3. Wildfire: Current Environment and Behavior[1]

Wildfire is considered to be one of Lake County's most dangerous natural disaster threats. The potential for a large, destructive wildland-urban interface fire is considered to be extremely high within the county.[2] The lands of Lake County have evolved with fire, and fire will continue to shape the landscape. Many Lake County residents understand that it is not a question of if a wildfire will occur here, but rather when. Much of the vegetation in the county is adapted to—meaning it has evolved with—fire. For example, ponderosa pine (*Pinus ponderosa*) and incense cedar (*Calocedrus decurrens*) both produce very thick bark with age, helping them to withstand the heat of low and moderate intensity fire. Understanding fire and its role in the ecosystem will help us to better coexist with it, resulting in less catastrophic wildfire.

3.1. Introduction: Defining the Wildfire Problem

It is generally accepted today that fires in post-European California are less frequent and more severe compared to patterns present before European settlement. Lake County is no exception to this pattern. How wildfire will affect Lake County depends on several factors, including topography, weather, and the condition and type of vegetation and other fuels. Understanding environmental conditions in Lake County helps us to formulate practices or actions that can best modify the local environment to improve its *fire resiliency,* or ability to rebound after a wildfire. This chapter explains those factors, and the fuels, fire history, and fire science that better our understanding of the wildfire problem in Lake County today.

3.2. Fire Behavior Characteristics

Knowing the attributes of *fire behavior* is important in order to communicate the various threats from any fire and the benefits of mitigation. Flame lengths, *fire intensity, heat output,* rate of spread, residence time, and whether the fire burns on the surface or crown are all ways to describe fire behavior and to relate its resistance to *control* and potential damage or positive impacts from fire. The following paragraphs provide an introductory definition to these terms.

Surface Fires

On flat or moderate terrain (<30% slopes) in light fuels, fires usually burn as a surface fire. Surface fires may advance quickly with short or long *residence time* and a range of heat output, and as such, they respond well to suppression. A manageable fire is one of the desired results of *fuel modifications.*

Crown Fire Potential

Crowning activity indicates locations where fire is expected to travel into and possibly consume the crowns (or tops) of trees. Crown fires typify a fire of high intensity and exhibit high heat output and rates of spread. These attributes challenge suppression efforts. When a fire burns through tree crowns, countless embers are produced and distributed, sometimes over long distances. These embers can start new fires (or spot fires), which can each grow and confound the finest fire-suppression forces.

Crown fire initiation (or torching) occurs when ladder fuels are present, providing a connection between the surface fuels and the crown fuels. The higher the base of the tree canopy away from surface fuels, the more difficult it is for crown fires to ignite. Once in the tree canopy, crown fire spread is more likely in dense canopies and with high wind speeds.

Fire Intensity

Fire intensity describes the amount of heat that is released by flaming combustion in a specific unit of time (BTU/ft./sec[3]). This measurement captures the energy of a fire in any location; it is often confused with fire severity, which is a term describing fire effects *(see below)*.

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[1] Elements of this chapter were written by Carol Rice, Wildland Resource Management.

[2] Smith, G. 2005 Lake County Natural Hazard Mitigation Plan (HMP). p. 79.

[3] BTU: British Thermal Units (heat)/feet/second.

Fire Severity

Fire severity describes the resulting effects of a fire, based on the amount of soil damage and tree mortality. It is determined by observing vegetation and soil conditions after a fire. The relationship between predicted fire behavior characteristics (flame length, heat per unit area, fireline intensity, etc.) and fire severity are being explored, but are not yet well established. Long flame lengths, large amounts of torching, crown fire presence, high fireline intensity, and high heat per unit area are all indicators of potentially severe fires.

Flame Length

Flame length is the span of the flame from the tip to the base, irrespective of its tilt. This factor most influences the probability of structure damage and ease of fire suppression. Flame length is highly correlated with fire intensity, which can help predict fire severity. Flame lengths less than four feet are associated with fires that are more easily controlled—generally with hand crews—and are also associated with the widespread low-intensity fires prevalent prior to European settlement. In contrast, flame lengths longer than twelve feet often thwart suppression efforts, and are associated with crown fires seen on the front pages of newspapers. Typically fuel-management goals aim for production of flame lengths less than four feet.

Rate of Spread

The rate of spread measures how fast the *leading edge* of a fire advances. A rate of spread faster than fire-line-building capacity will challenge fire-suppression efforts. High spread rates also indicate the potential for quick changes in fire spread direction, which could endanger firefighters and increase the potential damages. High rates of spread in grass can exceed three hundred feet per minute. In rare crown fires, rates of spread can exceed one hundred feet per minute. A more acceptable rate of spread would be one that is slower than the line-building capacity of fire-suppression forces to encircle the fire. Slow-burning fires in forested fuel types spread at a rate of two to eight feet per minute.

Residence Time

The residence time of a fire defines how long the leading edge of the fire burns in any one location. Usually grass fires are consumed quickly and have a short residence time (e.g. 30 seconds), in contrast to the residence time of fires in a deep duff layer, which can burn for hours. Foliage and *suspended dead material* are usually consumed in less than 90 seconds. Residence time is useful in predicting tree mortality and potential for fire-induced *hydrophobic* soils.

Heat Per Unit Area

Heat per unit area is defined as the total heat produced by flaming combustion in any one location. This does not include long *burn-out times* and smoldering. This factor is especially important in determining soil heating and is a fairly good predictor of potential root damage and *cambium* heating, all indicators of fire severity. Smoldering produces the vast majority of smoke in a fire, but most fire behavior models don't include smoldering combustion.

3.3. General Wildfire Environment Descriptions

Fire ecology is the study of fire and its relationship to the physical, chemical, and biological components of an ecosystem. Within Lake County are several ecosystem types, all of which have evolved with fire *(see Chapter 4 for more information on these types)*. Lake County is located in a fire-dependent environment; in fact, fire has played a prominent role in shaping the natural environment here. Wildfire will happen; exclusion of wildfire is not an option.

The absence of natural fire events due to massive fire-suppression efforts over recent decades, compounded by historic logging and land-management practices and urban and suburban development, has lead to an increase in the density and type of live vegetation. This situation has also lead to an increase in the size, amount, and distribution of dead fuel within the county. As a result, forests and shrublands are more crowded, trees are unable to retain their vigor, and they are more vulnerable to insects, disease, and stand-destroying fires. In contrast, frequent, low-intensity surface fires (such as occurred historically) would have cleansed the forest floor of fuels, and maintained open stands of trees and a mosaic of chaparral vegetation. Cool, frequent fires help keep forests healthy. A challenge for Lake County, and most areas of the West, is how to remove the unnaturally high levels of fuel, while maintaining ecosystem functions, processes, and health. This CWPP explores those options.

3.3.1. Topography

Topographic features such as slope, aspect, and the overall form of the land have a profound effect on fire behavior. Topography directly and indirectly affects the intensity, direction, and spread rate of wildfire. Fires burning in flat or gently sloping areas tend to burn more slowly, and to spread in a wider ellipse than fires on steep slopes. Streams, rivers, and canyons tend to channel local *diurnal* and general winds, which can accelerate the fire's speed and affect its direction, especially during *foehn* wind events. Local winds are greatly affected by topography, which "bends the wind" as it flows around or over landforms. Topography also causes daily upslope and downslope winds. The topographic features of aspect and elevation affect vegetation; solar exposure affects fuel moisture.

Lake County has a mixture of rugged mountains, rolling hills, and broad valleys. Elevations within the county range from 640 to 6,873 ft. Due to the remoteness and steepness of slopes within the county, fire equipment and personnel can be limited in their access to wildland fires. Drainages can act as chimneys, which can move wind and fire very quickly up a gentle and/or steep slope. This adds significant fire risks to Lake County communities.

3.3.2. Weather

This section describes common weather conditions and weather patterns that exist at the time the most damaging fires could occur, along with routine conditions during which serious fires may occur.

Weather conditions significantly impact the potential for fire ignition, as well as rates of spread, intensity, and the direction fire burns. Wind, temperature, and *relative humidity* are the weather variables used to predict fire behavior.[4] *Fire weather* refers to weather elements that influence *fire ignition,* behavior, and suppression; such as temperature, relative humidity, wind speed and direction, precipitation, atmospheric stability, and *aloft winds.*

Lake County's winters are usually cool and wet, contrasted with hot, dry summers. Average annual precipitation ranges from 24 inches in the lower areas to more than 70 inches in the mountainous regions. Temperatures range from an average low of 32˚ F in the winter to average highs of 95˚ F in the summer.

Pacific Ocean marine airflow has a profound influence on dry-season temperatures in the county, by providing high-moisture air and cooler temperatures to portions of the county. This marine influence may reduce fire hazards to those areas of the county that are affected by the moist air. Although much of the coastal interior mountains remain cool as a result of this air, areas not influenced by marine airflow may record temperatures well into the 100's during summer months. These climatic factors significantly increase the *fire hazard* within Lake County. In addition, the long growing season, approximately 230–260 days within the Clear Lake basin, creates a significant amount of vegetation.[5]

Lake County's microclimate influences potential fire risk. Westerly winds from the coast often influence how a fire may burn within the county.[6] These winds can move a fire very fast across the landscape as well as transport burning embers miles in front of the fire line, which can ignite structures.

Wind is considered the most variable and difficult weather element to predict. Wind increases the flammability of fuels by removing moisture through evaporation, by pre-heating fuels in a fire's path, and by increasing spotting distances (the distance at which a spot fire might be set by a flying ember). Wind velocities and directions may vary in vertical elevation, with somewhat different impacts on fire behavior. The direction and velocity of surface winds can directly control the direction and rate at which the fire spreads. Winds that blow

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[4] Husari, S., T. Nichols, N.G. Sugihara, and S.L. Stephens. 2006. "Fuel Management." In: N.G. Sugihara, J. van Wagtendonk, K.E. Shaffer, J. Fites-Kaufman, and A.E. Thode, editors. *Fire in California's Ecosystems*. Berkeley: University of California Press. Pp. 444–465.

[5] HMP. p. 15.

[6] Tunnell, Jeff. Bureau of Land Management. Fire Mitigation and Education Specialist. Personal Communication. September 12, 2008.

more than 20 feet above the ground can carry embers and firebrands downwind, causing spot fires to precede the primary front.

Prevailing winds during fire season (generally June through October) in Lake County are out of the northwest. Winds also blow north or northeast, moving hot air from the Central Valley; although rare foehn winds usually blow from the north. All of these winds help to create hot and dry fire conditions. Weather conditions can change rapidly as upper-level wind currents and pressure systems in the western states shift locations, and both dry and wet frontal systems move through the mountainous terrain. Frontal winds associated with low-pressure systems moving across the area can create hazardous fire conditions. Winds in advance of the frontal system can reach speeds exceeding 60 mph over ridges. The atmospheric instability dilutes and disperses smoke, but also creates torching (running crown fires are a result of strong winds) and spot fire problems (distances increase as winds increase).

Fires during foehn events—or subsiding winds—usually result in extreme fire behavior because they are particularly strong and dry, thus reducing fuel moistures. This leads to easier ignitions and increased fire behavior. Foehn winds can also cause extreme fire behavior at night, when fires normally die down.

3.3.3. Hydrology

The *hydrology* of an area describes the flow of water across and through the land. Lakes, ponds, streams, wetlands, and springs are just a few examples of features that contribute to the hydrology of an area. The presence of these features tends to increase the humidity of a local site and can make it more resistant to the effects of fire. In the case of ponds and lakes, their availability as water sources for suppression is also important.

Lake County's hydrologic features are abundant. Thousands of waterways flow through the region, from small *ephemeral* streams to large creeks and rivers, eventually making their way to the Pacific Ocean. As mentioned in Chapter 1, the four distinct watersheds of the county are: Upper Cache Creek, Upper Putah Creek, Upper Stony Creek, and the Upper Mainstem Eel River. Along with the numerous streams and rivers, there are many lakes, including Clear Lake, from which the county takes its name.

Clear Lake is a Clean Water Act Section 303(d) Impaired Watershed due to an overabundance of mercury and nutrients. This situation can be aggravated by fire and ash, either from wildfires or *controlled burning.* The Lake was impacted by the 1996 *Fork Fire,* which caused increased sediment in the lake, and resulted in several treatment plants not able to adequately treat water due to the high turbidity.

3.3.4. Vegetation and Fuels

Vegetation varies by size, height, and density; and combined with other flammable material on the site, it often provides the fuel that feeds wildfire. The volume and distribution of fuels, the *moisture content,* and the arrangement of fuels are all factors that greatly influence resulting fire behavior.

Fuel includes anything that can burn: grass, shrubs, and trees, as well as fences, decks, furniture, cars, and houses. These can be described either as *fuel models* (as described in section 3.4 below), or in terms of sizes, volumes, and arrangement: light fuels (consisting of grass, dry leaves, baskets, and kindling-size twigs), medium fuels (shrubs or fences), or heavy fuels (logs, trees, or homes). The arrangement of the volume and sizes of fuels in any one space, along with the moisture content, greatly influences fire behavior.

Nearly every major fuel type in California exists within Lake County. Examples include grasslands, oak woodlands, *brush,* mixed conifer forests, and hardwood forests.[7] Because of this diversity, Lake County can experience virtually any type of wildfire that can occur in California, from fast-spreading grass fires to full-scale forest fires. Adding to this vegetative fuel problem is the presence of Sudden Oak Death (SOD) within some parts of the county. SOD is a forest disease caused by the pathogen *Phytophthora ramorum.* This pathogen has caused widespread dieback of tanoak (*Lithocarpus densiflorus*) and several other oak species, especially in areas near the

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[7] California Department of Forestry and Fire Protection (CAL FIRE), Sonoma-Lake-Napa Unit. Fire Management Plan 2005. *Mitigating Fire Loss through Community Level Pre-Fire Planning*. p. 19. http://cdfdata.fire.ca.gov/pub/fireplan/fpupload/fpppdf107.pdf.

Napa and Sonoma county borders. The presence of areas affected by this pathogen has increased the amount of hazardous fuels within the county.[8]

The virtual exclusion of widespread low- to moderate-severity fire has affected the *structure* and *composition* of Lake County vegetation types. Conifer stands are generally denser, mainly in small- and medium-size classes of shade-tolerant and *fire-sensitive* tree species. Fuels have become more vertically continuous, contributing to more spatially homogeneous forests. Selective cutting of large *overstory trees* and the relatively warm and moist climate during much of the twentieth century may have enhanced conditions for tree seedling establishment.

See section 3.4 for a description of the planning area fuels. See Chapter 4 for more information on local vegetation types and their fire ecology.

3.3.5. Wildlife

Wildlife in Lake County includes animals, plants, insects, other invertebrates, and fish. The variety of organisms in Lake County is extensive and a reflection of the overall landscape diversity found within the county. According to the California Department of Fish and Game's California Natural Diversity Database (CNDDB), there are at least 114 rare or endangered species of flora and fauna found within the county.[9] Rare and endangered species aside, the county's vegetative diversity is home to several hundred species of wildlife. All of the species found within the county, from the bald eagle and osprey, to Lake County western flax and Cobb Mountain lupine, depend on the environment around them to provide the food, water, and shelter they need to survive.

Threatened and Endangered Species

California has a large number of threatened and endangered species. While most biologists acknowledge that fire plays a role in the environment in which these species live, little is known about the relationship of these species to fire. Their response to fire of varying intensities, frequencies, and seasons is also not well understood; even less the effects of various hazard reduction treatments on rare species. All of the species found within the county have had to adapt to fire in some way in order to survive within this landscape. Some organisms learn to flee, others sprout as a result of fire, while others store extensive amounts of seed within the soil in order to re-occupy a site after a fire. These adaptations have helped to establish the flora and fauna found here.

In order to reduce potential adverse effects to flora and fauna, and especially to state and federally listed Threatened and Endangered (T&E) species, fuel reduction planners (such as Registered Professional Foresters) must use the best available information regarding each species within a project area, including considering critical habitat attributes that species need in order to survive. Information such as breeding period, migration patterns, blooming period, and much more, can help planners reduce fire threat while creating and/or enhancing or restoring necessary habitat within the county.

Within Lake County, there are at least thirteen species that are considered threatened or endangered. The following table lists these T&E species and the habitat attributes associated with each species that must be considered in planning fire prevention and suppression actions.

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[8] CAL FIRE. Fire Management Plan 2005. p. 37.

[9] California Natural Diversity Database (CNDDB) Quick Viewer. http://imaps.dfg.ca.gov/viewers/cnddb_quickviewer/app.asp

Figure 3-1. Threatened and Endangered Species Found in Lake County

Species and Status	Specific Habitat Requirements[10],[11]
Bald eagle *Haliaeetus Leucocephalus* SE	**FEEDING:** Requires large bodies of water, or free flowing rivers with abundant fish, and adjacent snags or other perches. Groups may feed gregariously, especially on spawning fish. Scavenges dead fish, water birds, and mammals such as voles. Open, easily approached hunting perches and feeding areas used most frequently. **COVER:** Perches high in large, stoutly limbed trees, on snags or broken-topped trees, or on rocks near water. Roosts communally in winter in dense, sheltered, remote conifer stands. In Klamath National Forest, winter roosts were 16-19 km (10-12 mi) from feeding areas. **REPRODUCTION**: Nests in large, old-growth, or *dominant* live tree with open branchwork, especially ponderosa pine. Nests most frequently in stands with less than 40% canopy, but usually some foliage shading the nest. Often chooses largest tree in a stand on which to build stick platform nest. Nest located 16-61m (50-200 ft) above ground, usually below tree crown. Tree species apparently not so important as height and size. Nest usually located near a permanent water source. **WATER:** In California, 87% of nest sites were within 1.6 km (1 mi) of water. **PATTERN:** Requires large, old-growth trees or snags in remote, mixed stands near water.
Boggs Lake hedge-hyssop *Gratiola heterosepala* SE[12]	Grows in shallow water and the edges of *vernal pools.* Threatened by agriculture, urbanization, development, and grazing. Important to identify appropriate fire-fighting water drafting sites so as not to affect this species.
Burkes goldfields *Lasthenia burkei* FE[13]/SE	Grows in *meadows, seeps,* and vernal pools at an elevation between 45 and 1800 ft. Blooms between April and June. Threatened by agriculture, urbanization, development, and grazing.
California Wolverine *Gulo gulo* SE	**FEEDING:** Feeds primarily on small mammals and carrion. Prey includes marmots, ground squirrels, gophers, mice, deer carcasses, other vertebrates, berries, and insects. May kill large snowbound prey, but most large prey found by scavenging carrion. May drive bears or mountain lions from carcasses. Forage in open to sparse tree habitats on ground, in trees, burrows, among rocks, in or under snow, and sometimes in shallow water. May locate prey under deep snow. Cache food. **COVER:** Prefer areas with low human disturbance. Use caves, hollows in cliffs, logs, rock outcrops, and burrows for cover, generally in denser forest stages. **REPRODUCTION:** Den in caves, cliffs, hollow logs, cavities in the ground, under rocks; may dig dens in snow, or use old beaver lodges. **PATTERN:** Hunts in more open areas, using dense cover for resting and reproduction.
Few-flowered navarretia *Navarretia leucocephala ssp. pauciflora* FE/ST[14]	Grows in vernal pools at an elevation between 1200 and 2600 ft. Blooms between May and June. Threatened by altered hydrology, erosion, grazing, vehicles, and recreation.

[10] California Department of Fish and Game. *Life History Accounts and Range Maps – California Wildlife Habitat Relationships System.* www.dfg.ca.gov/biogeodata/cwhr/cawildlife.aspx.

[11] California Native Plant Society. *Inventory of Rare and Endangered Plants.* http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi.

[12] SE: State Endangered.

[13] FE: Federally Endangered.

[14] ST: State Threatened.

Species and Status	Specific Habitat Requirements[10,11]
Indian Valley brodiaea *Brodiaea coronaria ssp. Rosea* FE	Grows in chaparral and valley and foothill grasslands within Lake County at elevations between 1000 and 4350 ft. Blooms between May and June. Threatened by vehicles, dumping, and horticulture collection.
Lake County stonecrop *Sedella leiocarpa* FE/SE	Grows in vernal pools, and valley and foothill grasslands within Lake County at elevations between 1100 and 2400 ft. Blooms between April and May. Threatened by grazing, altered hydrology, development, and trampling.
Lake County western flax *Hesperolinon didymocarpum* SE	Grows in chaparral, woodlands, and valley and foothill grasslands within the county at elevations between 1000 and 1100 ft. Blooms between May and July. Threatened by grazing, agriculture, and urbanization.
Loch Lomond button celery *Eryngium constancei* FE/SE	Grows in vernal pools within the county at elevations between 1400 and 2600 ft. Blooms between April and June. Threatened by development and vehicles.
Many-flowered navarretia *Navarretia leucocephala ssp. plieantha* FE/SE	Grows in vernal pools at an elevation between 90 and 2900 ft. Blooms between May and June. Threatened by grazing, development, and vehicles.
Northern spotted owl *Strix occidentalis caurina* FT[15]	**FEEDING:** Feeds in forest habitats upon a variety of small mammals, including flying squirrels, woodrats, mice, voles, and rabbits. Also eats small birds, bats, and large arthropods. Usually searches from a perch and swoops or pounces on prey in vegetation or on the ground. May cache excess food. **COVER:** Uses dense, multi-layered canopy cover for roost seclusion. Roost selection appears to be related closely to thermoregulatory needs; intolerant of high temperatures. Roosts in dense overhead canopy on north-facing slopes in summer. In winter, roosts in oak habitats. In northern regions of the state, daytime roosts averaged 165 m (549 ft) from water; in southern regions, daytime roosts averaged only 51 m (173 ft) from water. **REPRODUCTION:** Usually nests in tree or snag cavity, or in broken top of large trees. Less frequently nests in large mistletoe clump, abandoned raptor or raven nest, in cave or crevice, on cliff or ground. Mature, multi-layered forest stands are required for breeding. Nest usually placed 9-55 m (30-180 ft) above the ground. **WATER:** Probably requires a permanent water source. May reduce heat stress by bathing. Drinks freely in captivity. **PATTERN:** Requires blocks of 40-240 ha (100-600 ac) of mature forest with permanent water and suitable nesting trees and snags. In northern California, apparently prefers narrow, steep-sided canyons with north-facing slopes.
Slender orcutt grass *Orcuttia tenuis* FT/SE	Grows in vernal pools within the county at elevations between 100 and 5300 ft. Blooms between May and September. Threatened by agriculture, residential development, grazing, vehicles, recreational activities, logging, fire, trampling, and non-native plants.

[15] FT: Federally Threatened

Species and Status	Specific Habitat Requirements[10,11]
Western yellow-billed cuckoo *Coccyzus americanus occidentalis* SE	**FEEDING:** Gleans grasshoppers, cicadas, caterpillars and other larger insects from foliage. Occasionally preys on frogs or lizards, or feeds on fruit. **COVER:** Densely foliaged, deciduous trees and shrubs, especially willows, required for roosting sites. **REPRODUCTION:** Nests in dense cover as above; nest is a flimsy, open cup of twigs built on horizontal limb of tree or shrub at height of 0.6 to 7.8 m (2-25 ft). **WATER:** Restricted when breeding to riverbottoms and other mesic habitats where humidity is high. **PATTERN:** Inhabits extensive deciduous riparian thickets or forests with dense, low-level or understory foliage, and which abut slow-moving watercourses, backwaters, or seeps. Willow almost always a dominant component of the vegetation. Also utilizes adjacent orchards, especially walnut. Nests typically in sites with at least some willow, dense low-level or understory foliage, high humidity, and wooded foraging spaces in excess of 93 m (300 ft) in width and 10 ha (25 ac) in area.

3.4. Fuel: Description of Standard Fuel Models[16 17]

A fuel model is a standardized description of fuels available to a fire based on the amount, distribution, and continuity of vegetation and wood.[18] Fuel models distinguish between vegetation such as tall and short chaparral, tall and short grass, timber with and without an understory, and oak woodland with and without understory vegetation. They describe the structure (or arrangement), and amount of the vegetative fuels primarily, as well as the kinds of plants that grow in the vegetation. Fire managers use fuel models within the Fire Behavior Prediction System (FBPS)—called FBPS #1, 4, 8, 9, and 10, etc.—to forecast how fast a fire will spread, how damaging the fire might become (in terms of fire intensity), or whether it is likely to torch in the area. Information regarding fuel volumes and fire behavior descriptions is available from the publication *How to Predict the Spread and Intensity of Forest and Range Fires*.[19]

Fuel models describe vegetation structure, in addition to typical species composition; structure largely determines the fuel that will actually support the fire. The understory is more important than the overstory. The most significant factor is the amount and distribution of smaller-diameter fuels, because these materials generally spread wildland fires. A grassy field, with oak trees that cover less than one-third of the slope, would be classified as a grass fuel model because the contribution of oak leaves and branches to fire behavior may be negligible (due to the minor amount of leaf drop or the relative height at which the first branches grow above the ground). Similarly, where chaparral covers less than one-third of a conifer stand, it would be classified as a conifer stand. The amount and size of dead material distinguishes among the three choices of conifer fuel models.

Another important factor in fuel models is the amount of dead biomass and the ratio of live-to-dead material where there is significant brush and tree stands. Dead biomass contributes fine fuel litter, as well as carrying flames more readily.

According to the 2005 Sonoma-Lake-Napa County Fire Management Plan of the California Department of Forestry and Fire Protection (CAL FIRE), many of the state's thirteen fuel models can be found within Lake County. Among other things, this information helps fire-suppression agencies to determine what kind of fire might be expected in different areas. Following is a map, description, and list of fuel models found within the county, as determined by CAL FIRE.

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16 Harrel, Dick and Teie, William. 2001. *Will Your Home Survive? A Winner or Loser? A guide to help you improve the odds against Wildland Fire.* Pp. 17–26.

17 Anderson, Hal E. 1982. *Aids for Determining Fuel Models for Estimating Fire Behavior*. General Technical Report INT-122.Published by the USDA Forest Service Intermountain Forest and Range Experiment Station.

18 National Park Service. *Glossary of Fire Terms.* www.nps.gov/archive/seki/fire/fire_gloss.htm.

19 Rothermel, Richard C. 1983. *How to predict the spread and intensity of forest and range fires*. General Technical Report INT-143. Published by the USDA Forest Service Intermountain Forest and Range Experiment Station.

The table below illustrates the relationship between fuel models and typical Lake County vegetation types. The vegetation types are broad classifications of vegetation communities. These vegetation types and their fire ecology are discussed in greater detail in Chapter 4.

Figure 3-2. Relationship between Lake County Vegetation Types and Typical Fuel Models.

Vegetation Type	Typical Fuel Model[20] [21]
Grassland	Fuel Model 1, 2
Chaparral	Fuel Model 4, 5, 6
Chamise/Redshank Chaparral	Fuel Model 4, 5
Foothill Woodland	Fuel Model 2, 8
Ponderosa Pine/Mixed Conifer	Fuel Model 9, 10
Closed-Cone Pine/Cypress	Fuel Model 4
Montane Hardwood/Conifer	Fuel Model 8

Model 1 – 2 Grass Models

Fuel Model 1 – This model contains annual and perennial short grasses, about 1-ft tall, that are fairly uniform and homogenous. Less than 1/3 of the area contains other types of vegetation such as trees and shrubs. There is approximately 3/4 tons[22] per acre of fuel at a depth of about 1 foot. Fire spread is governed by the fine, very porous, and continuous herbaceous fuels that have cured or are nearly cured. Fires are surface fires that move rapidly through the cured vegetation and contain flame lengths approximately 4-ft high.

Fuel Model 2 – This model is dominated by grasses approximately 1 to 2 feet tall, typical of Lake County's oak savannah. The grasses within this model generally occur under an open, wooded timber canopy. There is approximately 4 live/dead tons of <3" fuel per acre at a depth of about 1 foot. Also occurring within the 1-ft fuel bed are approximately 2 tons of 1/4" dead material as well as a 1/2 ton of live (foliage) material. Fire spread occurs in the live/dead fine surface materials. Areas with high fuel loads associated with the hardwood and conifer component can be intense and cause *firebrands.* Fires within this model can produce flames over 9 feet.

Model 4 – 6 Shrub Models

Fuel Model 4 – This model is characterized by stands of mature brush (mixed chaparral) 6 or more feet high with continuous, interlinking crowns. There is approximately 13 live/dead tons of <3" fuel per acre at a depth of 6 feet. Also occurring within the 6-ft fuel bed are approximately 5 tons/acre of 1/4" dead fuel as well as 5 tons/acre of live fuel. Fires within this model are very intense and spread quickly through this almost entirely closed canopy system. Burning embers created by these intense fires often create spot fires in front of the fire. Fires within this model can produce flames over 50-ft tall.

Fuel Model 5 – This model consists of the same species composition as Fuel Model 4, but individual plants are shorter, usually sparser, and less mature with little or no dead material component. Most of the fuels within this model are alive, consisting of green vegetation that is not very volatile. This fuel model occurs on poor sites, on recent burns, and may occur under tree canopies. There is approximately 3.5 live/dead tons of <3" fuel per acre to a depth of about 2 feet. Also occurring within the 2-foot fuel bed are approximately 1 ton of 1/4" dead material as well as 2 live tons per acre. Fires in this fuel model do not burn intensely, or rapidly due to high concentration of live material. Flames can reach heights of over 13 feet.

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[20] There is a wide variety of fuel volume, structure, and size class distribution within vegetation types; fuel models should be determined by site-specific conditions. Fuel models can be classified by comparing photographs of fuel models with on-site conditions (Anderson 1982), by using expert opinion to translate vegetation types to fuel models, or by using a "key" provided in Rothermel (1983).

[21] Anderson, Hal E. 1983. *Predicting Wind-driven Wild Land Fire Size and Shape.* Res. Pap. INT-305. Ogden, UT. Intermountain Forest and Range Experiment Station. p. 26.

[22] This includes both live and dead vegetation. Dead vegetation, i.e. dead branches, responds quickly to weather conditions while live fuels, i.e. flowering branches, are slower to change with weather and are less flammable.

Fuel Model 6 – This model consists of vegetation that is taller and more flammable than that of Fuel Model 5, but not as tall or as dense as Fuel Model 4. Interior live oak, young chemise, and manzanita are all considered species associated with this model. In many instances a Fuel Model 5 will evolve into a Fuel Model 6 by the latter part of the summer. There is approximately 6 live/dead tons of <3" fuel per acre to a depth of about 2.5 feet. Also occurring within the 2.5-foot fuel bed are approximately 1.5 tons of 1/4" dead material per acre. Fires in this model will burn in the foliage of standing vegetation, but only when wind speeds are greater than 8 mph. Fires within this model can produce flames about 12-ft tall.

Model 8 – 10 Timber Litter Models

Fuel Model 8 – This model consists mainly of needles, leaves, and occasionally twigs below a conifer or hardwood canopy. Fuel loads can vary due to inhibited growth caused by overstory shade. There is approximately 5 live/dead tons of <3" fuel per acre to a depth of about 0.2 feet. Also occurring within the 0.2-ft fuel bed are approximately 1.5 tons of 1/4" dead material per acre. Fires within this model are generally slow burning and of low intensity within the compacted vegetation, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Fires in this model do not pose a control threat unless high temperatures, low relative humidity, and high winds would allow the fire to spread into the canopy. This model represents what is created by a shaded fuel break. Fires within this model can produce flames about 2-ft tall.

Fuel Model 9 – This model is similar to Fuel Model 8, except it has more fine fuels, which increase fire severity. There is approximately 3.5 live/dead tons of <3" fuel per acre to a depth of about 0.2 feet. Also occurring within the 0.2-ft fuel bed are approximately 2.9 tons of 1/4" dead material per acre. Autumn fires in the hardwoods in this model are predictable, but high winds will actually cause higher rates of spread than predicted, because of spotting caused by rolling and blowing leaves. Concentrations of dead and downed woody material will contribute to possible torching, spotting, and crowning. Fires within this model can produce 7-ft flames.

Fuel Model 10 – This model consists of a shrub, sapling, or immature tree understory with a diseased and/or mature overstory. There is approximately 12 live/dead tons of <3" fuel per acre to a depth of about 1 foot. Also occurring within the 1-ft fuel bed are approximately 3 tons of 1/4" dead material as well as 2 live tons per acre. Fires in this model burn with a moderate rate of spread and can be very intense. *Crown scorch* (and/or torching) of individual trees and spot fires are common within Fuel Model 10. This fuel model poses the most control problem of all the fuel models within the three timber litter models. Fires within this model can produce flames over 100-ft high in extreme conditions.

Figure 3-3 below describes the distribution of fuel volume (also called fuel loading) by size class, along with the overall height of the fuel complex (fuel bed depth). Fuel loading is measured in tons per acre (noted as T/A, by 1-hour, 10-hour, 100-hour, and live fuels). It further indicates what the moisture is when fires tend to stop burning in dead fuels (Moisture of Extinction Dead Fuels). The table indicates the predicted rate of spread (ROS) in chains per hour, along with the flame length (FL) in feet per minute. A *chain* is 66 feet in length, so the measurement "chains per hour" is roughly equivalent to the measurement "feet per minute."

Figure 3-3. Description of Fuel Models and Fire Behavior [23]

Fuel Model	Typical Fuel Complex	Fuel Loading (T/A) 1-H	10-H	100-H	Live	Fuel Bed Depth (ft)	Moist. of Extinction Dead Fuels (%)	ROS* ch/h	FL* (ft)
1	Short Grass	0.74	0.00	0.00	0.00	1.0	12	78	4
2	Timber	2.00	1.00	.50	.50	1.0	15	35	6
3	Tall Grass	3.01	.00	.00	.00	2.5	25	104	12
4	Chaparral	5.01	4.01	2.00	5.01	6.0	20	75	19
5	Brush	1.00	.50	.00	2.00	2.0	20	18	4
6	Dormant brush	1.50	2.50	2.00	.00	2.5	25	32	6
7	Southern rough	1.13	1.87	1.50	.37	2.5	40	20	5
8	Closed timber litter	1.50	1.00	2.50	0.00	0.2	30	2	1
9	Hardwood litter	2.92	.41	.15	.00	0.2	25	8	3
10	Timber	3.01	2.00	5.01	2.00	1.0	25	8	5
11	Light logging slash	1.50	4.51	5.51	0.00	1.0	15	6	4
12	Medium logging slash	4.01	14.03	16.53	.00	2.3	20	13	8
13	Heavy logging slash	7.01	23.04	28.05	.00	3.0	25	14	11

*ROS and FL are represented under a fine dead fuel moisture of 8%, a mid-flame wind speed of 5 mph and live fuel moisture, if present, of 100%.

3.5. Fire History

The fire history of an area is a description of the time, space, and cause of fires in the area. In fire jargon, *"fire risk"* is often associated with fire history, as this term describes the events that cause a fire to start (i.e. ignitions).

Fire history is important because it illustrates the potential for future fires. Large fires often repeat themselves; thus it is useful to understand burning patterns over time. An area's fire history also portrays ignition patterns that can target effective prevention programs. For example, if there is a history of frequent fires along a well-traveled route, roadside vegetation management may be in order. Additionally, fire history discerned through fire scars on tree rings may indicate the way fires have changed over time, both in frequency and intensity. This may point to appropriate goals for future fuel conditions.

3.5.1. Fire Caused by Natural Lightning

Lightning fires in Northern California, including Lake County, are common in the summer and fall months, particularly in the higher elevations where strikes are more likely to occur. Fires ignite when lightning strikes coincide with rainless, windy weather; however, lightning fires rarely occur in the spring. Lightning fires pose a significant threat to Lake County and its many communities, especially during dry lightning events where burning conditions are met.

In the summer of 2008, over 2,000 fires burned throughout Northern California as a result of thunderstorms and dry conditions that occurred from the coast to the Sierra Nevada. Approximately 4,046 acres burned within Lake County at that time. These fires, fueled by extremely dry vegetation, quickly overwhelmed fire-fighting resources as they burned through thousands of acres. Lake County, as well as much of the rest of Northern California, experienced unhealthy, smoky days for a long period of time (over a month in some Northern California communities). When lightning starts multiple fires, suppression resources may not be adequate or available for new fires. This occurred in June of 2008 when the *Walker Fire (see below)* started in the middle of the lightning fire siege of Northern California. The *Walker Fire* was understaffed for many days while resources were committed elsewhere.

[23] Anderson 1982. p. 3.

3.5.2. Native American Period Fire History

It is widely understood that during the pre-settlement period, Native Americans used fire as a resource-management tool throughout California and the West. In fact,

> "When Spanish explorer Juan Rodriguez Cabrillo anchored in San Pedro Bay in October of 1542, it was the chaparral fires that gave him the signal that the coast was occupied by humans. A succession of explorers, missionaries, and settlers thereafter would continually note the 'smoky air' from these fires in their journals in every corner of the state – in the coastal redwood forests, the tule marshes of the Delta, the southern oak woodlands, the mixed conifer forests, and the northern hazelnut flats".[24]

The use of fire as a tool ranged from plant cultivation and land clearing to mast production and hunting. For example, in Lake County the native Pomo burned bracken fern patches to enhance them; the new fronds were eaten and the rhizomes used to create basket designs.

The acreage burned by California's earliest humans was significant; fire scientists Robert Martin and David Sapsis estimate that 5.6 to 13 million acres of California burned annually under both lightning and indigenous people's *fire regime*s.[25] However, fire scientist Scott Stephens, Sapsis, and others have now estimated lower numbers. They estimate that 4,447,896 acres burned annually in California prior to 1800, excluding the southwestern deserts.[26] This estimate of prehistoric annual area burned in California is 88% of the total annual "extreme" wildfire area burned in the entire United States within a single decade (1994–2004).[27] From 1950 to 1999, the average annual area burned by wildfire in all vegetation types in California was approximately 25,2047 acres/yr, only approximately 5.6% of what traditionally burned in a similar timeframe.[28] Regardless of errors in either estimation, prior to modern fire suppression very large amounts of land burned in California. Skies were likely smoky much of the summer and fall in California during this period.[29]

3.5.3. European Settlement Fire History

During European settlement, logging—primarily of the largest, oldest trees—became common, with subsequent changes in forest structure and fuel volumes. Many forms of land management during this era (such as logging, grazing, development, and most notably fire suppression) have influenced the fire history of Lake County.

As a result of large destructive fires in the West and Midwest in the early part of the 1900's, the perception of fire as a beneficial tool, such as seen by Native Americans, was overlooked and instead viewed as a major threat to lives, property, and natural resources. The outcome of this viewpoint was the "10 a.m. policy" adopted by the US Forest Service in 1935. This policy sought to aggressively suppress fires and have them extinguished by 10 a.m. the morning following a fire being discovered. This type of land management activity (intensive fire suppression), combined with increased development, a resulting lack of homeowner defensible space, logging of the largest trees, etc., has led to an increase in the amount of flammable materials now accumulated within Lake County. Today it is widely accepted that fires now burn longer and hotter than those prior to European settlement.

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[24] Anderson, M.K. 2006. "The Use of Fire by Native Americans in California." In: N.G. Sugihara, J. van Wagtendonk, K.E. Shaffer, J. Fites-Kaufman, and A.E. Thode, editors. *Fire in California's Ecosystems*. Berkeley: University of California Press. Pp. 417.

[25] Anderson, M.K. 2005. *Tending the wild: Native American knowledge and the management of California's natural resources.* University of California Press, Berkeley p. 136.

[26] Stephens, S.L., Robert E. Martin, Nicholas E. Clinton. 2007. *Prehistoric Fire Area and Emissions from California's Forests, Woodlands, Shrublands, and Grasslands*. Forest Ecology and Management 251 (2007) 205–216.

[27] Stephens, S.L., et al. 2007.

[28] Stephens, S.L., et al. 2007.

[29] Stephens, S.L., et al. 2007.

"More area is burning at high intensity, and this is related, in part, to higher quantities and more homogeneous fuels caused by accumulation during the fire-suppression period."[30]

However, a small amount of *prescribed fire* (controlled burning) has been used to some extent by local ranchers following European settlement. As well, Dr. Harold Biswell completed extensive burning at Cow Mountain and Hoberg's Resort during the late 1940's and into the 1960's. The burns were done to help demonstrate the use of controlled burning and the benefits it had on the landscape, increasing grazing, wildlife habitat, and tree growth. Many local ranchers, hunters, and other landowners supported these burns.

3.5.4. Recent Fire History

During the last century, fire history has changed dramatically. Forest fuels have changed through more modern cultural practices of timber harvesting, mining, and grazing. Fire control in the west, including Lake County, has been extremely effective, particularly since the 1930's. Wildfire now *escapes* less than two percent of the time—but those escaped fires cause the vast majority of damage.

Lake County fire history shows that there have been several major wildland-urban interface (WUI) fires. In the autumn of 1961, a 9,000+-acre fire burned through the Cobb Mountain area, destroying several structures. In the fall of 1964, the South County region again was subject to a 52,000-acre fire known as the *Hanley Fire* that started near the Lake/Napa County border northwest of Calistoga. This wildland fire ultimately burned all the way to the city limits of Santa Rosa, approximately forty miles southwest. That same year, a 15,000-acre wildland fire started at the Lake County dump (possibly the result of the past practice of burning garbage at the dump) and threatened the community of Middletown. In the fall of 1968, the Lower Lake area was subject to a 10,000-acre wildland fire. In 1981, the *Lang Peak Fire* consumed 11,000 acres. In 1981, the *Cow Mountain Fire* traveled eastward from the Bureau of Land Management (BLM) lands near Ukiah in Mendocino County and burned to the foothills near Lakeport. In 1985 an interface fire burned through the Hidden Valley residential community, leaving significant property damage.[31] The *Mendenhall Fire* burned approximately 70,000 acres in Lake and Mendocino Counties in 1987, while the *Fouts Fire* burned 19,000 acres in Lake and Colusa Counties.[32]

The most recent large fires in Lake County have been the 1996 *Fork Fire,* the 2001 *Trough Fire,* and the 2008 *Walker Fire*. The *Fork Fire* started on the southern end of the Mendocino National Forest and burned 83,000 acres and eleven structures. The fire threatened the northern shore of Clear Lake, including the communities of Nice and Lucerne, and burned east almost to the Colusa County line. The *Trough Fire* started in eastern Colusa County at an intersection of U.S Forest Service roads in heavy brush and moved into Lake County. This fire burned through 24,970 acres, including portions of the Snow Mountain Wilderness. The most recent large fire—the *Walker Fire*—started on June 22, 2008. The likely source of this fire was a vehicle being driven near Indian Valley Reservoir hitting a rock with its metal undercarriage. This fire burned 14,500 remote acres in the eastern portion of Lake County.

Maps 3-3 and 3-4 at the end of this chapter show Lake County fire history, both by the decade in which the fire occurred, and by the ignition source (where known). This is useful to compare fire history both temporally and by cause.

3.6. Fire Hazard

The term "hazard" is usually used in the fire community in relation to topography and *fuel complex* (the volume type, condition, arrangement, and location of fuels).[33] Fire hazard is influenced by past disturbances. The history of fire or management activities greatly alters the hazard for better or worse, by changing the overall moisture of the site, as well as the volume and spatial arrangement of the fuels. This history is characterized by three fire-management eras: the time before human occupation when lightning was the only ignition source, the

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[30] Skinner, C.N., A.H. Taylor, and J.K. Agee, 2006. "Klamath Mountain Bioregion" In: N.G. Sugihara, J. van Wagtendonk, K.E. Shaffer, J. Fites-Kaufman, and A.E. Thode, editors. *Fire in California's Ecosystems*. Berkeley: University of California Press. p. 179.

[31] Smith, G. 2005. Lake County Natural Hazard Mitigation Plan Risk Assessment. Pp. 13–14.

[32] Juntunen, L., and Hansmith, A. 2004. Fire Safe Plan for the Communities of Lake County. Pp. 2–3.

[33] Husari, et al. 2006.

era of Native American occupation when fire was used extensively, and the era after European Settlement when fire was largely suppressed (as discussed in the Fire History section above).[34]

3.6.1. Hazard Assessment

To quote from the CDF Fire and Resource Assessment Program (FRAP) website:

> "CDF [CAL FIRE] has developed a hazard assessment methodology for the California Fire Plan to identify and prioritize pre-fire projects that reduce the potential for large, catastrophic fires."[35]

The fuel hazard ranking tells us the expected behavior of fire in severe weather (when wind speed, humidity, and temperature make conditions favorable for a catastrophic fire). The method for determining the fuel hazard ranking is based on: a) fuel model, b) slope, c) brush density, and d) tree density.

Evaluation of fuel model and slope will result in a surface rank, which indicates the "rate of fire spread and heat per unit area associated with each unique fuel model-slope combination."[36] This describes how fast and hot a potential fire can burn in a given area. The methodology then measures how abundant ladder fuels and crown fuels are in the area. Coupled with potential fire behavior, CAL FIRE ranks the fire hazard in any location.

If an area has a very high surface rank (a very high rate of fire spread and heat per unit area), along with dense crown and ladder fuels, then it is highly probable that a fire could reach catastrophic proportions there during severe weather conditions. The area would receive a very high hazard rating. If an area has a moderate surface rank (a low rate of fire spread and heat per unit area) and has very little crown and ladder fuel, then there is a low probability of a catastrophic fire occurring there and it would receive a moderate hazard rating.

Lake County has delineated areas where fire protection responsibility is local (Local Responsibility Area/LRA), state (State Responsibility Area/SRA), or federal (Federal Responsibility Area/FRA). *See Chapter 6 for a full explanation of the county's fire protection agencies and a map of coverage areas.* Fire Hazard Severity Zones (FHSZs) were originally mapped for the SRA in 1985, and for LRA in 1996. CAL FIRE began updating these maps in 2006 in order to implement the new WUI building codes that have since been adopted by the California Building Standards Commission. This mapping also incorporates current scientific knowledge, most notably the consideration of firebrands as a source of fire spread and ignition. FHSZs represent areas of variable size, ranging from 20–200 acres for urban and wildland areas respectively. These zones consider homogenous characteristics based on climax fuel conditions over a 30–50 year period. *For more information on Hazard Mapping and associated Building Codes, please see: www.fire.ca.gov/fire_protection/fire_protection_prevention_planning_wildland.php*.

Much of Lake County is within what's termed the Very High Fire Hazard Severity Zone (FHSZ), as opposed to High or Moderate. Very High FHSZ is the most threatening of the three zones. In Lake County, most of the area designated Very High is not heavily occupied by residents and is in public ownership, such as the Mendocino National Forest and Cow Mountain Recreation Area. However, there are many residential communities that also lie within this zone. These areas include, but are not limited to, the Rivieras, Nice, Lucerne, and Cobb. While most of the county's residential communities lie within the High or Moderate FHSZ, these communities are unfortunately still in close proximity to the Very High FHSZ, and therefore still can be at major risk from wildfire. Map 3-5 at the end of this chapter displays the CAL FIRE fire hazard severity zones for Lake County.

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[34] Stephens, S.L., and N.G. Sugihara. 2006. "Fire Management and Policy Since European Settlement." In: Sugihara, N.G., J. van Wagtendonk, K.E. Shaffer, J. Fites-Kaufman, and A.E. Thode, editors. *Fire in California's Ecosystems.* Berkeley: University of California Press. Pp. 431–443.

[35] CAL FIRE. 2005. Fire and Resource Assessment Program (FRAP). "Hazards Maps and Data." http://frap.cdf.ca.gov/data/fire_data/hazard/mainframes.html.

[36] CAL FIRE. FRAP. "Fuel Ranks Maps and Data." http://frap.cdf.ca.gov/data/fire_data/fuel_rank/index.html.

3.7. Fire Regime

The fire regime is an objective measurement of fire's historic natural occurrence in the landscape, which is not necessarily the current condition or appearance. The fire regime includes the season, frequency, intensity, and spatial distribution of fires. There is quite a wide variability of "natural" intervals, intensities, and seasons, but some generalities can be made. Each vegetation type has its own fire regime. A standardized set of five fire regimes is used nationwide.[37,38]

The five historical fire regimes are classified based on the average number of years between fires (fire frequency) combined with the severity (amount of overstory replacement) of the fire on the dominant overstory vegetation. These five regimes include:

I: 0 to 35-year frequency and low (surface fires most common) to mixed severity (less than 75% of the dominant overstory vegetation replaced);

II: 0 to 35-year frequency and high (stand replacement) severity (greater than 75% of the dominant overstory vegetation replaced);

III: 35- to 100+-year frequency and mixed severity;

IV: 35- to 100+-year frequency and high severity;

V: 200+-year frequency and high severity.

As scale of application becomes finer, these five classes may be defined with more detail, or any one class may be split into finer categories.

Although the fire regimes within Lake County have been altered due to fire suppression and other land management activities, there are at least two pre-settlement fire regimes found here. According to information collected and analyzed by CAL FIRE, Lake County has a natural *fire return interval* between 0-35 years of low severity fire (Fire Regime I), and between 35-100 years of mixed severity fire (Fire Regime III).[39] *See Map 3-6 at the end of this Chapter.*

3.7.1. Condition Class

The difference in fire regime between pre- and post-European settlement is described by the *condition class,* or degree of departure from the historical natural fire regime. Mapping of the fire regime condition class has been done nationwide and is widely used. Usually where the condition class indicates that fire has been absent for an unnaturally long time, the hazard and potential damages are high to both the environment and human developments in the area.

Condition class is based on a relative measure describing the degree of departure from the historical natural fire regime. The departure from natural fire regimes results in changes to one or more of the following ecological components: vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated disturbances (e.g. insect and disease mortality, grazing, and drought). There are no wildland vegetation and fuel conditions or wildland fire situations that do not fit within one of the three classes.

The three classes are based on low (FRCC[40] 1), moderate (FRCC 2), and high (FRCC 3) departure from the central tendency of the natural (historical) regime. "Low departure is considered to be within the natural

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[37] Hardy, K.M., C.C. Schmidt, J.M. Menakis, and N.R. Samson. 2001. "Spatial Data For National Fire Planning And Fuel Management." *International Journal of Wildland Fire* 10: Pp. 353–372.

[38] Hann, W.J., and D.L. Bunnell. 2001. "Fire And Land Management Planning And Implementation Across Multiple Scales." *Int. J. Wildland Fire* 10: Pp. 389–403.

[39] California Fire Alliance. *Fire Planning And Mapping Tools.* http://wildfire.cr.usgs.gov/fireplanning.

[40] *Fire Regime Condition Class* website. *Definition.* Hann et al. 2008. Interagency and The Nature Conservancy, USDA Forest Service, US Department of Interior, The Nature Conservancy, and Systems for Environmental Management. October 2006. www.frcc.gov.

(historical) range of variability, while moderate and high departures are outside."[41] Areas considered at a high or moderate departure from the natural regime are experiencing dramatic increases in fire behavior, intensity, severity, and fire size.[42]

The greater the departure from the natural fire regime, the greater the variations to ecological components and the higher the risk of losing *key ecosystem components*. For example, FRCC 3 classification means that fire regimes have been greatly altered from their natural range (e.g., from 3-10 years between fires prior to European settlement to 50-70 years since), and likewise, vegetation characteristics have been dramatically altered from their natural range. For example, an area may have experienced a fire regime of small, frequent, low-intensity fires prior to European settlement. However, because fire suppression has been successful, only one fire has burned the area in the past 100 years. The fuels have become voluminous and hence fire behavior is predicted to be intense, with the potential to kill trees that have survived other fires over the centuries. The fuels have also become more uniform, creating conditions that facilitate fire spread and result in a large fire. Therefore, the risk of losing key ecosystem components is high.

Fuel management projects can restore the vegetation type and structure through prescribed fire and/or other types of management techniques in a spatial distribution that can mimic the effect of natural fire regimes. Thus fuel management can move a condition class to one more closely resembling pre-European settlement, regardless of recent fire history.

Condition class does not relate directly to fire hazard but is designed to better predict the effects from a fire, specifically, fire-related risks to ecosystems. All three condition classes (1, 2, and 3) exist in Lake County, based on a natural fire regime of I and III, and a fire history interval of 0-35 and 35-100 years. This means that within Lake County there exist areas with low, moderate, and high departures from the historic natural fire regime. The largest area in Lake County (at 45%) contains those ecosystems with a low departure from their natural fire regime, and hence low risk of key ecosystem loss. Another 22% are at a moderate departure. Those areas with a significant departure and high risk of ecosystem loss, are 20% of the county lands, and located primarily in the mountainous regions of the north and south. Finally, 13% are not classified because they are not wildlands. Map 3-7 at the end of this chapter shows Lake County condition classes.

3.8. Fire Threat

> "Fire threat can be used to estimate the potential for impacts on various assets and values susceptible to fire. Impacts are more likely to occur and/or be of increased severity for the higher threat classes. Fire Threat is derived from a combination of fire frequency (how often an area burns) and expected fire behavior under severe weather conditions. Fire frequency is derived from 50 years of fire history data. Fire behavior is derived from fuels and terrain data. These data inputs are also catalogued within CERES and available via the CDF-FRAP web site. Detailed documentation is under development and will be posted on the FRAP web site."[43]

According to CAL FIRE, Lake County's fire threat ranges from Moderate to Extreme, but most of the county is considered High to Very High. Map 3-8 at the end of this chapter shows Lake County predicted fire threats.

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[41] National Wildfire Coordinating Group, Fire Regime Condition Class Definition. June 2003. www.nwcg.gov/teams/wfewt/message/FrccDefinitions.pdf.

[42] *Fire Regime Condition Class* website. 2006.

[43] California Department of Forestry and Fire Protection, Fire and Resource Assessment Program, Metadata Record: Fire Threat, 2005, frap.cdf.ca.gov/data/frapgismaps/output/fthreat_map.txt{ TA \l "http://frap.cdf.ca.gov/data/frapgismaps/output/fthreat_map.txt" \s "http://frap.cdf.ca.gov/data/frapgismaps/output/fthreat_map.txt" \c 1 }.

3.9. Changing Fuels in the Wildland-Urban Interface

The above information and assessments provide a context for and history of Lake County's changing wildfire environment. This changing fire environment, along with increasing urbanization and other human uses have created conditions where one can assume that human life and property, as well as key ecosystem components, are at increasing risk from the effects of high-intensity wildfires.[44]

Although there is variation among sites as to when fire suppression was successfully implemented, the temporal patterns of fire occurrence in the pre-fire suppression period indicate that most stands in California's Klamath *bioregion* experienced at least several fires each century. This suggests a general fire regime of frequent, low-to moderate-intensity fires.[45] Fire exclusion, logging, grazing, forest clearing, and urbanization have combined to alter fire regimes that are now quite different from their historical character. "More area is burning at high intensity, and this is related, in part, to higher quantities and more homogeneous fuels caused by accumulation during the fire-suppression period".[46]

This changing wildfire environment is most notable within the wildland-urban interface, where land management decisions of the past are now affecting fire behavior in the backyards and watersheds of rural and suburban developments. These problems were created over a long time, and they will not likely be solved rapidly. The use of defensible space, shaded *fuelbreaks,* and other fuel reduction efforts along the interface can reduce these wildfire risks.[47] This CWPP outlines actions to do just this in Chapter 8.

See the following pages for the maps associated with this chapter.

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[44] Biswell (1989); Sierra Nevada Ecosystem Project (SNEP). (1996a). "Fire and Fuels." Final report to Congress, Vol. I. Assessment summaries and management strategies. Wildland Resources Center Report No. 36. Davis, CA: Centers for Water and Wildland Resources, University of California; Pp. 62–71.

[45] Skinner et. al. 2006.

[46] Skinner et. al. 2006.

[47] Husari et al. 2006.

Map 3-1. Lake County Hydrology

Map 3-2. Lake County Fuel Models

Map 3-3. Lake County Fire History by Decade

Map 3-4. Lake County Fire History by Ignition Source

Map 3-5. Lake County Fire Hazard Severity Zones

Map 3-6. Lake County Fire Regime

Map 3-7. Lake County Condition Class

Map 3-8. Lake County Fire Threat