggests that annual and some perennial grasses have the strongest effects on fire regimes and act as ecosystem transformers. In many ecosystems, the dense growth habit and flammable tissue of invasive grasses create continuous drier fuels that are lacking in uninvaded communities. Further research should evaluate the effect of these and other invasive life forms (forbs, shrubs, trees, etc.) on fire regimes to guide management efforts to conserve and restore California native plant communities.

REFERENCES

Brooks, M., T. Dudley, G. Drus, and J. Matchett. 2008. *Reducing wildfire risk by integration of prescribed burning and biological control of invasive tamarisk* (*Tamarix* spp.). USGS Administrative Report, Project 05-2-1-18, El Portal, CA.

Brooks, M.L., et al. 2004. Effects of invasive alien plants on fire regimes. *BioScience* 54:677-688.

Corbin, J.C., C.M. D'Antonio, and S.J. Bainbridge. 2004. Tipping the balance in the restoration of native plants: Experimental approaches to changing the exotic:native ratio in California grassland. In *Experimental Approaches To Conservation Biology*, ed. M. Gordon and L. Bartol. University of California Press, Los Angeles.

Keeley, J.E., J. Franklin, and C.M. D'Antonio. 2011. Fire and invasive plants on California landscapes. In *The Landscape Ecology of Fire*, ed. D. McKenzie, C. Miller, and D.A. Falk. Springer, NY.

Pettit, N. and R. Naiman. 2007. Fire in the riparian zone: Characteristics and ecological consequences. *Ecosystems* 10:673-687.

Phillips, B.G. 1992. *Status of non-native plant species, Tonto National Monument, Arizona*. The University of Arizona, School of Renewable Natural Resources, Cooperative National Park Resources Study Unit, Tucson, AZ.

Rejmanek, M. and D.M. Richardson. 1994. Invasive alien plants in California: 1993 summary and comparison with other areas in North America. *Madroño* 41:161-177.

Rogers, G.F. and J. Steele. 1980. Sonoran Desert fire ecology. In *Proceedings of the Fire History Workshop*. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Tucson, AZ.

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SUSTAINABLE AND FIRE-SAFE LANDSCAPES: ACHIEVING WILDFIRE RESISTANCE AND ENVIRONMENTAL HEALTH IN THE WILDLAND-URBAN INTERFACE

by Sabrina L. Drill

Invasive plants, those non-native species that cause ecological or economic harm, are one of the great threats to the health of Southern California's wildland-urban interface (WUI) areas. Fire is one of the greatest threats to the homeowners living in those areas. Unfortunately, for many years a false conflict was created between these two issues, when fire departments, nurseries, and others recommended invasive plants to homeowners as part of a fire-safe landscape.

The Natural Resources team at UC-Cooperative Extension (UCCE) in Los Angeles County created the Sustainable and Fire-Safe (SAFE) Landscapes program to increase fire safety and wildland health by showing homeowners how to create and maintain fire-safe landscapes *without* introducing invasive species.

Limiting the use of invasive species in highly fire-prone areas is particularly important for a number of reasons. First, both the fire risk and the risk of plant invasion are heightened by the geography. Homeowners in the WUI who use invasive plants are exacerbating both problems, often unwittingly, since their properties border our few remaining areas of natural habitat. In addition, several of the invasive species commonly planted in these areas possess weedy characteristics that make them highly flammable.

MYTHS ABOUT FIRE, RISK, AND SAFETY

There are several myths about fire and risk in Southern California areas. The first is that fire-safe landscapes require a lot of water and must be wet or damp throughout fire season, or that a landscaped area cannot be both fire-safe and drought tolerant. In fact, one of the features that can decrease the risk posed by a plant species is its ability to retain high moisture content in leaves and other tissues with very little water. From an invasive plant perspective, however, this means that the plants most likely to invade chaparral and coastal sage-dominated areas successfully may also be those exotics recommended as drought-tolerant.

Another myth is that most California native plants are intrinsically highly flammable, and that chaparral and coastal sage systems require frequent fire to be healthy. While several Southern California natives do possess characteristics that make them fire-prone, many are actually highly resistant and tolerant of fire and recover quickly after a wildfire, making them excellent choices for a fire-safe landscape.

A final myth is that a green groundcover is intrinsically fire-resistant. While a low, prostrate growth form and high moisture content are fire-resistant traits, plants such as iceplant, ivy, and periwinkle (often referred to as vinca) can pose a fire risk. This is because under that deceptively healthy-looking green surface is often hiding a layer of dead, dry, entangled thatch. The healthy looking top layer tends to discourage proper landscaping maintenance, thereby contributing to its fire hazard.

Contrary to what many people think, it is not possible to make

In October 2003, numerous wildfires (indicated by red outlines) burned simultaneously throughout Southern California and northern Baja California, Mexico. Image captured by the Moderate Resolution Imaging Spectro-Radiometer (MODIS) on the Terra satellite on October 26, 2003.

Invasive plants including castor bean (*Ricinus communis,* foreground) and black mustard (*Brassica nigra*) invade a canyon in Griffith Park, Los Angeles, 10 months following the May 2007 fire that burned 800 acres. Photograph by the author.

broad statements about fire-risk and invasive plants, just as you cannot for native plants. Each species must be evaluated separately. Finally, it is impossible to discuss the fire risk potential of any plant without also taking into account its health at any given time. Any plant will burn under the right conditions, and the most "fire-resistant species" can become great fuel for a wildfire if it contains a lot of dead tissue due to a lack of proper maintenance.

FIRE AND INVASIVE PLANTS

Fire and plant invasions are related in several ways. In natural plant communities, the presence of invasive plants can increase the risk of wildfire. For example, in sparsely vegetated areas, such as desert communities, invasive plants often occupy the space between the native desert scrub, thereby creating a continuous fuel load that more easily ignites and transmits fire (Klinger et al. 2006). In riparian areas, invasive plants like giant reed (*Arundo donax*), which produce a great deal of biomass and then become dormant and dry, can increase the intensity and severity of fire. Native riparian species generally do not burn easily, and fires in riparian areas are naturally rare and of low intensity. But with the introduction of invasive species like arundo, fire in riparian areas can occur in a wider range of climatic conditions, and easily spread from surface to crown fires (Bell et al., 2006). It can also inhibit fire recovery, and post-burn, arundo can resprout from rhizomes and colonize new downstream areas, inhibiting native regrowth.

After a fire, disturbed areas are highly prone to invasion by weedy pioneers such as annual grasses. Vegetation types that may have been fire tolerant and recovered well under natural conditions may now be subject to *type conversion.* Type conversion is a process by which after disturbance, one type of plant community replaces the one that had originally been there. Frequent fires may cause replacement of chaparral by non-native grasslands. There is a feedback loop—exotic grasses invade a natural area, leaving the area more fire prone, then they recover faster than the native plants. Hence, the progression is from a native community, to a native community with some invasive plants, to a community dominated by invasive plants.

This can occur even faster when areas are not only more fire prone, but when frequent fires are also promoted by fire starts due to human activities (campfires, disposal of flaming trash (e.g., cigarette butts), sparks from cars and other motors, downed power lines, etc.) (Keeley et al. 2006a). This process may have been exacerbated even further by human activities such as post-fire seeding, which in the past actively introduced invasive species such as wild oat (*Avena* spp.) and rye (*Lolium* spp.). Previously, this was thought to be a useful tool for erosion prevention. Several studies, however, have found it to be of very limited utility (Keeley, et al. 2006b).

THE SAFE LANDSCAPES PROGRAM

As described above, the SAFE Landscapes program was designed to deal with a specific issue involving invasive plants and fire, namely the fact that certain invasive species have been recommended for planting in the wildland/urban interface. To develop the program, we first convened a steering committee that included fire agencies, public and private land managers, environmental groups, and representatives from the nursery and landscape industry. Steering committee meetings were themselves educational forums, as they were an opportunity for members to learn from each other.

Our first step was to collect and review the recommendations for fire safe landscaping being promoted and disseminated by various groups in Southern California. We reviewed over 100 planting guides to identify those that recommended the use of invasive plants in fire-safe or water-conserving gardens. We used the current list of invasive plant species of Southern California developed by the California Invasive Plant Council as a reference. We found 34 lists that included invasive plants among their recommendations, and the agencies and organizations sponsoring those lists were sent letters identifying the invasive plants they recommended and asking them to remove those species. Some of these larger organizations that have revised or are in the process of revising their planting guides include Lowe's, Monrovia Nursery, the Natural Resources Conservation Service, Los Angeles County Fire Department, Beverly Hills Fire Department, the City of Santa Clarita, and Cuyamaca College.

QUALITIES OF FIRE-RESISTANT VS. HIGHLY FLAMMABLE PLANTS

While we avoid recommending particular plant species, we do focus on characteristics that make plants more or less fire-resistant.

Fire-resistant plants:

- store water in leaves or stems
- produce very little dead or fine material
- possess extensive, deep root systems for controlling erosion
- maintain high moisture content with limited watering
- grow slowly and need little maintenance
- are low-growing in form
- contain low levels of volatile oils or resins
- have an open, loose branching habit with a low volume of total vegetation

Highly flammable plants:

- Retain large amounts of dead material within the plant
- Produce a large volume of litter
- Contain volatile substances such as oils, resins, wax, or pitch

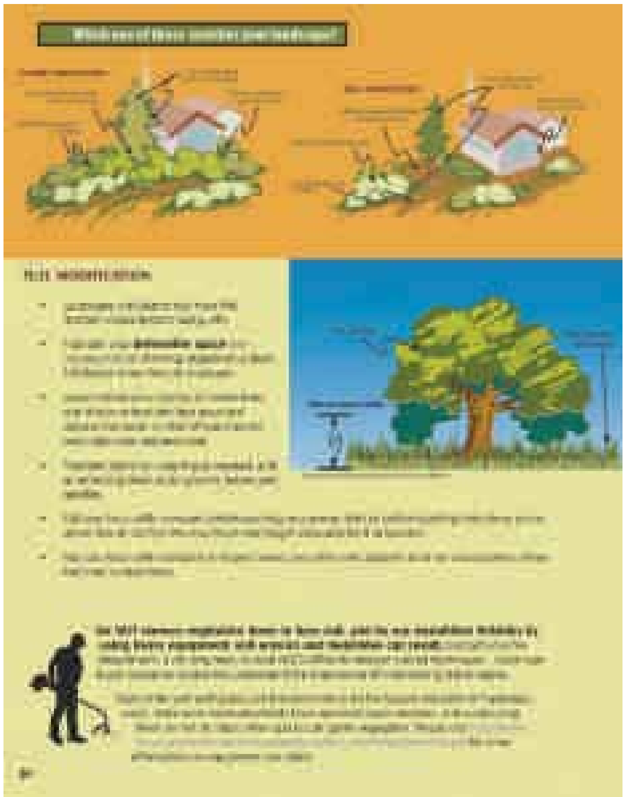
PRINCIPLES OF FIRE-SAFE LANDSCAPING

While we identified, reviewed, and made recommendations to improve existing plant lists, for our own program we have avoided distributing a list. This is because we feel that plant lists can be misleading, giving the homeowner or landscape designer the impression that fire-safe landscaping is just about choosing the right species and avoiding the wrong ones. Because any plant species can burn, we focus instead on the underlying principles behind designing a fire-safe home and landscape, and on maintaining structures and plants properly.

First, we begin by working from the structure out, rather than from the wildlands in. Homeowners often spend far more effort "clearing brush"—removing native vegetation that is 100 or more feet from around their homes—rather than on changes they can make to the structure itself or within the first 30 feet. In ember-driven wildfires, it can be far more effective to protect property by making sure that embers cannot enter the home through doors, windows, vents, or other gaps, than on any actions focused on the surrounding plants. We advise the homeowner to make sure that flammable materials such as firewood, fuel canisters, and even fences and trellises can't provide a conduit for fire to reach the house, and that embers cannot collect under decks or eaves.

Of course we also recommend choosing burn-resistant building materials for roofs, siding, and decks. UCCE research on fire-resistant materials and construction methods

A landscape in the Altadena area after appropriate fire hazard reduction. Vertical and horizontal space was created by pruning and selectively removing vegetation between native shrubs, reducing the continuity of fuel without removing more vegetation than necessary. Photograph by J. Lopez, Los Angeles County Fire Department.



Pages from the SAFE Landscapes Southern California Guidebook to Sustainable and Fire-Safe Landscapes in the Urban Wildland Interface. Graphic design by V. Borel, UC Cooperative Extension.

helped drive the creation of new building codes for WUI areas. These were adopted by the State of California in 2007 and apply to any new construction. For more information about making structures more resistant to wildfire, see the fire resistant building page of our website, *http://ucanr.org/safelandscapes.*

Beyond the building, the major principles to follow include thinking about the defensibility of the landscape—creating a space where firefighters can safely defend the structure from wildfire. This involves making sure to achieve a vertical and/or horizontal separation among plants so that a ground fire cannot move upward into tree crowns, becoming a high ember-producing fire. We advise homeowners to remove any dead plant material from roofs and anywhere it can collect, including keeping plants pruned and trimmed to remove thatch build-up. We also advise the use of proper irrigation to keep plants healthy. A healthy plant is usually a fire-resistant plant.

INFORMATION DELIVERY

One of the difficulties in educating the public about fire safety is that people generally disregard the issue until a large fire occurs. Then there is a sudden surge of interest in the topic that wanes rapidly once the emergency has passed. However, another good time to target homeowners is in the spring when they receive fuel management notifications from local fire agencies. At UCCE we wanted to reinforce the idea that fire preparedness and landscape maintenance were year-round tasks, so we decided to deliver that information in a calendar.

Each month's page includes a brief discussion of relevant issues regarding fire ecology and landscape preparedness, and highlights two or more invasive plant species to avoid. We also took advantage of the calendar format to include the start dates for major Southern California wildfires along with the number of structures lost and acres burned. In addition to highlighting the year-round nature of the issue, by utilizing a calendar format we sought to get the information off the pile of "should-read" desk material, and onto the kitchen wall where it could be absorbed slowly.

With support from the National Fish and Wildlife Foundation, the Renewable Resources Extension Act, the California Community Foundation, the Los Angeles and San Gabriel Rivers Watershed Council, the National Park Service, and the Los Angeles and Ventura County Fire Departments, in 2007 and 2008 SAFE Landscapes Calendars were distributed to over 49,000 residents in the wildland/urban interface areas of Los Angeles and Ventura counties through direct mail and at events and workshops. Mail-in surveys were included.

Of 241 survey respondents, 80% found the calendar useful and 73% said the information was new to them. Also, 73% planned to save the calendar for future reference. Most importantly, 76% reported being more concerned about invasive

plants after reading the calendar, 81% said they had avoided buying invasive plants, 55% said they would change their landscape because of the calendar, and 51% specifically said they were removing these invasive species from their landscapes.

In addition to the calendar, UCCE created the SAFE Landscapes website, *http://ucanr.org/safelandscapes*, and a SAFE Guidebook that contains similar information to the calendar, but in a non-dated, non-year-specific format (so it can be used as an educational document for several years). We also held workshops in both 2007 and 2008 to provide more comprehensive information to homeowners as well as to landscape designers and architects.

In addition, we participated in numerous workshops and symposia of a more technical nature on fire ecology, fire preparation, and post-fire recovery in wildlands. We also provided extensive support to the City of Los Angeles following the Griffith Park fire, an 800-acre blaze that affected a large portion of that city park in May 2007. UCCE helped to develop the post-fire recovery strategy, which highlighted the need to control invasive plants and provided training to park maintenance staff to recognize and treat infestations.

THE FUTURE

Our work so far has focused on the landscaped area within the first 100 feet of a home. Beyond that, homeowners often look at the naturally vegetated area as a source of risk, rather than see the benefits of natural plant communities. To solve it they may choose a "scorched earth" approach, meaning that they remove every bit of vegetation, leaving just dirt. As more properties are developed at the edge of wildlands, individual efforts to manage fuels can result in significant loss of native habitat. The removal of most or all of the vegetation in these areas can leave disturbed soils ripe for invasion by weedy species. Hence, the common practice of clearing all vegetation in early spring can lead to a build-up of invasive plants and fine fuels by the time fire season arrives. The replacement of deep-rooted native perennial vegetation by shallow-rooted weedy annuals can also create an erosion hazard, with or without a wildfire occurring.

The next step we hope to take in expanding our program will be to train homeowners as well as vegetation management contractors in methods for a "light-touch" approach to fuel reduction. This will focus on creating vertical and horizontal space, while retaining as much native vegetation as possible to provide habitat and protect slopes. Creating this space—by selectively removing and pruning vegetation so that there is space between individual plants, rather than a continuous, connected mass of vegetation—means that fire cannot spread as easily.

The SAFE Landscapes program is only one of several statewide projects led by the University of California Cooperative Extension and the Division of Agriculture and Natural Resources. Similar projects that focus on different plant communities are taking place on the coast and mountains of Northern California, around Lake Tahoe, in San Diego, and in other areas. I encourage you to contact your local Cooperative Extension office to find out more.

REFERENCES

Bell, C.E., J. DiTomaso, and M. Brooks. 2006. Invasive Plants and Wildfires in Southern California. Brochure. University of California Cooperative Extension, http://ucce.ucdavis.edu/files/filelibrary/1359/39103.pdf.

Keeley J.E., C.J. Fotheringham, and M. Baer-Keeley. 2006a. Demographic patterns of post-fire regeneration in Mediterranean-climate shrublands of California. *Ecological Monographs* 76:235-255.

Keeley J.E., et al., 2006b. A 21st century perspective on post-fire seeding. *Journal of Forestry* 104:103-104. Klinger, R.C., M.L. Brooks, and J.M. Randall. 2006. Fire and invasive plant species. In *Fire in California's Ecosystems*, ed. Neil G. Sugihara et al., pp. 499-516. University of California Press, Berkeley, CA.

Klinger, R.C., M.L. Brooks, and J.M. Randall. 2006. Fire and invasive plant species. In *Fire in California's Ecosystems,* ed. Neil G. Sugihara et al., pp. 499-516. University of California Press, Berkeley, CA.

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THE ROLE OF FIRE SAFE COUNCILS IN CALIFORNIA

by Yvonne Everett

In many wildland ecosystems, fire is a natural phenomenon that brings a redistribution of resources and renewal. Species such as Coulter pine (*Pinus coulteri*) depend upon fire for their survival (Stuart and Sawyer 2001). Yet fire is potentially hazardous and destroys valuable resources. For many years the response was clear. Any wildland fire that could be put out was put out. Now, after over a century of often successful fire suppression, overwhelming scientific evidence that fire helps to sustain ecosystem function and biological diversity, as well as skyrocketing suppression costs, are convincing arguments for "let burn" policies in wilderness areas.

However, the wilderness is no longer so far away. As the fingers of our housing developments extend into ever more ridges surrounding expanding communities, we are reaching deeper into wildfire territory. In 19 states, over 50% of homes are now in this wildland-urban interface (WUI), led by California with 5,087,909 houses counted in the WUI in 2000 (Stewart et al. 2006). While some of us bemoan the lack of local government planning that allows this expansion to continue, most of us still expect fire services to fight fires in the WUI to protect lives and homes.

But fighting wildland fire in the WUI is complicated. Structures and unknown caches of explosive or toxic household materials make fire fighting very dangerous. When residents evacuate their homes in the face of wildfires, they block road access for emergency response personnel. And despite their training, skills, and resources, fire services are often overwhelmed by the scale of wildfires in the WUI. For all these reasons, the single solution approach of relying entirely on suppression for fire management needs to be revisited.

One response to the increased threat of wildfire in the WUI has been the emergence of Fire Safe Councils. These are locally-based groups of volunteers whose goal is to reduce wildfire hazards to communities. Today, there are over 150 Councils in California. Some are neighborhood homeowner groups; others are county level associations of fire service professionals. There are rural councils focused on fuel treatments and urban groups specializing in public education. While some have paid staff, most are volunteer-led. Councils carry out a wide range of critical fire preparedness activities that are beyond the capacity of fire services.

Members of the Trinity Fire Safe Council meet to work on defining the wildland urban interface for their wildfire protection plan. All photographs courtesy of the Trinity Fire Safe Council unless otherwise noted.

A recent survey of Fire Safe Councils in California focused on where Councils are located, what types of activities they carry out, and what Councils see as their greatest challenges (Everett and Fuller 2010). The study indicated that Councils are very widespread, that they carry out a range of critical activities, and that they face similar challenges.

The responding Councils were located in 19 California counties, from San Bernardino in the south to Del Norte in the north. Most counties have one county-level Fire Safe Council and often numerous community-level Councils. San Diego County, for example, with nearly three million people, includes a county-wide Fire Safe Council that serves as an umbrella for over 50 community Councils (Fire Safe Council of San Diego 2010). Often local representatives of state or federal agencies have assisted in local Council formation.

Council membership is diverse and often includes members with significant skills and experience. The majority of community-level Councils indicated having 8-20 regular active members. Almost all indicated that most or all of their members are private landowners. Over half reported volunteer fire department members and or professional fire service staff among their regulars. Over half of the Councils reported having active or retired federal, state, and local government representatives as council members. Half of the Councils include members from community based non-governmental organizations. Most of the Councils reported that they commonly collaborate with other organizations.

Fire Safe Councils reported activities in three general categories: public education and outreach; planning for wildfire; and implementing risk reduction activities.

Councils reach many thousands of people with fire preparedness and

ABOVE: **Bull Pine prescribed burn carried out by the Orleans-Somes Bar Fire Safe Council on private land in the Six Rivers National Forest. Photograph courtesy of the Orleans-Somes Bar Fire Safe Council •** RIGHT: **A number of homeowners along Highway 3 in Long Canyon teamed up with the Trinity County Fire Safe Council to reduce fuels around their homes and along their access road. After the rest of the neighbors saw what it looked like, they requested assistance with their defensible space too.**

safety brochures and newspaper inserts, booths at county fairs, and programs for local schools and neighborhood and community meetings. Workshops and training days on creating defensible space and chipping fuels are common, often organized with agency partners such as CalFire. Some Councils also reach out to other Councils. For example, since 2003 the Northern California Councils have held four well-attended gatherings for regional networking and peer training.

Planning and finding support for their activities are major Council activities. The 23 Councils who reported on funding had raised $12,919,066 for their work over the last decade. The majority of funds (63%) came from federal sources and from state government (20%). Federal monies came largely through the California Fire Safe Council, an incorporated nonprofit organization that helps to distribute federal agency grants (Fire Safe Council 2010). Additional federal dollars were distributed in counties with large proportions of federally managed lands by Resource Advisory Committees, with funding provided by Congress under the Secure Rural Schools and Community Self-Determination Act of 2000. Most of this money, $9,956,050, was used to treat fuels, while $666,100 was used for public outreach. The remaining $2,324,700 went to Community Wildfire Protection Plan (CWPP) preparation and other planning.

CWPP is a federally promoted protocol for community-based fire preparedness planning under the Healthy Forest Restoration Act (2003). Communities prepare their plan in collaboration with agency and local officials (Communities Committee et al. 2004; Ganz et al. 2007). The plans usually identify projects to reduce fuels, protect structures, develop evacuation plans, and the like. Communities with a completed CWPP proposal endorsed by local government are

Shaded fuel break on federal land next to private parcel. This homeowner lost his fire insurance until the Fire Safe Council was able to get permission from the USFS to complete the thinning.

more competitive for federal funds administered through the California Fire Safe Council's Grant Clearinghouse. All of the ten county-level Councils reporting had either completed CWPPs or were working to complete one. Half of the 18 community-level Councils had also completed a CWPP.

Fire Safe Councils reported diverse fire preparedness and response projects, including emergency communications, facilitation of emergency response, home improvement, and fuel reduction. The specific activities carried out by a particular Council depend on local needs and capacity. The most emphasized activity was fuels treatment. Eliminating fuels and access points for fire on and around structures is widely accepted as a critical factor in reducing losses to wildfire (USDA 2007). At the time of the survey, 23 Councils reported having completed fuel reduction work on 25,647 acres. Fuel reduction was largely on private lands immediately adjacent to structures or along access roads. The Councils reported that at least 3,655 landowners were participants in these fuel reduction treatments.

While Fire Safe Councils are responding to the increased threat of fire in the WUI, they also face significant challenges. The most widely reported challenge was increasing and maintaining community awareness and participation in Council activities. Respondents struggled with how to generate and maintain public interest in fire management issues. In areas with many absentee landowners, it has proven challenging to reach them and gain permission to treat their land. But for projects that involve creating a fuel break for a neighborhood or along an access road, contiguous properties must be treated. Finding funding, especially for fuel reduction projects, operational expenses, and liability insurance, was the second ranked challenge for Fire Safe Councils. Fuel reduction—and especially convincing landowners to reduce fuels on their property—was a third key issue. To many, fuel reduction is controversial. Some people simply don't want to bother to do the work. Others are concerned about its environmental impact, such as destabilizing slopes by removing native vegetation or of habitat loss caused by clearing.

It seems clear that Fire Safe Councils in California are playing a critical role in community-based fire management that complements fire service activities. It is to be hoped that over time increased education, fire preparedness, and ecologically appropriate fuel reduction activities will enhance our ability to live with fire, even as we work to halt the expansion of the WUI.

REFERENCES

Communities Committee, National Association of Counties, National Association of State Foresters, Society of American Foresters, and the Western Governors' Association.

COUNTY FIRE SAFE COUNCILS IN CALIFORNIA

There are over 150 local or "community-level" Fire Safe Councils in California and most have a link to a county fire safe council. County-level councils with websites active in 2010 are listed here.

Alameda Diablo Fire Safe, *http://www.diablofiresafe.org/*
Alpine Fire Safe Council, *http://www.alpinefiresafe.org/*
Amador Fire Safe Council, *http://www.amadorfiresafe.org/*
Butte County Fire Safe Council, *http://www.thenet411.net/*
Contra Costa Diablo Fire Safe Council, *http://www.diablofiresafe.org/*
Fire Safe Council of El Dorado County, *http://www.edcfiresafe.org/index.php*
Humboldt County Fire Safe Council, *http://co.humboldt.ca.us/planning/fire_safe_council/fsc_default.asp*
Kern River Valley Fire Safe Council, *http://www.krvfiresafecouncil.org/News.htm*
Lake South Lake Fire Safe Council, *http://www.southlakefiresafecouncil. org/about.htm*
Lassen County Fire Safe Council, *http://www.lassenfiresafecouncil.org/*
Eastern Madera County Fire Safe Council, *http://www.maderafsc.org/html/contact.htm* (out of date)
Fire Safe Marin, *http://www.firesafemarin.org/links.htm*
Mariposa County Fire Safe Council, *http://www.mariposafiresafe.org/*
Mendocino County Fire Safe Council, *http://firesafemendocino.org/*
Monterey Fire Safe Council, *http://firesafemonterey.org/*
Napa Communities Firewise Foundation, *http://www.napafirewise.org/*
Fire Safe Council of Nevada County, *http://www.firesafecouncilnevco.com/*
Orange County Greater Laguna Coast Fire Safe Council, *http://www.lagunacoastfiresafecouncil.org/*
Placer County Fire Alliance, *http://www.placerfirealliance.org/*
Plumas County Fire Safe Council, *http://plumasfiresafe.org/*
Riverside County—see Inland Empire Fire Alliance, *http://www.fireinformation.com/*
Sacramento County Folsom Fire Safe Council, *http://www.folsomfsc.org/about.us/our.mission.php*
San Benito County Fire Safe Council, *http://www.sbfsc.org/*
San Bernardino County see Inland Empire Fire Alliance, *http://www.fireinformation.com/*
Fire Safe Council of San Diego County (37 councils), *http://www.firesafesdcounty.org/localfscs.html*
San Francisco Peninsula Fire Safe Council, *http://www.rlinc.org/rlinc/firesafe.html*
San Luis Obispo County Fire Safe Council, *http://www.fscslo.org/*
San Mateo Fire Safe, *http://www.smcfiresafe.org/*
Santa Clara Fire Safe Council, *http://www.sccfiresafe.org/FAQs.htm*
Santa Cruz Soquel Fire Safe Council, *http://www.soquelfiresafe.org/aboutus.php*
Shasta County Fire Safe Council, *http://www.westernshastarcd.org/scfsc.html*
Sierra County Firesafe and Watershed Council, *http://www.scfswc.com/*
Fire Safe Council of Siskiyou County, *http://www.firesafesiskiyou.org/Public/HomePage*
Trinity County Fire Safe Council, *http://www.tcrcd.net/fsc/index.html*
Tuolumne County Highway 108 Fire Safe Council, *http://www.tuolumnefiresafe.org/*
Ventura Ojai Valley Fire Safe Council, *http://www.firesafeojai.org/*
Yuba County Watershed Protection and Fire Safe Council, *http://www.co.yuba.ca.us/firesafe/default.htm*

2004. *Preparing A Community Wildfire Protection Plan: A Handbook for Communities in the Wildland Urban Interface*. http://www.safnet.org/publications/cwpp_oct08.pdfCalifornia Fire Safe Council Annual Report. http://www.firesafecouncil.org/about/schedminutereport.cfm.

Everett, Y. and M. Fuller. 2011. Fire Safe Councils in the Interface. Society and Natural Resources. 0:1-15. http://www.informaworld.com/10.1080/08941920903313835

Fire Safe Council of San Diego. Active Local Fire Safe Councils. http://www.firesafesdcounty.org/localfscs.html.

Ganz, D., A. Troy, and D. Saah. 2007. Community involvement in wildfire hazard mitigation and management: Community based fire management, fire safe councils, and community wildfire protection plans. In *Living on the Edge: Economic, Institutional, and Management Perspectives on Wildfire Hazard in the Urban Interface*, eds. A. Troy and R. Kennedy, pp. 143-164. Elsevier Ltd., New York, NY.

Stewart, S.I., V.C. Radeloff, and R.B. Hammer. 2006. The wildland-urban interface in the United States. In *The Public and Wildland Fire Management: Social Science Findings for Managers*, ed. S.M. McCaffrey, pp. 197-202. Gen. Tech. Rep. NRS-1. U.S. Department of Agriculture, Forest Service, Northern Research Station, Newtown Square, PA.

Stuart, J. and J. Sawyer. 2001. *Trees and Shrubs of California*. University of California Press, Berkeley, CA.

U.S. Department of Agriculture Forest Service Independent Large Wildfire Cost Panel. 2007. Towards a collaborative cost management strategy: U.S. Forest Service large wildfire cost review recommendations. A Report on 2006 Wildland Fires chartered by the U.S. Secretary of Agriculture. http://www.fs.fed.us/fire/publications/ilwc-panel/BR6988-1.pdf

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FIRE-RESISTANT LANDSCAPING: A GENERAL APPROACH AND CENTRAL COAST PERSPECTIVE

by Suzanne Schettler

When planning a landscape in a rural-residential area, it is a natural impulse to consult a list of fire-resistant plants and select only those that are deemed fire-safe. Consulting more than one list can uncover a problem, however: lists contradict each other. For example, our native yarrow (*Achillea millefolium*) shows up on some lists as fire-resistant and on others as flammable. Other species show up in contradictory fashion as well. Most lists are a compilation of opinions, guesses, informed guesses, and other people's guesses.

THE WILDFIRE ENVIRONMENT

Some factors in the fire environment are beyond human control, and are almost beyond comprehension. First, wildfires are extremely unpredictable, burning some vegetation while adjacent sites are left untouched. Second, the rapidly rising column of hot air from a wildfire sucks in oxygen to feed the base of the fire, creating winds of tornado speeds. These high winds carry burning embers (firebrands) a mile or more, igniting spot fires in a leapfrog fashion and spreading the fire farther and faster than the actual flame front. Firebrands are not necessarily single burning coals; they can be a shower of small embers, resembling Fourth of July fireworks but not organized into pretty patterns. And third, because wildfires often occur during especially hot, dry, and windy weather conditions, the temperatures can be extremely high. After the Trabing Fire near Watsonville in 2008, investigators determined that the temperatures had reached 3,000 degrees Fahrenheit. I was shown a blob of melted aluminum, small enough to hold in the palm of a hand, that was all that remained of an extension ladder.

Some comparative temperatures may be of interest. Paper ignites at about 451 degrees F, depending on its composition. Lead melts at 400 to 600 degrees F, depending on its purity. Aluminum melts at about 1,600 degrees F, a blast furnace for making steel runs at approximately 2,300 degrees F, and a kiln for cement production is fired at 3,000 degrees F.

There are no plants and no structures that can withstand such heat. At these temperatures, spontaneous combustion ignites a structure from within. As the Basin Complex Fire in Big Sur approached a home in 2008, the owners moved their important possessions into a metal storage container on the property before they evacuated. When they returned, the house was untouched but the storage container held only ashes. Such incidents of internal ignition happen more often than we think.

WHAT WE CAN DO

In spite of these formidable conditions, we are not helpless. Second graders are taught the Fire Triangle (see page 18). The three sides of the triangle are heat, oxygen, and fuel—take away any one of them and fire cannot burn. There is little that can

Low-growing native plants minimize potential fire hazard immediately adjacent to this home. Native irises (*Iris* spp. and hybrids), sea thrift (*Armeria maritima*), *Phlox douglasii*, and low-growing manzanitas (*Arctostaphylos* spp.) are featured. Horizontal separation between plants is illustrated by the walkway at the left and center, and vertical separation is illustrated at the right. However, as the vines growing up the house increase in size they could become a fire hazard. The homeowners might want to replace them with low-growing plantings in large ornamental pots. Photograph by landscape architect R. Lutsko, reprinted with permission of *Pacific Horticulture*.

be done to reduce the industrial temperatures described above. And oxygen cannot be cut off unless a fire is small and can be smothered. The one element we can control is fuel, and vegetation is fuel. We can control the vegetative fuel when we design a new landscape or retrofit an existing one.

HOW FLAMMABLE ARE NATIVE PLANTS?

Bert Wilson is a native plant nursery owner and former firefighter. In September of 2005, near the end of the dry season, he compared the flammability of various plants. He placed a one-centimeter flame of a propane torch in contact with foliage of a clipped branch and recorded the time to ignition, repeating several times per plant. Most of the native plants he tested were growing in the ground and were unwatered. He performed the experiment in a closed barn so breezes would not influence the results.

What he found was not what he expected. The results were not consistent, either within genus or species, or with the literature. The more drought-tolerant the plant, the longer it took to ignite. And unwatered natives fared better than watered nonnatives; a watered apple and a watered common lilac burned faster than many manzanitas. Manzanitas as a group were quite variable, and watered samples were not necessarily slower to ignite than unwatered ones. Ceanothus species were relatively hard to burn; a light dust-off by overhead watering every two weeks made them really hard to burn.

SOME GENERALIZATIONS

In spite of the fallibility of lists of "fire-resistant" or "fire-prone" plants, there are some general guidelines that do relate to species selection. Plants with fine foliage have a high surface-to-volume ratio and therefore are more quickly heated through to an ignition temperature than are larger leaves. Conversely, plants with larger, thicker leaves are slower to ignite. Plants with resinous sap are chemically more volatile than plants with watery sap. Conifers (except for redwoods) are generally fairly flammable. Species that accumulate dry litter are a hazard. But even these guidelines are relatively minor factors in reducing flammability.

Here interest is focused away from the house, which is casting a late-afternoon shadow across the patio and lawn. The perennial border creates a focal point viewed *from* the house, rather than framing the view *toward* the house. Bulky vegetation is farther back, blurring the property line. All photographs by S. Schettler unless otherwise noted.

SEPARATION IS THE KEY

The question is not "Is a particular species fire-resistant?" What really makes a landscape fire-resistant is not the species that are planted but the three-dimensional geometry of their placement and the kind of care they receive. The spaces between plants, and the space between vegetation and a structure, are of great importance. There should be horizontal and vertical gaps in the vegetation. The individual plants should have elbow room, not just when they are initially planted but when they are full-grown. It may be useful to consult a knowledgeable horticulturist in advance to identify the mature size of plants in a given soil type and climate. And bulky vegetation should be positioned away from structures. The area immediately surrounding a home can function as a firebreak, comprising low vegetation or hardscape. This also becomes a work area if firefighters are defending a home and are lugging heavy hoses to protect the structure.

DESIGN FACTORS

Foundation plantings evolved when it was considered unsanitary for the first floor of a house to sit close to the ground and plants were needed to camouflage a tall foundation. Thomas Church and other landscape architects began moving away from this approach in the mid-1900s. Rather than using plants to frame the view of the house from the street, they placed the plantings where they can be enjoyed looking outward from the house and patio. This removes the bulk of the vegetation (fuel) from near the house, literally turning the design inside-out and creating fire resistance at the same time. For fire resistance, it is important to graduate the vegetation, with least volume near the structure.

In a fire-resistant landscape, a traditional perennial border is not located at the foundation of the house, but is set at a little distance where it invites exploration. This concept translates readily to our Mediterranean climate.

THERE IS NO SUCH THING AS A FIRE-PROOF PLANT…

Iceplant (*Carpobrotus edulis*) burned in the Trabing Fire in 2008. Photograph by R. Casale, NRCS.

…OR A FIRE-PROOF STRUCTURE.

(*Before*): Mike Evans, co-owner of Tree of Life native plant nursery in Southern California, built this cabin over the course of three years. The cabin was carefully designed for fire safety, there was 100' clearance to mineral soil in all directions, and the forest understory was cleared for hundreds of yards all around. Both photographs by M. Evans.

(*After*): The Cedar Fire of 2003 burned so hot that the structure fire started on the inside: a piece of furniture, a pillow, a towel, the tablecloth (who knows?) ignited, perhaps spontaneously.

Islands are a good way to create separation in the vegetative fuel. They can either form the framework for the layout of a new landscape or can be retrofitted by cutting broad trails through existing vegetation such as chaparral, breaking it up into discontinuous patches. Human-scale islands of mounded vegetation visually remind us of natural topography in the larger landscape, so that one has the experience of being immersed in the landscape rather than merely walking over it.

Since fire climbs upward, it is important to eliminate fire ladders. A fire ladder exists when there is continuous or nearly continuous vegetation extending from the ground up to the tree canopy. Care in the placement of shrubs, and maintaining substantial vertical gaps between shrubs and trees, can prevent the development of fire ladders.

Steep slopes are particularly vulnerable to fire, as fire low on the slope preheats vegetation higher up. Terracing a steep slope makes the site more useable, allows rainfall to soak in rather than run off, and reduces the intensity of a potential fire. A tree or shrub burning low on the slope cannot readily ignite a plant higher up if the slope is broken by level areas.

Homeowners in forested settings are being increasingly encouraged by Cal Fire and local fire agencies to reduce hazardous vegetation and create defensible space (see sidebar). This is accomplished through a combination of methods. Dense trees can be thinned to feature the most attractive and well-spaced specimens. In a mixed evergreen forest, understory shrubs and ferns that remain after some trees are removed can provide the basis for a new garden. Trees that are retained should have their lower branches removed to eliminate fire ladders; the remaining foliage should be at least high enough to walk under. Shrubs can likewise be "limbed up" and selectively pruned to showcase beautiful trunks while reducing fuel and creating separation from the ground-level vegetation.

HORTICULTURAL PRACTICES

Aside from the three-dimensional geometry of the planting, the single most effective fire-resistant measure is to perform horticultural maintenance on a regular basis: groom, dead-head, prune, rake, tidy up. Fire ladders that have been initially eliminated may need to be maintained by periodically reopening the vertical gaps as plants grow.

Mulch conserves moisture and suppresses weeds, but wood chips or bark should not be deeper than 3-6" in order to limit flame lengths. In the event a firebrand lands on it and smolders, the mulch should be kept a few feet away from structures so it can't carry a creeping fire to a building.

Irrigation can sustain moisture content in the vegetation through the dry season, making it slower to ignite. There is a delicate balance, however. The life of drought-tolerant trees and shrubs is shortened if irrigation stimulates year-round growth and the plants do not have a natural annual dormancy during the dry season. The best basic irrigation regime is to mimic a good, long rainy season. Watering can start about October 1, be discontinued once rains begin, resumed again when the rains end, and then tapered off during May.

Most shrubs of the chaparral have a deep taproot but also have branch roots near the ground surface to collect water from showers that wet only the upper soil layers. If supplemental watering is desired during summer, it should be infrequent and light. Here again, nature is the model. In the Central Coast region of California, natural rainfall in summer is rare and light.

Some plants can provide cues for the timing of summer watering. Bush monkeyflowers (the woodier *Mimulus* species) can be used as indicator plants; when they start to look dry and wilted, other plants in similar conditions will benefit from a light watering. The monkeyflowers are an exception to the requirement for summer dormancy and can even be kept in nearly continuous bloom if they are cut back halfway after bloom and then watered. Bush monkeyflowers are usually deer-proof and fully drought-tolerant, and are more versatile than many natives. They are on some fire-resistant plant lists, but Bert Wilson's experiment found that when they are dry and dormant they ignite readily.

DEFENSIBLE SPACE

By law in California, 100 feet of defensible space is required around homes and other structures. This creates a safe working area for firefighters to protect structures.

First 30 feet: "Lean, Clean, and Green"

Vegetation must be very low in volume and density. This does not translate to a barren moonscape, but it does mean low groundcovers and/or hardscape are dominant.

Next 70 feet (or to the property line if closer):

"Reduced Fuel Zone"

Create horizontal and vertical spacing between plants. The amount of space will depend on how steep the slope is and the size of the plants.

In Santa Cruz County, islands of low vegetation less than waist high may be scattered in the Reduced Fuel Zone for aesthetic and wildlife values. Some examples for different areas are listed below:

For Sun

- manzanitas (*Arctostaphylos* spp., low-growing forms)
- coyote bush (*Baccharis pilularis*)
- ceanothus (*Ceanothus* spp., low-growing forms)
- sedges (*Carex* spp.)
- buckwheats (*Eriogonum* spp., low-growing varieties)
- irises (*Iris* spp. and hybrids)
- sages (*Salvia* spp.)

For Part Shade

- huckleberry (*Vaccinium ovatum*)
- irises (*Iris* spp. and hybrids)
- snowberry (*Symphoricarpos albus*)
- California blackberry (*Rubus ursinus*)
- alum root (*Heuchera* spp.)

For Shade

- western bleeding heart (*Dicentra formosa*)
- western sword fern (*Polystichum munitum*)

CONCLUSION

One way to think about fire-resistance is to landscape as if you have a view: keep plenty of space open so you don't block the view. If you don't have a view, make one by

TOP: A combination of thinning and limbing up creates a shaded fuel break, reducing the intensity and speed of a potential fire. This is a sensitive way to handle rare shrubs such as silver-leaf manzanita (*Arctostaphylos silvicola*). To prevent erosion, the ground has not been scalped (cleared to bare soil). • MIDDLE: Island plantings are a good way to create separation in the vegetative fuel surrounding homes. Their presence reduces the spread of wildfire, while adding focal interest to the landscape. Here, a small island planting is located between two larger islands in the salvia garden at Cabrillo College in Santa Cruz County. More island plantings can be seen by zooming in to the Google Earth view of the UCSC Arboretum. • BOTTOM: Where space is available, a perimeter orchard of dwarf fruit trees can create a fuel break.

placing a garden structure or featured plant where it creates a focal point away from the house. Another way to think about fire-resistance it to picture a chess game after the game is halfway played and the remaining pieces are widely scattered across the board. There may be a cluster or two, but there are broad open spaces as well.

There are other considerations that contribute to fire-resistance in a landscape, but the two most important ones are plant geometry and horticultural practices. Although there can be no guarantees in the event of a wildfire, effective design and horticultural practices can dramatically shift the odds in one's favor.

There are many ways to accomplish a balance of defensibility, aesthetics, and ecological value. Three similar properties on a given hillside may achieve all these goals in three different ways.

REFERENCES

Cal Fire. 2009. Living with fire in Santa Cruz County. Contains detailed recommendations for separation distances between trees and shrubs on slopes and other useful information.

Church, T. 1983. *Gardens are for People,* 2nd ed. McGraw-Hill Book Company, San Francisco, CA.

Dawson, J. and R. Lucas. 2005. *The Nature of Plants: Habitats, Challenges, and Adaptations*. Timber Press, Portland, OR.

Fire Safe San Mateo County. 2010. *Living With Fire in San Mateo County.* Different counties have similar but not identical guidelines.

Santa Clara County FireSafe Council. 2009. *Living With Fire in Santa Clara County.* Similar to the Santa Cruz County version.

Wilson, B. 2005. Leaf burn times of California native plants. http://www.laspilitas.com/classes/fire_burn_times.html (accessed November 1, 2008).

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WILDFIRE SAFETY: LESSONS LEARNED FROM SOUTHERN CALIFORNIA

by Greg Rubin

The great San Diego wildfires of 2003 and 2007 have taught us a number of lessons, and surprisingly, much of the conventional wisdom is flying out the window. The truth is that none of *our* landscaping clients lost their homes despite being surrounded by native plants, despite being in the middle of these firestorms, and despite having neighbors with conventional landscapes whose homes burned to the ground. While there are many who still believe that if you plant native shrubs near your home, they will spontaneously combust and burn down your house, the reality is quite the opposite.

SAFETY IN NATIVES

So what is it about native landscapes that can lead to such fire resistance? One thing that contributes to it is to hydrate the plants with overhead irrigation throughout the warm months, from roughly early June to mid-October. The amount of moisture delivered can be slight—approximately a quarter inch of precipitation per watering. That equates to about 40 minutes on a rotator type system. The watering interval on an established landscape is once every 10-14 days, depending on location and exposure. Steep inland slopes may be watered as frequently as every 7-10 days, again depending on exposure. Each watering is about equivalent to a summer thunderstorm or fog drip—well within the tolerance range of most natives. The goal is to "dust off" the leaves (dust can actually become a problem on such drought tolerant landscapes!), wet the mulch, but not saturate hot soil. This helps avoid pathogen problems.

ABOVE: **During the Witch Fire of 2007 a non-native rosemary (*Rosmarinus officinalis*) on the left was incinerated next to a volunteer flat-top buckwheat (*Eriogonum fasciculatum*), which, though scalded, survived. Both were receiving twice monthly irrigation. Clearly this was enough hydration to ensure low combustibility in the native buckwheat but inadequate for the non-native rosemary. RIGHT: Green leaves are still evident on the *Eriogonum fasciculatum* (foreground) if you look closely, while all that remains of the *Rosmarinus officinalis* is a black smudge (background). All photographs by the author.**

Native leaves are able to absorb the overhead moisture, and it appears that they hang on to that moisture even in the face of flames. Other plants surely exhibit these properties; however, it typically requires much less water to hydrate a native

plant than an exotic. Ironically, it is often the plants that we think of as highly combustible that end up benefitting the most from this supplemental watering.

In fact, it seems that fire resistance in natives has less to do with plant selection than with hydration. An interesting study was conducted by Bert Wilson of Las Pilitas Nursery (*www.laspilitas.com*) where he examined the relative ignition times of various native and non-native plants when exposed to a propane torch. He also noted whether they were hydrated or not. Although not a scientifically controlled study, it is fairly unique and useful as a relative measure. Some plants that would ignite in 15 seconds took over a minute to do so once hydrated. Many of the ignition times for natives were far in excess of those for non-na-

TOP: A home that survived both the 2003 and 2007 San Diego fires. The house is surrounded completely by an 8-foot-wide decomposed granite apron. The plantings immediately outside this zone and for the first 30 feet are hydrated, low-growing, and well-spaced. BOTTOM: The same house, with the first 30 feet of well-watered plantings hidden behind a low rock wall. Outside of that perimeter are planted native groundcovers that are being irrigated about every 10 days in summer. Note also that in this particular case, a road (in the foreground) was constructed around the house approximately 100 feet away. This "country lane" actually doubles as a fire-break, which gives firefighters easy access. Note also the use of metal roofing to prevent embers from igniting the structure.

tives. It should be noted that Bert was also a volunteer firefighter for San Luis Obispo County for 14 years.

CLEARING VS. THINNING

In the panic that followed our great San Diego firestorm of October 2003, many agencies and insurance carriers required that surrounding property be cleared 100, 200, even 300 feet or more. This resulted in environmental devastation of huge swaths of land, horrible erosion problems, and the establishment of non-native grasses and weeds that become flashy fuels by the following August. Worse still, many homes whose surrounding landscape had been cleared to bare mineral soil for hundreds of feet *still* burned to the ground, sometimes surrounded by green lawn and palm trees. This certainly ran counter to the conventional wisdom that wholesale removal of vegetation (considered fuel for any fire) would prevent this kind of thing from happening.

As a former aerospace engineer, it also occurred to me that clearing all vegetation around a home actually created the perfect conditions for the high winds that accompany large fires to flow unperturbed (laminar flow). There was no longer any barrier to create turbulence or interference and slow down the 80 mph bone-dry winds laden with cinders as thick as the fire falls of Yosemite. Nothing, that is, except the houses. As chaparral ecologist Richard Halsey explains it, "You have created the perfect bowling alley for embers." On the other hand, low-growing, hydrated groundcovers and shrubs can disturb and cool the otherwise uninterrupted flow of fire. Allowing thinned natural vegetation to remain, in addition to landscape plantings that are irrigated, may in fact help prevent structures from igniting. This brings us to the subject of fire zones and defensible space.

ZONING AND DEFENSIBLE SPACE

It is critical that firefighters have an area or zone around a house where they can safely fight a fire. This is what is known as "defensible space." The first 30 feet is probably the most critical. This is where a passing fire crew quickly assesses whether it is safe to stop and set up a perimeter or move on. This first zone is where you want to have a considerable amount of hardscape—flagstone, boulders, pavers, cement, gravel, etc. Plants should be either lower growing or have an open "see-through" structure so as to limit potential fuel for a fire. They should be hydrated with once-per-week watering. Many native perennials and low-growing shrubs would fit the bill here. Try to avoid planting directly under the eaves, beginning plantings three to four feet out from them.

Zone 2 is the area that is 30 to 100 feet from your house. (This may extend up to 300 feet if your house is located on a ridge or at the end of a north- or east-facing box canyon. If there is existing chaparral growing in Zone 2, thin it by about 50%, because this actually removes about 70% of the fuel volume. Clear cutting or bulldozing only creates more problems. Thinning implies cutting the shrubs to the ground, but *not* removing by the roots. This prevents further erosion and soil disturbance that will bring up even more weeds. Chamise (*Adenostoma fasciculatum*), laurel sumac (*Malosma laurina*) growing near the house, and maybe some buckwheat (*Eriogonum fasciculatum*) and sage (*Salvia* spp.) are targeted first for thinning. Plants like manzanita (*Arctostaphylos* spp.), California lilac (*Ceanothus* spp.), hollyleaf cherry (*Prunus ilicifolia*), lemonadeberry (*Rhus integrifolia*), and bush rue (*Cneoridium dumosum*) are usually preserved,

These two photos depict the before and after condition of a stand of chaparral that has been thinned to roughly 50% canopy coverage. Debris has been chipped and replaced on site as a mulch to help prevent weed germination in the open areas. This area is now much more fire-resistant without resorting to clearing it entirely of native vegetation.

Once impenetrable chaparral in Zone 2 (30-100 feet from this person's home) has been transformed into a fire-resistant native "private park" through vegetation thinning, paths, a bench, a bridge, a bird bath, and the addition of some non-woody native perennials.

makes nutrition available to the invasives. The process of removing 50% of the existing canopy (thinning the chaparral), although not as invasive as wholesale clear-cutting or removal, is still a type of disturbance that allows for infection by weeds, much like an open wound.

If left to their own devices, weeds will severely compromise the ecology of native plant communities by robbing moisture and nutrition from the system. Worse, they act as fire ladders into the remaining native shrubs and trees that are now weakened and even more fire prone. This is the worst of all possible situations—an unhealthy plant community depleted of its moisture and full of the driest tinder so that the vegetation can easily combust. The fact that annual weeds are dead and dry by the end of summer is what leads to desertification (land degradation to desert-like conditions due to climatic changes and/or destructive land-use practices). Humidity levels actually drop in these weedy areas because none of the moisture is being held onto in living tissue. Unfortunately, this describes much of what is happening in California.

Controlling annual weeds can be a challenge. Certainly using mulched tree trimmings helps. Hand pulling may be enough when the amount of weeds makes it practical. However, with a typical seed bank of 10,000 to 100,000 seeds per cubic foot, post and/or pre-emergent chemical treatment may be required. Whatever method is chosen, it is essential that

although dead wood should be removed.

It is advisable to open up their structure when possible by pruning lower branches. All trimmings should be mulched and then placed back on the areas that have now been thinned out, to help suppress weeds. This is also an opportunity to lace the area with four-to-five-foot-wide paths that double as firebreaks and which further open up the vegetation. One can bring in benches, bird baths, non-woody perennials, signage, and other features to transform once impenetrable chaparral into an inviting, mature native landscape. The environment does not have to be destroyed in the name of fire safety. There are many creative, aesthetic landscaping "solutions" that lower the risk of fire danger.

MAINTENANCE CONSIDERATIONS

Good site maintenance is of paramount importance when it comes to fire safety. Non-native weeds are typically annuals and perennials that are dead or dormant by August. They tend to be rich in "lignin" which means their dry, dead carcasses sit on top of the soil, having robbed the system of nutrients and moisture. Compare this to wildflowers, which usually get reabsorbed into the soil after they die, so that by summer there is little evidence of the previous spring's show. Unlike native chaparral that tolerates intense but infrequent fires, non-native weeds welcome and promote frequent burning. It is therefore essential that they be controlled and removed.

Most native plant communities, by virtue of their specialized and finely adapted ecology, do not support the growth of non-native annual weeds when in a healthy and undisturbed condition. This is because the litter layer (mulch) that forms kills most weeds. In addition, most of the native plant community's nutrition is held in the mycorrhizal fungi and is not made available to the weeds (which are usually non-mycorrhizal). Disturbing the plant community opens up the canopy and the site be maintained as weed-free as possible once it has been opened up.

Another important maintenance step is continuing to keep the canopy coverage pruned to around 50%. Whenever possible, trees should be pruned up from their base six feet. Lower perennials and shrubs should be kept pruned to a height of about 18" when practical. A good rule of thumb is to provide clearance *between* tree limbs and groundcover (shrubs, perennials) that is a minimum of three times the height of the lower plants. All dead wood needs to be removed. In addition, most of the plants that have been cut to the ground (like chamise) will regenerate from basal burls. While they can be allowed to grow for up to one year, they will have to be cut to the ground again once their newer green growth starts to become woody.

If Zone 2 (30 to 100 feet from the house) is devoid of naturally occurring vegetation and is instead planted in irrigated natives, the maintenance should be fairly straightforward. The plants should mostly be lower-growing (under 18") and spaced for final size. This prevents plants growing on top of each other and forming a woody thatch. Shredded redwood bark (gorilla hair) that has been matted down with water so that it is poorly aerated is the mulch of choice and is usually quite effective at controlling annual weeds, especially when combined with hand weeding, or with pre-emergents in large, hard to maintain areas where hand pulling simply isn't practical. The next section details plant selection and protocols for a firewise native landscape.

FIREWISE PLANNING AND PLANTING

Zone 1 must be irrigated, ideally with overhead irrigation once a week. This ensures that the plantings are always hydrated and less likely to burn. There should be lots of hardscape (flagstone, interlocking pavers, decomposed granite, gravel, etc.), including an apron of these same materials that extends beyond the eaves line. There are a number of native plants that will both tolerate this frequent watering and provide low fuel volume. Some attractive evergreen shrubs meeting these requirements include lower-growing manzanitas like *Arctostaphylos* 'Carmel Sur,' 'Radiant,' 'Emerald Carpet,' and 'Pacific Mist,' as well as medium-height manzanitas like 'Sunset' and 'Howard McMinn.'

Lower-growing, garden-tolerant wild lilacs would include *Ceanothus thyrsiflorus repens*, and *Ceanothus gloriosus* 'Heart's Desire' and 'Anchor Bay'. Native perennials that could tolerate these conditions would include seaside daisy (*Erigeron glaucus* 'WR'), Mattole River fuchsia (*Zauschneria* [*Epilobium*] *septentrionalis*), and goldenrod (*Solidago* spp.). Monkeyflower (*Mimulus aurantiacus*) may be shorter-lived under these conditions but will certainly put on a show for the two to five years it survives (just get a new one when it dies). Decorative 6-12" boulders placed on the rootballs of the plants surrounded by gorilla hair can be used for mulch, but the bark must be watered down to consolidate it immediately after planting.

Zone 2 ideally consists of either thinned chaparral or lightly hydrated native plantings. Coyote brush (*Baccharis* 'Pigeon Point'), California lilac (*Ceanothus* 'Yankee Point'), manzanita (*Arctostaphylos* 'John Dourley'), and San Diego marsh elder (*Iva hayesiana*) are all excellent choices if this area is to be planted. A smattering of larger shrubs, such as Ceanothus 'Blue Jeans' and 'Concha,' coffeeberry (*Rhamnus* 'Eve Case' and 'Mount San Bruno'), and toyon (*Heteromeles arbutifolia*) are all fine as long as they are situated in groups of three or less to prevent creating a large fuel mass. There should be about 10 feet between these small groups of larger shrubs. It is also a good idea to create small firebreaks by incorporating lots of trails in this area that are at least four feet wide. Fully established Zone 2 plantings must be irrigated about once every 8-14 days during the warm months with overhead irrigation in order to promote adequate hydration. The possibility of lightly irrigating existing chaparral in Zone 2 (wetting leaves and mulch, but not to the saturation point) is being investigated by the author.

CONCLUSION

Fire in Southern California is an unfortunate inevitability; however, homeowners can create defensible space around their homes that avoids wholesale environmental destruction. Proper hydration of landscape plants is critical. Utilizing a large proportion of hardscape within the first 30 feet of structures, along with plants that are low-growing, contain a low fuel volume, and are regularly irrigated is recommended. Beyond this first zone, lightly watered native plantings or chaparral thinning is a good practice, especially when considering that it typically takes much less water to hydrate native plants than exotics. This, in combination with good site maintenance, should help keep homes defensible during fires.

REFERENCES

Halsey, R.W. 2008. *Fire, Chaparral, and Survival in Southern California,* 2d ed. Sunbelt Publications, San Diego, CA.

Wilson, B. 2011. A Manual of California Native Plants, http://www.laspilitas.com/cat1.htm. (accessed March 31, 2011).

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THE MENDOCINO COUNTY FIRE SAFE COUNCIL

by Julie Rogers

It was the spring of 2003. Due to budget constraints, the California Department of Forestry and Fire Protection (Cal Fire) had decided to close the Ukiah Air Attack Base, responsible for fighting wildfires in Mendocino County and beyond. The residents of our rural county were not pleased, and the fight was on.

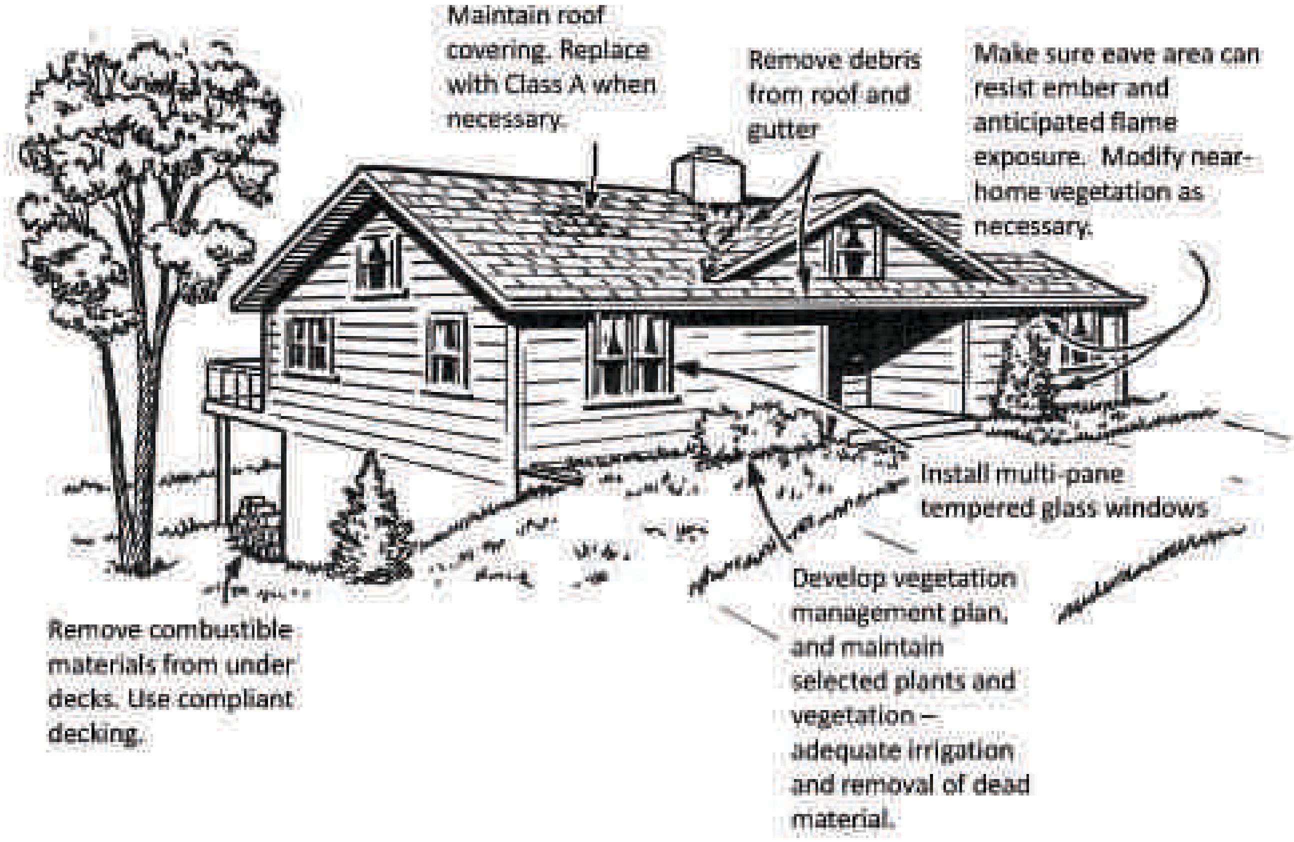
Colin Wilson was the perfect person to represent our county's cause. Imposing, articulate, and persuasive, the president of our County Fire Chiefs' Association told the State Board of Forestry that, without aircraft, his ability to fight wildfires in Mendocino County would be severely hampered. The Board listened, and soon funding for the Base was restored.

Long a fan of our fire-fighting planes, I joined the cause, and so was introduced to the wide, wide world of wildland fire and its impacts on people, homes, and the environment. Soon I learned that many of our residents were petrified by fear of wildfires. Their homes were on steep, wooded hillsides far from fire stations. They counted on aircraft to be there quickly to protect them. What would happen if the planes were gone?

Listening to such stories, I was struck by the helplessness they conveyed. Then a town dweller myself, I wondered why people moved into

ABOVE AND LEFT: Research shows that small embers entering attic vents are the most common cause of home destruction in wildfires. Above photograph by D. Koski. Left photograph by P. Armstrong. • BELOW: The widespread destruction caused by the 2003 Cedar Fire in San Diego County motivated fire chief Colin Wilson to found the Mendocino County Fire Safe Council. This was the largest wildfire in California history, tragically killing 15 persons, burning 2,227 homes, and consuming 280,000 acres of wildlands and suburbs in San Diego County. Photograph by D. Koski.

GUIDELINES FOR A FIRE-SAFE HOME



A pictorial summary of key preventative measures homeowners living in the wildland-urban interface can take to minimize destruction from wildfires. Diagram taken from ANR publication #8392, Home Survival in Wildfire-Prone Areas; Building Materials and Design Considerations, http://anrcatalog.ucdavis.edu/Items/8393.aspx, ©2010 Regents of the University of California. Used by permission.

remote areas if they weren't prepared to face the risks. Shouldn't they take some responsibility for themselves? I asked Chief Wilson, "Does our county have a grassroots effort to prepare for wildfires?" His response: "No, but I wish we did." We agreed to stay in touch.

At a workshop that winter we first heard of "Fire Safe Councils." These groups were accomplishing great things, and their model seemed right for our county. So our effort began. In January 2004, 90 people attended our first public meeting. Chief Wilson, who had just returned from a deadly fire "down south," showed slides of daylight turning to darkness as communities were engulfed by smoke and flames. He expressed a vision of people prepared to meet all the challenges wildfires might bring. Attendees responded with enthusiasm and support, and the Mendocino County Fire Safe Council (MCFSC) was born (*www.firesafemendocino.org*).

Just what is a Fire Safe Council? It is a group of persons concerned about wildfire safety in their local area and working to improve it. The group can be whatever size, form, and scope the local needs require. The MCFSC serves an entire county, but in many areas a regional, watershed, or community boundary is more practical. Ours is an autonomous nonprofit corporation, but in other places Fire Safe Councils are affiliated with county governments, Resource Conservation Districts, other nonprofits, and fire agencies, or are completely independent with no affiliation or formal structure at all.

Some small groups have chosen also—or instead—to become Firewise Communities. The Firewise program, sponsored by the National Fire Protection Association, provides incentives for communities to continue improving their wildfire preparedness year after year (see *www.firewise.org*). We are now incorporating this excellent program into our outreach activities.

Our Fire Safe Council is equipped to apply for, receive, and manage funding available to groups like ours. To date we have secured nearly $800,000 for wildfire preparedness projects. We produced our county's Community Wildfire Protection Plan (CWPP) in 2005, and have created two editions of a non-technical, easy-to-read publication called "Living with Wildfire in Mendocino County" (*http://firesafemendocino.org/pdf/index.html*).

RESOURCES FOR MORE INFORMATION

Fire Safe Councils. This article includes a section on starting a Fire Safe Council, and an updated list of existing Fire Safe Councils. *http://en.wikipedia.org/wiki/Fire_safe_councils*

Firewise, a national program promoting homes that are not only "defensible" but also "survivable" without firefighters' intervention, *http: //www.firewise.org* and *http://firewise.org/usa/index.htm*

U.C. Berkeley's Center for Fire Research and Outreach, *http://firecenter.berkeley.edu*

Mendocino County Fire Safe Council, includes several publications written by the Council, as well as links to other resources, *www.firesafemendocino.org*

CAL FIRE (California Department of Forestry and Fire Protection, formerly called CDF), *http://www.fire.ca.gov* and *http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland.php*

Firefighters United for Safety, Ethics, and Ecology, which strives to balance fighting fires with the environment's needs: *www.fusee.org*

"How to Plant Weed Wise and Fire Safe: A Guide to Keeping Inland Mendocino County Safe and Beautiful," *http://www.firesafemendocino.org/pdf/FireSafe%20Landscaping.pdf*

But the rubber truly meets the road at the local level. Seven years into our work, a dozen local fire safe groups have formed. Each is addressing situations in its own road association, subdivision, ranch, or neighborhood that hinder its safety and emergency response efforts.

Exactly what are they doing? Moving flammable materials away from homes, reducing brush along narrow roads, creating accurate maps for firefighters and medics, posting reflective road and address number signs, starting phone trees, and making their home water supplies accessible for fire-fighting. (An excellent four-page pamphlet, "Developing Home Water Supplies for Fire Protection" is available at *http://firesafemendocino.org/pdf/watersupply.pdf*.)

This house is burning, even though surrounding vegetation is not, suggesting that it was ignited by embers and not by nearby trees. Photograph by D. Koski.

Crucially, they are also heeding the advice of U.S. Forest Service researcher Jack Cohen to make their houses resistant to airborne burning embers produced by wildfires, as these are the top cause of home destruction from wildfires. Cohen says that "little things" like litter on roofs or decks and in rain gutters, plants in wooden planters, jute doormats, brooms, and lawn furniture cushions are often what ignite first from embers. U.C. Cooperative Extension researcher Steve Quarles has found that burning embers frequently invade attics and under-deck spaces; he recommends covering all such openings with metal mesh of 1/8" or less. Both researchers have found that little embers blowing inside attics are the major culprits in homes being lost to wildfires. They also warn homeowners to replace wood shake roofs with fire-resistant ones, as shake roofs—and the homes they cover—almost never survive wildfires.

Armed with knowledge, people in our county are deciding what they will do when a wildfire approaches. Will they be able to evacuate safely? If not, what are their alternatives? They may need to go to a safety zone—a large outdoor area previously cleared of flammable items—or to a home that has been especially well prepared, as described above. In addition, a few able-bodied, well-trained, and properly equipped persons may plan to stay in the area to put out little fires before they become big ones, knowing that smoldering embers can cause homes to ignite up to eight hours after the fire front has passed. Overall, and most important, neighbors are meeting neighbors, sharing resources, and working together for their common safety.

What is the relationship between our county-wide council and local ones? It is one of support. The MCFSC does not tell local groups how to organize or what to do. We do not require them to elect officers or keep meeting minutes. In fact, we strive to spare them from administrative tasks so they can focus on resolving their on-the-ground needs. We provide suggestions, education, networking, resources, and assistance as requested, knowing that each group has its own values, concerns, and abilities. If a group's needs exceed their means—as, for example, if their roads are overgrown and their residents frail—we seek assistance on their behalf. We apply for funding and administer the project when funding arrives.

How do local groups begin? Most often, one or two persons contact us, worried about their neighborhood's overgrown brush. We offer to attend a road association meeting, social event, or informal roadside gathering to explain our work. Usually a few persons step forward to lead. They want to meet again and involve more people. Another date is set, and a local fire safe group is born.

Over the years, the Mendocino County Fire Safe Council's perspective on wildfires has dramatically changed. When we first began, I viewed fire as only an enemy to be fought and feared, an invader that threatened to destroy everything in its path. Now I know that wildland fire is an integral natural process in the California landscape and that we humans have in fact invaded its turf! Following are some insights I have gained:

1) Many homes have been built in locations where fires historically burned lightly and frequently across the landscape, reducing flammable vegetation and benefiting local flora and fauna.
2) In an effort to protect those poorly placed homes, wildland fires have been so vigorously suppressed that the ecosystems are disturbed and the vegetation overgrown.
3) Most fire agencies view all wildland fires as enemies to be attacked rather than potential partners in maintaining healthy ecosystems.
4) Fear of liability has nearly eliminated the beneficial practice of prescribed fire (controlled burns conducted under strictly limited conditions).
5) Many wildland residents do not understand true forest health, but consider thick forests with heavy underbrush to be "natural," although historically they are not.

Researcher Jack Cohen maintains that today's wildfire "disasters"—fires in which many homes burn—are primarily the result of a "fire exclusion paradigm," the longstanding American attitude that fire is always bad and must be stopped. But wildland fire can be our friend, and this is precisely what the MCFSC now teaches. We explain that if we understand how fire behaves, accept the risks of living in wildland environments (often referred to as the wildland-urban interface or WUI), and prepare ourselves and our homes to survive, we can truly "live with wildfire."

Whatever their size, form, or approach, Fire Safe Councils, Firewise Communities, and similar groups are gradually improving Californians' ability to survive and thrive in wildland areas. Is there a Fire Safe Council in your area? If so, join it. If not, help start one, or look into becoming a Firewise Community.

Together we can greatly reduce the damage that wildfires cause to homes in fire-prone areas and can move toward restoring our ecosystems to good health.

Air tankers offer invaluable assistance to firefighters on the ground, but the fire retardant they carry must be delivered carefully due to its detrimental impacts on waterways. Photograph by P. Armstrong.

REFERENCES

Cohen, J. The wildland-urban interface fire problem: A consequence of the fire exclusion paradigm. *Forest History Today*, Fall 2008, http://www.foresthistory.org/publications/FHT/FHTFall2008/Cohen.pdf

Quarles, S.L. 2010. Home survival in wildfire-prone areas: Building materials and design considerations, https://ucanr.org/freepubs/docs/8393.pdf

Stephens, S.L. et al. 2009. Urban-wildland fires: How California and other regions of the US can learn from Australia. *Environmental Research Letters* 4:1 014010, http://iopscience.iop.org/1748-9326/4/1/014010/pdf/1748-9326_4_1_014010.pdf

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NEW CNPS FELLOW—TERESA SHOLARS

by Lori Hubbart

As a teenager, Teresa Ann Sholars fell in love with wild California, despite an urban upbringing. Her home town, the San Joaquin Valley burg of Fresno, was fairly close to the mountains, where her family had a cabin. As a lanky tomboy of 14, Terry Baxter landed a summer job that helped set the course of her life.

Her family had friends who raised cattle and horses, and every summer they moved with their herds up to mountain pastures in the Sierra Nevada. Terry signed on as a babysitter for their young child, but then she saw ranch hands riding cutting horses, herding livestock, and tracking strays through the wildlands. That work called to her in a powerful way that babysitting did not, and she persuaded them to let her switch jobs. Thus began the wild career of Terry the Teenage Summer Wrangler.

Those summers in the High Sierra nurtured her spirit and convinced Teresa to seek a career working with nature. Her family may have been taken aback, but she pursued her goal with the steely determination of a wrangler going after a stray heifer. She received a B.S. in environmental planning and management from the University of California, Davis, in 1974 and an M.S. in ecology from Davis in 1975. Those were the days when botany students spent a lot of time in the field, with gracious, larger-than-life older scientists as their mentors.

Teresa has golden memories of working with some stellar botanists, such as following Jack Major and Ledyard Stebbins as they clambered up hillsides seeking interesting plants.

One special memory is of a field trip with Herbert Mason for a class on aquatic ecology. She was also intimidated, sitting next to the author of the classic *Flora of the Marshes of California,* and remembers clearly his answer to her question of how one goes about writing a flora. His answer: "Just do it!"

She also found someone who shared her dream of combining science, learning, teaching, regional specialization, and homesteading. He was a fellow graduate student, the brilliant, charismatic Robert E. Sholars. They got married and headed north to study the gnarled and picturesque "pygmy forest" of Mendocino County.

Together they set about discovering and defining the relationships between the plants and the extreme, highly acidic "pygmy" soils. They were lucky to work with a pioneering older scientist, Hans Jenny, professor of soil science at U.C. Berkeley. Teresa and Rob often rode horses to their pygmy forest research sites, and she remembers digging a thousand test holes in the soil.

Taking a break with her companion Max in the Sierra National Forest just outside of Yosemite National Park. Max travels with Teresa on all of her plant collecting trips, and is a most agreeable botanizing partner. Photograph by L. Foote.

Teresa teaching a 2007 Lupine identification workshop for the Pacific Northwest Herbarium Conference in Idaho. Photograph by B. Ertter.

Robert E. Sholars' short but important book, *The Pygmy Forest and Associated Plant Communities of Coastal Mendocino County*, came out in 1982. The couple, along with their good friends, Hans and Jean Jenny, were very involved in education and advocacy on behalf of the pygmy forest. They worked for public acquisition of a notable pygmy sphagnum bog site, and Rob and Jean provided information that helped win the Sierra Club's lawsuit to protect pygmy forest in the Coastal Zone.

While still graduate students, Teresa and Rob had joined the Dorothy King Young Chapter of the California Native Plant Society. They were the "kids" of the group, since most of its members were translocated retirees. They were all thrilled to be learning about native plants together.

In 1986 Teresa, while on sabbatical from the College of the Redwoods, began her Ph.D. program in botany at U.C. Berkeley, where she worked under her major professor, Robert Ornduff. She sat at the Jepson tea times with venerable botanists like Lincoln Constance, Laura May Dempster, Annetta Carter, and got to know Barbara Ertter, who remains a close friend. The huge *Jepson Manual* project was underway, but several genera lacked authors. Jim Hickman, its first editor, asked Teresa to author the genus *Lupinus*.

It was a hard but exhilarating time, sharing a country homestead with her husband and three lively young children. They had gotten through losing their first house in a fire, but then in 1988 Rob Sholars was killed in an auto accident. Teresa then threw herself into raising her children and teaching natural history at the College of the Redwoods in Fort Bragg. Her hopes of completing her Ph.D. faded under the weighty responsibilities of being a single parent and family breadwinner.

The work revising the taxonomy of lupines challenged her intellect and helped her stay focused on botany. As a research associate at the Jepson Herbarium, Teresa was able to study lupines all over the state, sometimes in the company of distinguished botanists. The camaraderie, the mental stimulation, and the beauty of California's wild places helped her rebuild her life.

Teresa's many friends from her CNPS home chapter, Dorothy King Young, were tremendously supportive of Teresa during those hard times. Chapter members were thrilled and proud when she began working on lupines.

In 1987 Teresa began serving as rare plant coordinator for the chapter, a position she still holds. Over the years she has given many talks and field trips for the chapter, and has inventoried and written plant lists for many important natural areas within the chapter's purview.

Perhaps most importantly, she has been the linchpin of the Chapter's unofficial, but vital conservation committee. In that role she has actively advocated for conservation of rare plants and plant communities, written letters, testified at public meetings, and met with a variety of stakeholder groups. She has also provided critical scientific information for chapter conservation chairs and presidents.

In 36 years of teaching in the Life Science Department at the College of the Redwoods, Teresa has introduced countless students to native plants and to CNPS. She has become a mentor to some students who have gone on to careers in botany or ecology in academics, agencies, or conservation organizations. Many returning students need Teresa's classes in order to be more effective in their work.

In a county with no four-year colleges, she has personified the principles behind scientific inquiry. Her educational and outreach work has given credibility to the biological sciences, native plants, and CNPS.

Now married to Michael Lloyd, a law enforcement officer, writer, and organic gardener, Teresa finds herself in the position of mentor and elder stateswoman of botany. She is currently finishing the treatment of *Lupinus* for the *Flora of North America*. We hope her life and work will inspire younger people to devote themselves to the natural history of particular regions.

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On a mule in the mountains of northern Baja California, holding a new subspecies of *Haplopappus* (the former botanical name for what is probably *Ericameria arborescens* var. *peninsularis*). The image is characteristic of Reid's sense of humor.

REID MORAN: 1916–2010

by Thomas Oberbauer

Reid Moran, a well-known expert on succulents and especially the genus *Dudleya,* the foremost authority on the plants of Baja California and Guadalupe Island, and a CNPS Fellow, died on January 21, 2010 in Lake County, California. Reid was an explorer, scholar, folksinger, and an extraordinarily dedicated scientist and botanist.

Reid was born June 30, 1916 in Los Angeles to parents who had grown up in San Luis Obispo. Early on, Reid was interested in geology like his father, and botany, publishing his first paper at the age of 17. His education at some of the most prestigious universities took a number of twists and turns. After communicating with a professor from Stanford University, he was accepted there. However, his studies were delayed one year when he took a spring and summer off to work in a placer (open-pit) mine in Alaska, collecting plants in his spare time. He graduated from Stanford in 1939 and then attended classes at the University of California, Berkeley.

Reid Moran in his office at the San Diego Natural History Museum in the early 1980s. All photographs courtesy of the San Diego Natural History Museum.

He also conducted studies on the California Channel Islands, worked as a park naturalist in Yosemite Valley, and attended the Yosemite Field School during the spring and summer of 1941. The Field School, which embodied the principle of parks as a place for education and study, was the first such school for the National Park Service and provided seven weeks of intensive study for nature guides. In Yosemite, he made contact with a professor from Cornell University, which he later attended, receiving a master's degree in 1942. At Cornell, he began a long friendship with Robert Thorne who later became director of the Rancho Santa Ana Botanic Garden.

World War II interrupted his studies, and he enlisted in the Army Air Corps. He was called up for duty in 1942 as a navigator on a B-24 bomber. His plane was shot down on its first mission and he parachuted into Yugoslavia. He was shipped back home, but on the way took a very slow passage with circuitous routes, including a hitch hiking foray through North Africa with stops in Algeria and Dakar, and a course through Brazil, collecting plants on the way. He was awarded the Distinguished Flying Cross and was discharged in 1946.

For a year and a half, he worked at the Santa Barbara Botanical Garden, but when given the opportunity to be groomed as its next director, he decided the position would be too confining. It was also during this time that he visited Guadalupe Island for the first time, accompanying George Lindsay who later became the director of the California Academy of Sciences. Reid then returned to UC Berkeley, working as the herbarium botanist and obtaining his Ph.D. in 1951. He then returned to Cornell and worked at the Bailey Hortorium (at the time the major U. S. center for the systematics of cultivated plants) for a couple of years. Later, he taught biology to American military forces in Japan and Korea, exploring nearby countries and collecting plants, particularly the Crassulaceae. By that time, George Lindsay was director of the San Diego Natural History Museum and was looking for a botanist. Reid took the job in 1957 and stayed for a quarter of a century.

Reid became very interested in Baja California. In 1963 and early 1964, he participated in a rugged, three-month long expedition traveling by mule down the central portion of Baja California. The purpose of the trip was to explore areas where no botanist had set foot before. During the journey, one of the mules was killed by a mountain lion and two others died of thirst. He took part in other expeditions including hiking solo the length of Angel de la Guarda, a 45-mile-long desert island in the Sea of Cortez. He also hiked over the top of Guadalupe Island more than a dozen times.

Beside his explorations of Guadalupe Island and the mountains of Central Baja California, Reid traveled in his boxy red and white International Harvester Scout (part Jeep and part safari vehicle) on any road he could find, fording flooded streams, avoiding flooded rivers, and conducting CNPS trips for the San Diego Chapter during the 1970s. While in his office, Reid was all business, working long hours into the night, but always willing to answer a question from a sincere botanist. On field trips, such as to the Sierra San Pedro Martir in 1977, his personality changed completely around the campfire. He became the life of the party, playing any guitar that someone brought along and singing old songs such as "Blood on the Saddle" in a deep baritone voice. He was a long time member of the San Diego Folk Song Society.

Physically Reid was what some have called a "specimen." He was six foot two, with massive shoulders of solid muscle, probably due to carrying his food, water, and plant presses on his back while hiking to remote areas. He often also carried a sectional tree pruning pole that could reach several meters in order to collect plants from steep cliffs. He was partial to red and usually wore a red floppy felt hat and a red T shirt. He could survive for days eating only unheated cans of beef stew. In conversation, he spoke slowly and with purpose. In his fifties he climbed Picacho del Diablo, the 10,000 foot high rock pinnacle in the northern part of Baja California. In his mid-sixties he led a group of botanists up the nearly vertical slopes of Northern Guadalupe Island to observe the endemic palms, and in his seventies he hiked ten miles up the island to an elevation of 4,000 feet.

His publications number in the hundreds, including descriptions of new species of plants from the Sierra de San Pedro Martir, the *Flora of Guadalupe Island, Flora of Angel de la Guarda,* and as a coauthor, the *Grasses of Baja California,* and the *Vascular Flora of Isla Socorro, Mexico.* He also finished the treatment of the Crassulaceae for the *Flora of North America* in 2009, and he is coauthor with Robert Thorne of *Vascular*

In the field sitting on a duffel bag next to the museum truck. He is examining a plant press drying setup, with the press suspended over a camp stove. It's likely he draped the tarp over the entire apparatus after he was satisfied that the stove was burning properly.

Plants of the High Sierra San Pedro Mártir, Baja California, Mexico: An Annotated Checklist that was published after his death.

Reid Moran had a dry wit and unusual sense of humor. He once published a paper in *Madroño* commemorating the collection of *Cneoridium dumosum* (bush rue) on a distant mountaintop in Central Baja California. The title was five lines long describing exactly where and when he found it. The entire text of the paper was "I got it there then." There were 28 more lines, all acknowledgments including the person who reviewed the text, his professors in college, and the person who mailed the manuscript. He also once named a plant with a term that translates into the word "silent." He indicated that it was not that the plant was especially quiet, but it was quieter than the other species in the genus.

His lectures also reflected this wit.

Reid Moran tending a plant press in Northern Baja California in 1970, and wearing his trademark red felt hat.

For example, Guadalupe Island had an endemic form of both a palm and a caracara. In a discussion of how the palms arrived on the island he stated, "It would have taken a caracara with great singularity of purpose to carry a palm fruit to the island." He also showed a blank slide to commemorate the extinction of *Hesperelaea*, a tree in the olive family from Guadalupe Island. When one visited the museum botanical collections, the title on the wall was "Hisbarium" rather than the normal term. Once when visiting the museum decades after he retired, he had cut out a heart-shaped piece of purple paper representing a purple heart for being wounded in action and presented it to Jon Rebman, the current curator, with the statement, "This is for you because you collect cacti."

During his time at the San Diego Natural History Museum, the number of botanical specimens increased from 44,000 to 108,000, with the vast majority being his. He made meticulous notes on the locations and associated species for all of his collections in a series of notebooks that are now available online at the museum's website. He seemed to have written them with the expectation that they would be read by others. He also made beautiful photographs of many of the plants he collected.

Reid moved to Northern California and married the former Ellen Boersma during the 1980s, but later divorced. He has a daughter Jenna of Washington D.C., a stepson Matthew Boersma of Santa Rosa, a sister Katharine Cashman of Reno, and several nieces and nephews.

In a short biography when he was made a Fellow of the California Native Plant Society in 1983, it was stated, "In a profession where single-minded dedication is needed, great physical endurance useful, and eccentricity cherished, Reid has always exceeded the requirements." He opened up an entire frontier for many CNPS members in Southern California, not just those from San Diego, but also those in the Los Angeles and Riverside areas.

In the July 1998 issue of *Fremontia* he wrote a large article about Guadalupe Island, its vegetation and its plight. His book on the flora of Guadalupe—published in 1996 by the California Academy of Sciences after nearly 50 years of study—was pivotal in encouraging members of the scientific world and politicians to remove the feral goats from Guadalupe Island. Reid also described a number of species considered rare and endangered in San Diego County and other parts of Southern California. Much of the information that was used in the early CNPS rare plant inventory for many of the rare plants in the San Diego region came from collections and data that he generated.

While Reid did not attend every meeting or field trip for the local CNPS chapter, he was the unofficial taxonomic and horticultural advisor to the San Diego Chapter. His field trips were real treats. He was a good educator, and his teaching and work reflected his great attention to detail. Reid Moran's passion about plants and botany is unparalleled. His work in the San Diego and Baja California region provides a scientific basis for all future studies in this region, and his personality always provided an interesting and sometimes unexpected viewpoint.

The historical and educational sections of this tribute to Reid Moran are taken from "Reid Moran, the Biography of a Botanist," written by B. Robinson, an unpublished report for Botany 496, San Diego State University, Mitchel Beauchamp, Instructor. Special thanks also to Judy Gibson from the San Diego Natural History Museum for the photographs and information in an obituary on the museum website.

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Long-time *Fremontia* designer and gardening enthusiast Beth Hansen-Winter in the stunning Oregon garden she has created. Photograph by D. Foglio.

BETH HANSEN-WINTER: CNPS DESIGNER EXTRAORDINAIRE

by Phyllis M. Faber

Beth Hansen-Winter became the designer for *Fremontia* for the July 1985 issue, and has maintained a smart, elegant look for the publication ever since. It's now been 25 years since she began designing publications for CNPS. While she has maintained a low profile all these years, *Fremontia* readers deserve to know a bit more about her.

Beth began her career of photography and design with a magazine in Monterey, California, and shortly thereafter as a designer and photographer of elegant coffee table books on Mexican art, culture, and history for a publisher in Mexico City. After returning to California, she worked as a freelance designer with Laurence Hyman, a nationally known sports publisher who had created the original *Fremontia* design and served CNPS as its artistic director. In her role working with him, Beth helped create magazines and yearbooks for such baseball teams as the New York Yankees, the Chicago Cubs, and the San Francisco Giants. Later, she also photographed ball club fans and the surrounding ambience—everything except the actual games—for a series of commemorative books on the World Series. While working with Laurence, Beth took over as designer of *Fremontia* and that has grown into a 25-year association with CNPS.

In 1984 I became the editor of *Fremontia* and welcomed Beth to the publication in the summer of 1985. In our early days of producing *Fremontia,* much of the work was done by hand. We sent manuscripts out to be typeset and Beth pasted up mechanicals using wax, Exacto knives, and a drafting table. In the mid-1990s we became computerized and our production methods changed completely. Beth did a substantial redesign of *Fremontia* around 2000, with a new cover look, new fonts, and a three-column format that allowed for more flexibility in layout design, and color was added in 2006. *Fremontia* has been and remains a distinguished voice for the California Native Plant Society ever since the journal was first published in 1973.

During the 1990s Beth also was the designer for the books the Society published—19 in all—as well as its book catalog. Over the years, she has designed books and covers for diverse clients throughout the country, but has always particularly enjoyed the botanical and natural history books that have come her way. In 1997 she completed *California's Wild Gardens* for CNPS and the California Department of Fish and Game; in 2002 she designed *The Shape of Life* for the Monterey Bay Aquarium; and in 2004 she completed *Plants and Landscapes for Summer Dry Climates* for the East Bay Municipal Utility District, three books that she's especially proud of.

Beth has lived in four countries (Kenya, India, Japan, and Mexico), traveled to many more, and is conversational in five languages (French, Swahili, Japanese, and Spanish, along with English, of course), but to me one of the most remarkable aspects of her life is her discovery and enthusiastic pursuance of the joys of the plant world. When Beth first began her association with CNPS, she was living in a warehouse studio in the Mission District of San Francisco—a building with no windows, only skylights. At the time, she could barely distinguish the difference between a rose and a daisy.

In 1994, she and artist husband Peter moved to a rental house in Petaluma, where she bought some plants for pots to make a bleak cement patio more visually bearable. There she first learned the difference between shade-loving and sun-loving plants. A year later, pots were crowded cheek-to-jowl in her garden; Beth was consuming catalogs and books and learning all the plant names, common and scientific. Before too long, her patio and garden were on the Petaluma garden tour. I was spellbound, to say the least.

In 2002, Beth and Peter moved to Oregon where they bought a lovely wooded six-acre property where Peter could build an art studio and Beth could create her dream garden. Having gone digital years before, *Fremontia* could be assembled by the use of a computer, a phone, and an occasional delightful visit. Three editors, Linda Vorobik, Bart O'Brien, and Bob Hass, have now successfully worked with her in this way.

Beth has created a stunning and magical garden in Oregon and is a mainstay and avid member of her study group in the Hardy Plant Society of Oregon, where one of her friends now refers to her as Bethipedia for her broad knowledge of plant names and horticulture. (She credits her aptitude for botanical Latin to familiarity gained from her many years working with *Fremontia* and other horticultural publications.)

So three cheers for Beth! She certainly deserves huge gratitude from both *Fremontia*'s editors and from its readers. We deeply appreciate her work, diligence, artistic creativity, and dedication.

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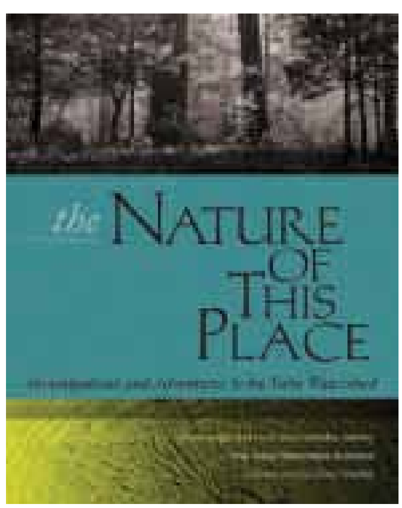
BOOK REVIEWS

The Nature Of This Place: Investigations and Adventures in the Yuba Watershed by Bruce Boyd and Liese Greensfelder, editors. 2011. Comstock Bonanza Press, Grass Valley, CA. 217 pages. $20.00, soft cover. ISBN# 978-0-933994-49-2.

What happens when a small group of people comes together out of a shared love of the land to create a true community? What if they are united by a watershed and a belief that every being in the community—not just the people, but all the animals, the plants, the small creatures, the flowing waters, and the habitat as a whole—have equal and respected rights within the community? In a community like this, nature is no longer an "it" but a "we," and is cared for by everyone. And if we are lucky, someone writes a book about it.

The Nature Of This Place is just such a book. It is an inspirational model for those of us who cherish California's wild lands and its magnificent wildflowers. It is an adventure that chronicles, with beautiful essays and historical background, how a community came together in partnership with a governmental agency to manage a forest habitat in the northern Sierra Nevada foothills of California. And, as one resident, Gary Snyder, writes in the introduction, "…this book is not only to share what we've learned so far, but will be for future readers an invitation to join in, add on, and help make the eventual transformation to a culture of durability, conscience, and sustainability possible here at the western edge of the continent and at the eastern edge of the Pacific."



The adventure that Bruce Boyd tells us began in 1991 when the Yuba Watershed Institute was born out of "a mild state of environmental militancy." The Bureau of Land Management (BLM) and the South Yuba River State Park were planning to erect a radio tower on Bald Mountain, which was a place treasured by the community for its unique serpentine Macnab cypress/ Garry oak/manzanita ecosystem and for the beautiful views of the South Yuba River canyon. The "environmental militancy" grew into a cooperative plan, as Boyd describes it, with "the enlightened BLM district manager, Deane Swickard, …to cooperate in the management of some 2,000 acres on six disparate BLM parcels."

The cooperative plan was developed with the BLM and two primary groups of residents, the newly created Yuba Watershed Institute and the local Timber Framer's Guild. Their mission was to sustainably manage the federal lands surrounding their own properties. The Cooperative Management Agreement that they created has the long-range objective to "encourage the recreation of an old-growth forest through management practices consistent with the natural process of forest succession." The management became the responsibility of the community, through the Institute and the Guild, with the BLM acting as a partner and "coach" in the effort. The group calls the lands the "Inimim Forest," after the local Maidu-Nisenan name for the ponderosa pines that grow abundantly in the area.

To educate, inspire, and get the support of local residents, The Yuba Watershed Institute created a journal in 1991 called "Tree Rings," to inform people about their work and about the rich experiences that come from knowing and loving the place in which they live. From articles, sketches, photography, and poetry compiled over 20 years from the journals, we experience their ponderings, discoveries, successes, and challenges of living on the land. This isn't just a story of setting land aside to preserve it, but one where people have learned to live in balance with nature, while in some cases even depending upon it for their livelihoods.

There are those in the watershed who make their living creating beautiful works of art, award-winning furniture, and other items from salvaged timber. It is a model that, with love, could revolutionize how we interact, enjoy, and merge with the land, as we create our place within, not over, nature. And, to complete the story, the radio tower was placed out of sight in a remote part of the land, and the community continues to be an'"alive" community that teaches its children how to know and love the land.

To give you a sense of the quality of the writing, here is an excerpt from a poetic piece by resident Tavia Cathcart:

> The "backyard" holds numerous beginnings. Radiating from the cabin is Bald Mountain, the South Yuba River canyon, rolling hills, neighbors to meet and visit. Beginning at the back door, I follow the flattened grass and deer tracks in the mud that soon turn to rocks and exposed roots in the slight depression called a trail…Patches of narrow sword-like native irises and newly sprouting violet leaves appear in shaded, moist areas…How will the creek song change as it breaks around a boulder or a log? Could I hear a deer or a mountain lion lapping at its surface? How attuned to this unnamed Yuba watershed "porous way" can I become?…The wind circles, carving space around me as though I have been sitting here for hundreds of years.

The titles of some of the other contributions in the book provide a flavor of what is to come, such as "In the Shadow of Manzanita," "The Saga of the Cranberry," "Learning from the Woods," "Meadow Restoration in the Inimim Forest," and "Winter Rain Children."

This is a book that stimulates the mind and nurtures our hearts, inspiring each of us to help create meaningful communities where we live. Ultimately, it will only be through winning the hearts and minds of people that we will begin to care more deeply about the places where we live, and through this learn to treat nature with respect and even kindness. This beautifully written and illustrated book can inspire us to do just that.

—Julie Carville

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CONTRIBUTORS (*continued from back cover*)

Phyllis M. Faber served as *Fremontia*'s editor from 1984-1999, and for many years was CNPS publications chair.

Lori Hubbart is currently conservation chair for the Dorothy King Young Chapter of CNPS, a garden writer, and land steward on the Mendocino coast.

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Betsey Landis is a member of the CNPS Chapter Council Policy Committee, and cochaired its fire policy subcommittee. For many years she has studied the long-term effects of fuel management and wildfire on native flora in Southern California.

Thomas Oberbauer recently retired as chief of the Multiple Species Planning Division for the San Diego County Department of Planning and Land Use. He participated with Dr. Reid Moran in field trips, lectures, and explorations, and received botanical advice from him for more than 30 years.

Julie Rogers is cofounder and executive director of the Mendocino County Fire Safe Council. She is also a former firefighter and pilot, and the author of two books.

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John O. Sawyer is a longtime member and Fellow (in 1995) of CNPS. A cofounder of the North Coast Chapter and past President (1974-1976) of the Society, John remains an active member of the CNPS Vegetation Committee.

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(continued on inside back cover)

FROM THE EDITOR

California native flora is under stress from increasingly chaotic weather, from extreme droughts to ferocious storms, and record high temperatures to record freezes. When it comes to habitat destruction and loss of species, however, the more immediate causes are increasing land development in, or adjacent to, wildland areas, and increasing wildfire frequency often linked to human activities. So we need to develop better management practices that conserve native habitats and reduce the damage wildfires cause.

These include fireproofing our homes, paying greater attention to how we landscape around them, and adopting land management practices that take into account differences in the natural role of fire within California's diverse ecosystems. As some of the articles in this special issue of *Fremontia* point out, there is also the problem of where we choose to situate our homes. Many are being built in fairly remote wildland areas, which makes them more prone to fire events, and more difficult and costly to protect. Should we discourage future development in these areas, and if so, how should we go about doing that?

This is not an issue of *Fremontia* that many will want to read at one sitting, since it contains a lot of information that can best be absorbed gradually. However it is an issue that may well serve as a continuing resource for all whose lives and work are impacted by fire in one way or another. Furthermore, all of the articles on fire that appear in this issue will soon be placed in the Conservation section of the CNPS state website.

A word of thanks for this issue goes out deservedly to CNPS member Betsey Landis, who cochaired CNPS's fire policy subcommittee, and helped formulate the Society's newest policy on native plants and fire safety. Her advice was invaluable.

—Bob Hass