VIA ELECTRONIC MAIL ONLY

Environmental Planning & Sustainability Section
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RE: Significant Ecological Areas (SEA) Ordinance: Public Review Hearing Draft
(August 23, 2018)

Dear Ms. Chi:

Endangered Habitats League (EHL) appreciates the opportunity to comment on this new draft. Our comments will focus on changes since the March 2018 version. We also note, as a general matter, that the structure of the Ordinance, compared to what it would replace, treats the need for an SEA CUP as an exceptional circumstance, only to come into play when the ministerial Development Standards cannot be met. This constitutes extraordinary streamlining for applicants. The trade-off must be a biologically sound ministerial process, without loopholes.

Conceptual SEAs

The staff report contemplates conversion of “Conceptual” SEAs in various foothill locations to standard SEAs. EHL strongly supports such formal designation as SEA. The “conceptual” status was always meant to be a temporary circumstance. It is evident that all appropriate community planning can and should occur within the SEA context. It is in the public interest to re-designate these areas as proposed in the staff report, to provide County-wide consistency, and to retain the biological integrity of the SEA program.

22.102.020 Definitions.

We concur with 1) the new Edge Effect definition and with 2) the clarification between Building Site and Development Area.

While reflecting County Fire Department guidance, the numerical requirement for fuel modification extending to 200 feet from a structure is excessive and indeed counterproductive for fire safety. Ignition of houses is largely through windborne
embers. Excessive clearance and thinning make it more likely for embers to reach a home. Clearing and thinning also foster highly flammable non-native weeds which pose greater ignition risk and more rapid spread than native vegetation.

Rather, the primary purpose of defensible space is for access by fire-fighters and their vehicles. This is well served by 100 feet. Indeed, a forensic post-fire scientific studies has not only documented the adequacy of 100 feet but shown that there is no added benefit beyond 60 feet in terms of which houses burn and which survive. (Enclosures)

At least at some future point, EHL recommends the substitution of official CALFIRE guidance, as contained in “General Guidelines for Creating Defensible Space, 2006.” (Enclosure) CALFIRE recommends a distance of 100 feet rather than 200 feet for clearing and/or thinning from a structure. This distance is the standard of practice in California and consistent with state law. However, it allows for greater distance in the special circumstance of community-wide defensible space or when the fire department finds exceptional hazard, such as steep slope adjacency.

As Fire Department guidance may well change over time, it is best not to “lock in” numbers at this time in the Ordinance, and thereby create conflicts for property owners and a need to amend the Ordinance. Rather, the Ordinance should reference the three zones of fuel modification while noting that Fire Department guidance will provide specific numerical requirements. This is the approach in the March 2018 version, and should be retained.

**22.102.040 Exemptions**

Endangered Habitats League (EHL) welcomes the Alternative Option for reduced SEA exemptions in the Antelope Valley, which reflects community input. The Alternative option would limit the single-family home and fallowed farmland exemptions to the vicinity of Acton, in the eastern portion of the Santa Clara River SEA that is outside of the National Forest boundary. While we favor removal of these exemptions everywhere, we support the Alternative Option as a substantial improvement.

EHL has previously commented that there is no biological basis to treat SEAs in the Antelope Valley differently from SEAs elsewhere. Due to careful crafting of the draft SEA Ordinance to accommodate virtually all single-family uses on a ministerial basis, ordinance compliance is simple and efficient. Furthermore, fallowed farmland provides raptor foraging habitat and may be important for landscape connectivity.

EHL appreciates the community input which led to this Alternative and finds that it would improve the draft Ordinance by providing greater uniformity throughout the County and greater scientific integrity.

**22.102.080 SEA Conditional Use Permit**
D Findings

We note and support the substantial improvement in the findings for SEA resiliency in the new draft. These changes, such as for contiguity, connectivity, and Priority Biological Resources, will increase the biological integrity of outcomes while still allowing for some SEA resource loss if accompanied by compensatory mitigation.

We believe, however, that an SEA CUP should follow the same site design path as a project complying with Development Standards. That is, it should consolidate development in the least impactful location (or locations), and provide maximum contiguous open space with the lowest perimeter to area ratio to reduce edge effects. These directives, if not spelled out in expanded findings, should go into the Implementation Guide as explanatory text for meeting the contiguity finding.

22.102.090 SEA Development Standards

C. Water Resources.

We remain concerned that the setback proposed for marshes, seeps, and springs is not adequate for buffering purposes. In our semi-arid climate, the year-round water supplied by marshes, seeps, and springs is of utmost importance for wildlife. It is vital that access and use be unfettered by human disturbance. It is also important that people not be placed in proximity to potentially dangerous species like mountain lions which use these water features. As most if not all marshes, seeps, and springs in our region will be ½-acre or less, the vast majority of these features would only receive 100-ft of setback, which is very small.

We recommend 300 feet for all marshes, seeps, and springs. While fuel modifications zones might comprise part of this setback, they are subject to the vagarious of changing fire department regulation. Furthermore, uses within fuel modification zones include human uses, such as stables and animal keeping, that will have adverse inhibitory effects on the wildlife using the water sources. Consultation with state and federal wildlife agencies might be helpful.

Also, we strongly concur that, for purposes of setback calculation, fuel modification zones must be included as developed area. These zones are cleared of vegetation to varying extents (often completely cleared), may be planted with non-native vegetation, provide less visual cover for wildlife, and are subject to erosion.

D. Land Use-Specific Development Standards

3. Land Divisions

The heart of the Ordinance is the avoidance and configuration standard for subdivisions. Once legal lots are created, the opportunity to create meaningful contiguous open space is foreclosed. SEA protection—and this Ordinance—will succeed or fail at the point of subdivision. The trade-off for ministerial approval absent an SEA
CUP is the requirement for at least 75% of the site configured to maximize intactness and reduce edge effects. Fragmentation of land, as defined in Definitions, is anathema to SEA functions and values over time, and there must be no loophole for evasion of this responsibility.

As currently drafted, “large lot” subdivisions are allowed to freely deviate from this core principle, and “checkerboard” land into highly fragmenting rectangular parcels. Setting aside 75% of such already fragmented land misses the goal entirely, which is to capture biological benefits at the point of subdivision. Interestingly, the Implementation Guide gets it exactly right in explaining how large lot subdivisions should proceed.

It should be stressed that there is no special legal status for “large lot parcel maps” in state law and a search of the Subdivision Map Act for this term came up empty. They are subdivisions like any other, and the parcels they create are just as legal and just as damaging as any other. There is no legitimate reason for landowners not to comply with configuration standards at the subdivision step—which is exactly the step at which the value of the land for future sale escalates.

As a simple remedy, the existing language in 3b could be moved into the initial section of 3. Land Divisions, so as to clearly apply to all subdivisions. We concur, though, with the test of “reasonable potential” in 3a for future development in Large Lot Parcel Maps to comply with other SEA Review standards. This standard is a lower bar but still reasonably protects SEA values until detailed development planning is done. However, for clarity it is important to include the applicable open space requirements in the examples of SEA Development Standards listed in 3a.

Suggested revisions, which also fully align with the Implementation Guide, are as follows:

3. Land Divisions. All land division projects shall be required to preserve at least 75 percent of the original undivided parcels as natural open space and shall not exceed a maximum development footprint of 25 percent of the project site. Development areas shall be designed in one contiguous location and result in the largest, intact blocks of habitat with the lowest perimeter to area ratio, to the maximum extent feasible.

a. Large Lot Parcel Map. Large lot parcel maps for sale, lease, financing, or transfer purposes, shall demonstrate that all resulting parcels have reasonable potential for future development that meets Section 22.102.090 (SEA Development Standards) (e.g. adequate areas of SEA Resource Categories 4 and/or 5, setback from water resources, 75 percent open space, clustered development) based on the original undivided parcels.

b. Land Divisions. All other land divisions shall not exceed a maximum development footprint of 25 percent of the project site. Development areas shall
be designed in one contiguous location and result in the largest, intact blocks of habitat with the lowest perimeter to area ratio, to the maximum extent feasible.

It is also well worth noting that “conservation subdivisions” as contemplated by the Ordinance will also increase the defensibility of structures during fire events, with improved firefighter access.

Implementation Guide

Land Divisions (p. 46)

Figure 31 is an excellent illustration contrasting a standard compared to a conservation subdivision.

Large lot parcel maps (p. 47)

We concur with this section’s description and guidance.

SEA Ordinance Findings (p. 61)

We urge that additional explanatory bullets be added to the guidance for SEA Finding part F for resiliency. This bullet should address consolidation of development and preservation of intact natural open space, mirroring the biologically sound concepts in Development Standards. For example:

• Has the project’s development footprint been consolidated in the least biologically impactful location (or locations)?
• Has the project open space resulted in the largest and most intact block of habitat with the lowest perimeter to area ratio?

Conclusion

EHL appreciates that progress of the Ordinance to date and makes additional suggestions to close loopholes and otherwise ensure a successful program, while still creating an efficient and clear path to development for landowners.

Yours truly,

Dan Silver
Executive Director
Enclosures

“How Much Defensible Space is Needed to Reduce Home Losses in Chaparral?”, California Fire Science Symposium, 2014

“The role of defensible space for residential structure protection during wildfires,” International Journal of Wildland Fire, 2014

General Guidelines for Creating Defensible Space, CALFIRE, 2006
How Much Defensible Space is Needed to Reduce Home Losses in Chaparral?


In the chaparral of San Diego County, CA, about 500 homes are lost to fire each year. Overall, the rate of home loss has doubled since 2000 and it’s expected to continue rising with the onset of climate change and increasing housing growth.

One of the key concerns at the wildland-urban interface is the extent of vegetation treatment needed to produce “defensible space” around homes. On these landscapes the goal is to produce cost-effective defensible space that reduces fire risks for homes and yet does not result in unnecessary habitat loss, which can increase invasive weed growth and soil erosion.

Syphard, Brennan and Keeley asked how the size of the defensible space zone affected fire outcomes using a dataset of 687,869 homes with their property boundaries. The data included 4315 homes destroyed by major fires between 2001 and 2010 in San Diego County. They randomly selected one thousand homes that were destroyed by fire and 1000 homes that survived the same fires. Using Google Earth aerial imagery, burned homes

Management Implications:

- The most effective measures to reduce structure losses are to “reduce the percentage of woody cover up to 40% immediately adjacent to the structure and to ensure that vegetation does not overhang or touch the structure.”

- There is no additional structure protection provided by clearing beyond 30m (100’), even on steep slopes, and the most important treatment zone is from 5-20m (16-58’).

- The amount of cover reduced is as important as the fuel modification distance; however complete removal of cover is not necessary. The term “clearance” should be replaced with “fuel modification” to emphasize this fact.

- Ornamental vegetation in wildland settings can contribute to structure loss and should be managed in the same way as native vegetation in the defensible space zone.

- This study does not address the distance necessary to protect fire fighters which should be considered as a separate problem.
were examined in the year prior to the fire to determine the size of “defensible space” created by fuel treatments. Both property line measurements and effective distance measurements were gathered for all 2000 homes, along with the percentage cleared land, number of sides of structure with touching or overhanging vegetation, vegetation cover type, housing density, percent slope, and distance to the next road (Fig.1).

These variables were analyzed by four different methods to show that “defensible space increased the likelihood of structure survival during wildfire.” However, the distance required was never more than 30m (100 ft.), even on steep slopes, and was most effective between 5-20 m (16-58 ft.) from the home. The effect of the percentage of cover was as important as distance and was effective when 60% of cover remained. Other important variables contributing to structure loss were ornamental vegetation and overhanging vegetation touching the structure.

While the results clearly show that new standards are needed to provide optimal defensible space around individual homes, the finding that “landscape factors such as low housing density and longer distances to major roads were more important than distance of defensible space for explaining structure destruction” is just as significant. This result emphasizes that reducing future wildfire losses depends on both better land use planning and appropriate mitigation methods.

Fig 1. Illustration of defensible space measurements. See Table 1 in full article for a complete definition of terms.
The role of defensible space for residential structure protection during wildfires

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Abstract. With the potential for worsening fire conditions, discussion is escalating over how to best reduce effects on urban communities. A widely supported strategy is the creation of defensible space immediately surrounding homes and other structures. Although state and local governments publish specific guidelines and requirements, there is little empirical evidence to suggest how much vegetation modification is needed to provide significant benefits. We analysed the role of defensible space by mapping and measuring a suite of variables on modern pre-fire aerial photography for 1000 destroyed and 1000 surviving structures for all fires where homes burned from 2001 to 2010 in San Diego County, CA, USA. Structures were more likely to survive a fire with defensible space immediately adjacent to them. The most effective treatment distance varied between 5 and 20 m (16–58 ft) from the structure, but distances larger than 30 m (100 ft) did not provide additional protection, even for structures located on steep slopes. The most effective actions were reducing woody cover up to 40\% immediately adjacent to structures and ensuring that vegetation does not overhang or touch the structure. Multiple-regression models showed landscape-scale factors, including low housing density and distances to major roads, were more important in explaining structure destruction. The best long-term solution will involve a suite of prevention measures that include defensible space as well as building design approach, community education and proactive land use planning that limits exposure to fire.

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Introduction

Across the globe and over recent decades, homes have been destroyed in wildfires at an unprecedented rate. In the last decade, large wildfires across Australia, southern Europe, Russia, the US and Canada have resulted in tens of thousands of properties destroyed, in addition to lost lives and enormous social, economic and ecological effects (Filmon 2004; Boschetti et al. 2008; Keeley et al. 2009; Blanchi et al. 2010; Vasquez et al. 2012). The potential for climate change to worsen fire conditions (Hessl 2011), and the projection of continued housing growth in fire-prone wildlands (Gude et al. 2011) suggest that many more communities will face the threat of catastrophic wildfire in the future.

Concern over increasing fire threat has escalated discussion over how to best prepare for wildfires and reduce their effects. Although ideas such as greater focus on fire hazard in land use planning, using fire-resistant building materials and reducing human-caused ignitions (e.g. Cary et al. 2009; Quarles et al. 2010; Syphard et al. 2012) are gaining traction, the traditional strategy of fuels management continues to receive the most attention. Fuels management in the form of prescribed fires or mechanical treatments has historically occurred in remote, wildland locations (Schoennagel et al. 2009), but recent studies suggest that treatments located closer to homes and communities may provide greater protection (Witter and Taylor 2005; Stockmann et al. 2010; Gibbons et al. 2012). In fact, one of the most commonly recommended strategies in terms of fuels and fire protection is to create defensible space immediately around structures (Cohen 2000; Winder and Stephens 2009; Cheney et al. 2001). Many jurisdictions provide specific guidelines and practices for creating defensible space, including minimum distances that are required among trees and shrubs as well as minimum total distances from the structure. These distances may be enforced through local ordinances or state-wide laws. In California, for example, a state law in 2005 increased the required total distance from 9 m (30 ft) to 30 m (100 ft).

Despite these specific guidelines on how to create defensible space, there is little scientific evidence to support the amount and location of vegetation modification that is actually effective.
at providing significant benefits. Most spacing guidelines and laws are based on ‘expert opinion’ or recommendations from older publications that lack scientific reference or rationale (e.g. Maire 1979; Smith and Adams 1991; Gilmer 1994). However, one study has provided scientific support for, and forms the basis of, most guidelines, policy and laws requiring a minimum of 30 m (100 ft) of defensible space (Cohen 1999, 2000). The modelling and experimental research in that study showed that flames from forest fires located 10–40 m (33–131 ft) away would not scorch or ignite a wooden home; and case studies showed 90% of homes with non-flammable roofs and vegetation clearance of 10–20 m (33–66 ft) could survive wildfires (Cohen 2000). However, the models and experimental research in that study focussed on crown fires in spruce or jack pine forests, and the primary material of home construction was wood. Therefore, it is unknown how well this guideline applies to regions dominated by other forest types, grasslands, or nonforested woody shrublands and in regions where wooden houses are not the norm.

Some older case studies showed that most homes with non-flammable roofs and 10–18 m (33–59 ft) of defensible space survived the 1961 Bel Air fire in California (Howard et al. 1973); most homes with non-flammable roofs and more than 10 m (33 ft) of defensible space also survived the 1990 Painted Cave fire (Foote and Gilless 1996). Also, several fire-behaviour modelling studies have been conducted in chaparral shrublands. One study showed that reducing vegetative cover to 50% at 9–30 m (30–99 ft) from structures effectively reduced fireline intensity and flame lengths, and that removal of 80% cover would result in unintended consequences such as exotic grass invasion, loss of habitat and increase in highly flammable flashy fuels (A. Fege and D. Pumphrey, unpubl. data). Another showed that separation distances adequate to protect firefighters varied according to fuel model and that wind speeds greater than 23 km h⁻¹ negated the effect of slope, and wind speed above 48 km h⁻¹ negated any protective effect of defensible space (F. Bilz, E. McCormick and R. Unkovich, unpubl. data, 2009). Results obtained through modelling equations of thermal radiation also found safety distances to vary as a function of fuel type, type of fire, home construction material and protective garments worn by firefighters (Zarate et al. 2008).

Although there is no empirical evidence to support the need for more than 30 m (100 ft) of defensible space, there has been a concerted effort in some areas to increase this distance, particularly on steep slopes. In California, a senate bill was introduced in 2008 (SB 1618) to encourage property owners to clear 91 m (300 ft) through the reduction of environmental regulations and permitting needed at that distance. Although this bill was defeated in committee, many local ordinances do require homeowners to clear 91 m (300 ft) or more, and there are reports that some people are unable to get fire insurance without 91 m (300 ft) of defensible space (F. Sproul, pers. comm.). In contrast, homeowner acceptance of and compliance with defensible space policies can be challenging (Winter et al. 2009; Absher and Vaske 2011), and in many cases homeowners do not create any defensible space.

It is critically important to develop empirical research that quantifies the amount, location and distance of defensible space that provides significant fire protection benefits so that guidelines and policies are developed with scientific support. Data that are directly applicable to southern California are especially important, as this region experiences the highest annual rate of wildfire-destroyed homes in the US. Not having sufficient defensible space is obviously undesirable because of the hazard to homeowners. However, there are clear trade-offs involved when vegetation reduction is excessive, as it results in the loss of native habitats, potential for increased erosion and invasive species establishment, and it potentially even increases fire risk because of the high flammability of weedy grasslands (Spittler 1995; Keeley et al. 2005; Syphard et al. 2006).

It is also important to understand the role of defensible space in residential structure protection relative to other factors that explain why some homes are destroyed in fires and some are not. Recent research shows that landscape-scale factors, such as housing arrangement and location, as well as biophysical variables characterising properties and neighbourhoods such as slope and fuel type, were important in explaining which homes burned in two southern California study areas (Syphard et al. 2012, 2013). Understanding the relative importance of different variables at different scales may help to identify which combinations of factors are most critical to consider for fire safety.

Our objective was to provide an empirical analysis of the role of defensible space in protecting structures during wildfires in southern California shrublands. Using recent pre-fire aerial photography, we mapped and measured a suite of variables describing defensible space for burned and unburned structures within the perimeters of major fires from 2001 to 2010 in San Diego County to ask the following questions:

1. How much defensible space is needed to provide significant protection to homes during wildfires, and is it beneficial to have more than the legally required 30 m (100 ft)?
2. Does the amount of defensible space needed for protection depend on slope inclination?
3. What is the role of defensible space relative to other factors that influence structure loss, such as terrain, fuel type and housing density?

Methods

Study area

The properties and structures analysed were located in San Diego County, California, USA (Fig. 1) – a topographically diverse region with a Mediterranean climate characterised by cool, wet winters and long summer droughts. Fire typically is a direct threat to structures adjacent to wildland areas. Native shrublands in southern California are extremely flammable during the late summer and fall (autumn) and when ignited, burn in high-intensity, stand-replacing crown fires. Although 500 homes on average have been lost annually since the mid-1900s (Calfire 2000), that rate has doubled since 2000. Most of these homes have burned during extreme fire weather conditions that accompany the autumn Santa Ana winds. The wildland–urban interface here includes more than 5 million homes, covering more than 28 000 km² (Hammer et al. 2007).

Property data

The data for properties to analyse came from a complete spatial database of existing residential structures and their
corresponding property boundaries developed for San Diego County (Syphard et al. 2012). This dataset included 687,869 structures, of which 4,315 were completely destroyed by one of 40 major fires that occurred from 2001 to 2010. Our goal was to compare homes that were exposed to wildfire and survived with those that were exposed and destroyed. To determine exposure to fire, we only considered structures located both within a GIS layer of fire perimeters and within areas mapped as having burned at a minimum of low severity through thematic Monitoring Trends in Burn Severity produced by the USA Geological Survey and USDA Forest Service. From these data, we used a random sample algorithm in GIS software to select 1000 destroyed and 1000 unburned homes that were not adjacent to each other, to minimise any potential for spatial autocorrelation. Our final property dataset included structures that burned across eight different fires. More than 97% of these structures burned in Santa Ana wind-driven fire events (Fig. 1).

Calculating defensible space and additional explanatory variables

To estimate defensible space, we developed and explored a suite of variables relative to the distance and amount of defensible space surrounding structures, as well as the proximity of woody vegetation to the structure (Table 1). We measured these variables based on interpretation of Google Earth aerial imagery. We based our measurements on the most recent imagery before the date of the fire. In almost all cases, imagery was available for less than 1 year before the fire.

Our definition of defensible space followed the guidelines published by the California Department of Forestry and Fire Protection (Calfire 2006). ‘Clearance’ included all areas that were not covered by woody vegetation, including paved areas or grass. Although Google Earth prevents the identification of understory vegetation, woody trees and shrubs were easily distinguished from grass, and our objective was to measure horizontal distances as required by CalFire rather than assess the relative flammability of different vegetation types. Trees or shrubs were allowed to be within the defensible space zone as long as they were separated by the minimum horizontal required distance, which was 3 m (10 ft) from the edge of one tree canopy to the edge of the next (Fig. 2). Although greater distances between trees or shrubs are recommended on steeper slopes, we followed the same guidelines for all properties. For all structures, we started the distance measurements by drawing lines from the centre of the four orthogonal sides of the structure that ended when they intersected anything that no longer met the requirements in the guidelines. A fair number of structures are not four sided; thus, the start of the centre point was placed at a location that approximated the farthest extent of the structure along each of four orthogonal sides.

We developed two sets of measurements of the distance of defensible space based on what is feasible for homeowners within their properties vs. the total effective distance of defensible space. We made these two measurements because homeowners are only required to create defensible space within their own property, and this would reflect the effect of individual homeowner compliance. Therefore, even if cleared vegetation extended beyond the property line, the first set of distance measurements ended at the property boundary. The second set of measurements ignored the property boundaries and accounted for the total potential effect of treatment. For all measurements, we recorded the cover types (e.g. structure >3 m (10 ft) long, property boundary, or vegetation type) at which the distance measurements stopped (Table 1). Because property
owners usually can only clear vegetation on their own land, it is possible that the effectiveness of defensible space partly depends upon the actions of neighbouring homeowners. Therefore, we also recorded whether or not any neighbours’ uncleared vegetation was located within 30 m (100 ft) of the structure.

To assess the total amount of woody vegetation that can safely remain on a property and still receive significant benefits of defensible space, we calculated the total percentage of cleared land, woody vegetation and structure area across every property. This was accomplished by overlaying a grid on each property and determining the proportion of squares falling into each class. Preliminary results showed these three measurements to be highly correlated, so we only retained percentage clearance for further analysis.

To evaluate the relative effect of woody vegetation directly adjacent to structures, we also calculated the number of sides of the structure with vegetation touching and recorded whether any trees were overhanging structures’ roofs.

In addition to defensible space measurements, we evaluated other factors known to influence the likelihood of housing loss to fire in the region (Syphard et al. 2012, 2013). Using the same data as in Syphard et al. (2012, 2013), we extracted spatial information from continuous grids of explanatory variables for the locations of all structures in our analysis. Variables included interpolated housing density based on a 1-km search radius; percentage slope derived from a 30-m digital elevation model (DEM); Euclidean distance to nearest major and minor road and fuel type, which was based on a simple classification of US Forest Service data (Syphard et al. 2012), including urban, grass, shrubland and forest & woodland.

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### Table 1. Defensible space variables measured for every structure

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance defensible space within property</td>
<td>Measure of clearance from side of structure to property boundary calculated for four orthogonal directions from structure and averaged</td>
</tr>
<tr>
<td>Total distance defensible space</td>
<td>Measure of clearance from side of structure to end of clearance calculated for four orthogonal directions from structure and averaged</td>
</tr>
<tr>
<td>Cover type at end of defensible space</td>
<td>Type of cover encountered at end of measurement (urban veg, wildland veg, orchard, urban to wildland, structure)</td>
</tr>
<tr>
<td>Percentage clearance</td>
<td>Percentage of clearance calculated across the entire property</td>
</tr>
<tr>
<td>Neighbours’ vegetation</td>
<td>Binary indicator of whether neighbours’ uncleared vegetation was located within 30 m (100 ft) of the main structure</td>
</tr>
<tr>
<td>Vegetation touching structure</td>
<td>Number of sides on which woody vegetation touches main structure (1–4) Structure with more than 4 sides were viewed as a box and given a number between 1 and 4</td>
</tr>
<tr>
<td>Vegetation overhanging roof</td>
<td>Was vegetation overhanging the roof? (yes or no)</td>
</tr>
</tbody>
</table>

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![Fig. 2. Illustration of defensible space measurements. See Table 1 for full definition of terms.](image-url)
Defensible space for structure protection

Analysis

We performed several analyses to determine whether relative differences in home protection are provided by different distances and amounts of defensible space, particularly beyond the legally required 30 m (100 ft), and to identify the effective treatment distance for homes on low and steep slopes.

Categorical analysis

For the first analysis, we divided our data into several groups to identify potential differences among specific categories of defensible space distance around structures located on shallow and steep slopes. We first sorted the full dataset of 2000 structures by slope and then split the data in the middle to create groups of homes with shallow slope and steep slope. We divided the data in half to keep the number of structures even within both groups and to avoid specifying an arbitrary number to define what constitutes shallow or steep slope. The two equal-sized subsets of data ranged from 0 to 9%, with a mean of 8% for shallow slope, and from 9 to 40%, with a mean of 27% for steep slope. Within these subsets, we next created groups reflecting different mean distances of defensible space around structures. We also performed separate analyses based on whether defensible space measurements were calculated within the property boundary or whether measurements accounted for the total distance of defensible space.

Within all groups, we calculated the proportion of homes that were destroyed by wildfire. We performed Pearson’s Chi-square tests of independence to determine whether or not the proportion of destroyed structures within groups was significantly different (Agresti 2007). We based one test on four equal-interval groups within the legally required distance of 30 m (100 ft): 0–7 m (0–25 ft), 8–15 m (26–50 ft), 16–23 m (51–75 ft) and 24–30 m (76–100 ft). A second test was based on three groups (24–30 m (75–100 ft), 31–90 m (101–300 ft) and >90 m (>300 ft) or >60 m (>200 ft)) to evaluate whether groups with mean defensible space distances >30 m (>100 ft) were significantly different from groups with <30 m (<100 ft). When defensible space distances were only measured to the property boundary, few structures had mean defensible space >90 m (>300 ft). Therefore, we used a cut-off of 60 m (200 ft) to increase the sample size in the Chi-square analysis. In addition to the Chi-square analysis, we calculated the relative risk among every successive pair of the Chi-square analysis. In addition to the Chi-square analysis, we also considered that the protective effect of defensible space for structures exposed to wildfire is conceptually similar to the effect of medication in producing a therapeutic response in people who are sick. In addition to pharmacological applications, treatment–response relationships have been used for radiation, herbicide, drought tolerance and ecotoxicological studies (e.g. Streibig et al. 1993; Cedergreen et al. 2005; Knezevic et al. 2007; Kursar et al. 2009). The effect produced by a drug or treatment typically varies according to the concentration or amount, often up to a point at which further increase provides no additional response. The effective treatment (ET50), therefore, is a specific concentration or exposure that produces a therapeutic response or desired effect. Here we considered the treatment to be the distance or amount of defensible space.

Using the software package DRC in R (Knezevic et al. 2007; Ritz and Streibig 2013), we evaluated the treatment–response relationship of defensible space in survival of structures during wildfire. To calculate the effective treatment, we fit a log-logistic model with logistic regression because we had a binary dependent variable (burned or unburned). We specified a 2-parameter model where the lower limit was fixed at 0 and the upper limit was fixed at 1. We again performed separate analyses for data subsets reflecting shallow and steep slope, as well as from measurements of defensible space taken within, or regardless of, property boundaries. We also performed analyses to find the effective treatment of percentage clearance of trees and shrubs within the property.

Multiple regression analysis

To evaluate the role of defensible space relative to other variables, we developed multiple generalised linear regression models (GLMs) (Venables and Ripley 1994). We again had a binary dependent variable (burned versus unburned), so we specified a logit link and binomial response. Although the proportion of 0s and 1s in the response may be important to consider for true prediction (King and Zeng 2001; Syphard et al. 2008), our objective here was solely to evaluate variable importance. We developed multiple regression models for all possible combinations of the predictor variables and used the corrected Akaike’s Information Criterion (AICc) to rank models and select the best ones for each region using package MuMIn in R (R Development Core Team 2012; Burnham and Anderson 2002). We recorded all top-ranked models that had an AICc value within 2 of that of the model with lowest AICc to identify all models with empirical support. To assess variable importance, we calculated the sum of Akaike weights for all models that contained each variable. On a scale of 0–1, this metric represents the weight of evidence that models containing the variable in question are the best model (Burnham and Anderson 2002). The distance of defensible space measured within property boundaries was highly correlated with the distance of defensible space measured beyond property boundaries ($r = 0.82$), so we developed two separate analyses – one using variables measured only within the property boundary and the other using variables that accounted for defensible space outside of the property boundary as well as the potential effect of neighbours having uncleared vegetation within 30 m (100 ft) of the structure. A test to avoid multicollinearity showed all other variables within each multiple regression analysis to be uncorrelated ($r < 0.5$).

Surrounding matrix

To assess whether the proportion of destroyed structures varied according to their surrounding matrix, we summarised the most common cover type at the end of defensible space measurements (descriptions in Table 1) for all structures. These summaries
were based on the majority surrounding cover type from the four orthogonal sides of the structure. We also noted cases in which there was a tie (e.g. two sides were urban vegetation and two sides were structures).

Results

Categorical analysis

When the distance of defensible space was measured both ‘only within property boundaries’ (Fig. 3) and ‘regardless of property boundaries’ (Fig. 4), the Chi-square test showed a significant difference \( P < 0.001 \) in the proportion of destroyed structures among the four equal-interval groups of distance ranging from 0 to 30 m (0–100 ft). This relationship was consistent on both shallow-slope and steep-slope properties, although the relative risk analysis showed considerable variation (Table 2). There was a steadily decreasing proportion of destroyed structures at greater distances of defensible space up to 30 m (100 ft) on the steep-slope structures with defensible space measured regardless of property boundaries (Fig. 4b). Otherwise, the biggest difference in proportion of destroyed structures occurred between 0 and 7 m (0–25 ft) and 8–15 m (25–50 ft) (Figs 3a–b, 4a).

When the distance of defensible space was measured in intervals from 24 m (75 ft) and beyond, the Chi-square test showed no significant difference among groups \( P = 0.96 \) for shallow-slope properties and \( P = 0.74 \) for steep-slope properties (Figs 3, 4), although again, the relative risk analysis showed considerable variation (Table 2). There was a slight increase in the proportion of homes destroyed at longer distance intervals when the defensible space was measured only to the property boundaries (Fig. 3a–b). This slight increase is less apparent when distances were measured regardless of boundaries (Fig. 4a–b).

The relative risk calculations showed that the ratio of proportions was generally more variable among successive pairs when the distances were measured within property boundaries (Table 2). For these calculations, the risk of a structure being destroyed was significantly lower when the defensible space distance was 8–15 m (25–50 ft) compared to 0–7 m (0–25 ft) on both shallow- and steep-slope properties. On the steep-slope properties, there was an additional reduction of risk when comparing 24–30 m (75–100 ft) to 16–23 m (50–75 ft). However, the risk of a home being destroyed was slightly significantly higher when there was 31–90 m (101–225 ft) compared to 16–23 m (50–75 ft). For distances that were measured regardless of property boundary (total clearance), the only significant differences in risk of burning were a reduction in risk for 8–15 m (25–50 ft) compared to 0–7 m (0–25 ft).
Effective treatment analysis

Analysis of the treatment–response relationships among defensible space and structures that survived wildfire showed that, when all structures are considered together, the mean actual defensible space that existed around structures before the fires was longer than the calculated effective treatment (Table 3). Regardless of whether the defensible space was measured within or beyond property boundaries, the estimated effective treatment of defensible space was nearly the same at 10 m (32–33 ft).

The effective treatment distance was much shorter for structures on shallow slopes (4–5 m (13–16 ft)) than for structures on steep slopes (20–25 m (65–82 ft)), but in all cases was <30 m (<100 ft). Although longer distances of defensible space were calculated as effective on steeper slopes, these structures actually had shorter mean distances of defensible space around their properties than structures on low slopes (Table 3).

The calculated effective treatment of the mean percentage clearance on properties was 36% for all properties, 31% for structures on shallow slopes and 37% for structures on steep slopes (Table 3). In total, the properties all had higher actual percentage clearance on their property than was calculated to be effective. However, this mainly reflects the shallow-slope properties, as those structures on steep slopes had less clearance than the effective treatment.

Multiple regression analysis

When defensible space was measured only to the property boundaries, it was not included in the best model, according to the all-subsets multiple regression analysis (Table 4). However, it was included in the best model when factoring in the distance of defensible space measured beyond property boundaries (Table 5). In both multiple regression analyses, low housing density and shorter distances to major roads were ranked as the most important variables according to their Akaike weights. Slope and surrounding fuel type were also in both of the best models as well as other measures of defensible space, including the percentage clearance on property and whether vegetation was overhanging the structure’s roof. The number of sides in which vegetation was touching the structure was included in the best model when defensible space was only measured to the property boundary. The total explained deviance for the multiple regression models was low (12–13%) for both analyses.

### Table 2. Number of burned and unburned structures within defensible space distance categories (m), their relative risk and significance

A relative risk of 1 indicates no difference; <1 means the chance of a structure burning is less than the other group; >1 means the chance is higher than the other group. The relative risk is calculated for pairs that include the existing row and the row above. Confidence intervals are in parentheses.

<table>
<thead>
<tr>
<th>Distance within property</th>
<th>Burned</th>
<th>Unburned</th>
<th>Relative risk</th>
<th>P</th>
<th>Burned</th>
<th>Unburned</th>
<th>Relative risk</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow slope</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–7</td>
<td>200</td>
<td>186</td>
<td>0.69 (0.12)</td>
<td>&lt;0.001</td>
<td>162</td>
<td>114</td>
<td>1.03 (0.16)</td>
<td>0.77</td>
</tr>
<tr>
<td>8–15</td>
<td>189</td>
<td>198</td>
<td>1.03 (0.30)</td>
<td>0.110</td>
<td>107</td>
<td>132</td>
<td>0.77 (0.39)</td>
<td>0.002</td>
</tr>
<tr>
<td>16–23</td>
<td>51</td>
<td>89</td>
<td>0.850</td>
<td>0.100</td>
<td>50</td>
<td>90</td>
<td>1.00 (0.17)</td>
<td>0.770</td>
</tr>
<tr>
<td>24–30</td>
<td>36</td>
<td>40</td>
<td>0.59 (0.24)</td>
<td>0.010</td>
<td>34</td>
<td>17</td>
<td>2.00 (0.17)</td>
<td>0.002</td>
</tr>
<tr>
<td>31–90</td>
<td>28</td>
<td>47</td>
<td>1.67 (0.63)</td>
<td>0.004</td>
<td>79</td>
<td>99</td>
<td>1.00 (0.17)</td>
<td>0.770</td>
</tr>
<tr>
<td>60 or 90+</td>
<td>10</td>
<td>6</td>
<td>0.040</td>
<td>8</td>
<td>9</td>
<td>1.01</td>
<td>0.830</td>
<td></td>
</tr>
<tr>
<td>Steep slope</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–7</td>
<td>245</td>
<td>128</td>
<td>0.82 (0.10)</td>
<td>0.001</td>
<td>224</td>
<td>128</td>
<td>0.84 (0.17)</td>
<td>0.000</td>
</tr>
<tr>
<td>8–15</td>
<td>174</td>
<td>148</td>
<td>1.00 (0.16)</td>
<td>0.750</td>
<td>158</td>
<td>139</td>
<td>0.87 (0.17)</td>
<td>0.210</td>
</tr>
<tr>
<td>16–23</td>
<td>85</td>
<td>68</td>
<td>0.66 (0.10)</td>
<td>0.010</td>
<td>73</td>
<td>83</td>
<td>0.73 (0.17)</td>
<td>0.700</td>
</tr>
<tr>
<td>24–30</td>
<td>29</td>
<td>56</td>
<td>1.04 (0.17)</td>
<td>0.004</td>
<td>50</td>
<td>50</td>
<td>0.73 (0.17)</td>
<td>0.700</td>
</tr>
<tr>
<td>31–90</td>
<td>29</td>
<td>28</td>
<td>0.95 (0.47)</td>
<td>0.050</td>
<td>39</td>
<td>68</td>
<td>1.00 (0.17)</td>
<td>0.770</td>
</tr>
<tr>
<td>60 or 90+</td>
<td>5</td>
<td>5</td>
<td>0.95 (0.47)</td>
<td>0.950</td>
<td>4</td>
<td>8</td>
<td>0.91 (0.47)</td>
<td>0.830</td>
</tr>
</tbody>
</table>

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### Table 3. Effective treatment results reflecting the distance (in metres, with feet in parentheses) and percentage clearance within properties that provided significant improvement in structure survival during wildfires

The property mean is the average distance of defensible space or percentage clearance that was calculated on the properties before the wildfires and provides a means to compare the effective treatment result to the actual amount on the properties.

<table>
<thead>
<tr>
<th>Distance within property</th>
<th>All parcels effective treatment (n = 2000)</th>
<th>Parcel mean</th>
<th>Shallow slope effective treatment (mean 8%) (n = 1000)</th>
<th>Parcel mean</th>
<th>Steep slope effective treatment (mean 27%) (n = 1000)</th>
<th>Parcel mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defensible space within parcel</td>
<td>10 (33)</td>
<td>13 (44)</td>
<td>4 (13)</td>
<td>14 (45)</td>
<td>25 (82)</td>
<td>11 (35)</td>
</tr>
<tr>
<td>Total distance defensible space</td>
<td>10 (32)</td>
<td>19 (63)</td>
<td>5 (16)</td>
<td>20 (67)</td>
<td>20 (65)</td>
<td>18 (58)</td>
</tr>
<tr>
<td>Mean percentage clearance on property</td>
<td>36</td>
<td>48</td>
<td>31</td>
<td>51</td>
<td>37</td>
<td>35</td>
</tr>
</tbody>
</table>
The cover type that most frequently surrounded the structures at the end of the defensible space measurements was urban vegetation, followed by urban vegetation leading into wildland vegetation, and wildland vegetation (Fig. 5). Many structures were equally surrounded by different cover types. There were no significant differences in the proportion of structures destroyed depending on the surrounding cover type. However, a disproportionately large proportion of structures burned (28 v. 9% unburned) when they were surrounded by urban vegetation that extended straight into wildland vegetation.

**Discussion**

For homes that burned in southern Californian urban areas adjacent to non-forested ecosystems, most burned in high-intensity Santa Ana wind-driven wildfires and defensible space increased the likelihood of structure survival during wildfire. The most effective treatment distance varied between 5 and 20 m (16–58 ft), depending on slope and how the defensible space was measured, but distances longer than 30 m (100 ft) provided no significant additional benefit. Structures on steeper slopes benefited from more defensible space than structures on shallow slopes, but the effective treatment was still less than 30 m (100 ft). The steepest overall decline in destroyed structures occurred when mean defensible space increased from 0–7 m (0–25 ft) to 8–15 m (26–50 ft). That, along with the multiple regression results showing the significance of vegetation touching or overhanging the structure, suggests it is most critical to modify vegetation immediately adjacent to the house, and to move outward from there. Similarly, vegetation overhanging the structure was also strongly correlated with structure loss in Australia (Leonard et al. 2009).

In terms of fuel modification, the multiple regression models also showed that the percentage of clearance was just as, or more important than, the linear distance of defensible space.
Defensible space for structure protection

However, as with defensible space, percentage clearance did not need to be draconian to be effective. Even on steep slopes, the effective percentage clearance needed on the property was <40%, with no significant advantage beyond that. Although these steep-slope structures benefited more from clearance, they tended to have less clearance than the effective amount, which may be why slope was such an important variable in the multiple regression models. Shallow-slope structures, in contrast, had more clearance on average than was calculated to be effective, suggesting these property owners do not need to modify their behaviours as much relative to people living on steep slopes.

Although the term ‘clearance’ is often used interchangeably with defensible space, this term is incorrect when misinterpreted to mean clearing all vegetation, and our results underline this difference. The idea behind defensible space is to reduce the continuity of fuels through maintenance of certain distances among trees and shrubs. Although we could not identify the vertical profile of fuels through Google Earth imagery, the fact that at least 60% of the horizontal woody vegetative cover can remain on the property with significant protective effects demonstrates the importance of distinguishing defensible space from complete vegetation removal. Thus, we suggest the term ‘clearance’ be replaced with ‘fuel treatment’ as a better way of communicating fire hazard reduction needs to home owners.

The percentage cover of woody shrubs and trees was not evenly distributed across properties, and we did not collect data describing how the cover was distributed. Considering the importance of defensible space and vegetation modification immediately adjacent to the structure, it should follow that actions to reduce cover should also be focussed in close proximity to the structure. The hazard of vegetation near the structure has apparently been recognised for some time (Foote et al. 1999; Ramsey and McArthur 1994), but it is not stressed enough, and rarely falls within the scope of defensible space guidelines or ordinances.

In addition to the importance of vegetation overhanging or touching the structure, it is important to understand that ornamental vegetation may be just as, if not more, dangerous than native vegetation in southern California. Although the results showed no significant differences in the cover types in the surrounding matrix, there was a disproportionately large number of structures destroyed (28% burned v. 9% unburned) when ornamental vegetation on the property led directly into the wildland. Ornamental vegetation may produce highly flammable litter (Ganteaume et al. 2013) or may be particularly dangerous after a drought when it is dry, or has not been maintained, and species of conifer, juniper, cypress, eucalypt, Acacia and palm have been present in the properties of many structures that have been destroyed (Franklin 1996). Nevertheless, ornamental vegetation is allowed to be included as defensible space in many codes and ordinances (Haines et al. 2008).

One reason that longer defensible space distances did not significantly increase structure protection may be that most homes are not destroyed by the direct ignition of the fire front but rather due to ember-ignited spot fires, sometimes from fire brands carried as far as several km away. Although embers decay with distance, the difference between 30 and 90 m (100 and 300 ft) may be small relative to the distance embers travel under the severe wind conditions that were present at the time of the fires. The ignitability of whatever the embers land on, particularly adjacent to the house, is therefore most critical for propagating the fire within the property or igniting the home (Cohen 1999; Maranghides and Mell 2009).

Aside from roofing or home construction materials and vegetation immediately adjacent to structures (Quarles et al. 2010; Keeley et al. 2013), the flammability of the vegetation in the property may also play a role. Large, cleared swaths of land are likely occupied at least in part by exotic annual grasses that are highly ignitable for much of the year. Conversion of woody shrubs with higher moisture content into low-fuel-volume grasslands could potentially increase fire risk in some situations by increasing the ignitability of the fuel; and if the vegetation between a structure and a fire is not readily combustible, it could protect the structure by absorbing heat flux and filtering fire brands (Wilson and Ferguson 1986).

The slight increase in proportion of structures destroyed with longer distances of defensible space within parcel boundaries was surprising. However, that increase was not significant in the Chi-square analysis, although there were some significant differences in the pairwise relative risk analysis. Nevertheless, the largest significant effect of defensible space was between the categories of 0–7 m (0–25 ft) to 8–15 m (26–50 ft), and it may be that differences in categories beyond these distances are not highly meaningful or reflect an artefact of the definition of distance categories. These relationships at longer distances are likely also weak compared to the effect of other variables operating at a landscape scale. Although the categorical analysis allowed us to answer questions relative to legal requirements and specific distances, the effective treatment analysis was important for identifying thresholds in the continuous variable.

The multiple regression models showed that landscape factors such as low housing density and longer distances to major roads were more important than distance of defensible space for explaining structure destruction, and the importance of
these variables is consistent with previous studies (Syphard et al. 2012, 2013), despite the smaller spatial extent studied here. Whereas this study used an unburned control group exposed to the same fires as the destroyed structures, previous studies accounted for structures across entire landscapes. The likelihood of a fire destroying a home is actually a result of two major components: the first is the likelihood that there will be a fire, and the second is the likelihood that a structure will burn in that fire. In this study, we only focussed on structure loss given the presence of a fire, and the total explained variation for the multiple regression models was quite low at ~12%. However, when the entire landscape was accounted for in the total likelihood of structure destruction, the explained variation of housing density alone was >30% (Syphard et al. 2012). One reason for the relationship between low housing density and structure destruction is that structures are embedded within a matrix of wildland fuel that leads to greater overall exposure, which is consistent with Australian research that showed a linear decrease of structure loss with increased distance to forest (Chen and McAnaney 2004). That research, however, only focussed on distance to wildland boundaries and did not quantify variability in defensible space or ornamental vegetation immediately surrounding structures. Thus, fire safety is important to consider at multiple scales and for multiple variables, which will ultimately require the cooperation of multiple stakeholders.

**Conclusions**

Structure loss to wildfire is clearly a complicated function of many biophysical, human and spatial factors (Keeley et al. 2009; Syphard et al. 2012). For such a large sample size, we were unable to account for home construction materials, but this is also well understood to be a major factor, with older homes and wooden roofs being most vulnerable (Franklin 1996; Cohen 1999, 2000). In terms of actionable measures to reduce fire risk, this study shows a clear role for defensible space up to 30 m (100 ft). Although the effective distances were on average much shorter than 30 m (100 ft), we recognise that additional distance may be necessary to provide sufficient protection to firefighters, which we did not address in this study (Cheney et al. 2001). In contrast, the data in this study do not support defensible space beyond 30 m (100 ft), even for structures on steep slopes. In addition to the fact that longer distances did not contribute significant additional benefit, excessive vegetation clearance presents a clear detriment to natural habitat and ecological resources. Results here suggest the best actions a homeowner can take are to reduce percentage cover up to 40% immediately adjacent to the structure and to ensure that vegetation does not overhang or touch the structure.

In addition to defensible space, this study also underlines the potential importance of land use planning to develop communities that are fire safe in the long term, in particular through their reduction to exposure to wildfire in the first place. Localised subdivision decisions emphasising infill-type development patterns may significantly reduce fire risk in the future, in addition to minimising habitat loss and fragmentation (Syphard et al. 2013). This study was conducted in southern California, which has some of the worst fire weather in the world and many properties surrounded by large, flammable exotic trees.

Therefore, recommendations here should apply to other non-forested ecosystems as well as many forested regions.

**Acknowledgements**

We acknowledge funding from the US Geological Survey Fire Risk Scenario Project and note that use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the US Government.

**References**


Defensible space for structure protection


General Guidelines for Creating Defensible Space

State Board of Forestry and Fire Protection (BOF)
California Department of Forestry and Fire Protection

Adopted by BOF on February 8, 2006
Approved by Office of Administrative Law on May 8th, 2006
Contents

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A. Purpose of Guidelines

Recent changes to Public Resources Code (PRC) 4291 expand the defensible space clearance requirement maintained around buildings and structures from 30 feet to a distance of 100 feet. These guidelines are intended to provide property owners with examples of fuel modification measures that can be used to create an area around buildings or structures to create defensible space. A defensible space perimeter around buildings and structures provides firefighters a working environment that allows them to protect buildings and structures from encroaching wildfires as well as minimizing the chance that a structure fire will escape to the surrounding wildland. These guidelines apply to any person who owns, leases, controls, operates, or maintains a building or structure in, upon, or adjoining any mountainous area, forest-covered lands, brush-covered lands, grass-covered lands, or any land that is covered with flammable material, and located within a State Responsibility Area.

The vegetation surrounding a building or structure is fuel for a fire. Even the building or structure itself is considered fuel. Research and experience have shown that fuel reduction around a building or structure increases the probability of it surviving a wildfire. Good defensible space allows firefighters to protect and save buildings or structures safely without facing unacceptable risk to their lives. Fuel reduction through vegetation management is the key to creating good defensible space.

Terrain, climate conditions and vegetation interact to affect fire behavior and fuel reduction standards. The diversity of California’s geography also influences fire behavior and fuel reduction standards as well. While fuel reduction standards will vary throughout the State, there are some common practices that guide fuel modification treatments to ensure creation of adequate defensible space:

- Properties with greater fire hazards will require more clearing. Clearing requirements will be greater for those lands with steeper terrain, larger and denser fuels, fuels that are highly volatile, and in locations subject to frequent fires.

- Creation of defensible space through vegetation management usually means reducing the amount of fuel around the building or structure, providing separation between fuels, and or reshaping retained fuels by trimming. Defensible space can be created removing dead vegetation, separating fuels, and pruning lower limbs.

- In all cases, fuel reduction means arranging the tree, shrubs and other fuels sources in a way that makes it difficult for fire to transfer from one fuel source to another. It does not mean cutting down all trees and shrubs, or creating a bare ring of earth across the property.

- A homeowner’s clearing responsibility is limited to 100 feet away from his or her building or structure or to the property line, whichever is less, and limited to their land. While individual property owners are not required to clear beyond 100 feet, groups of property owners are encouraged to extend clearances beyond the 100 foot requirement in order to create community-wide defensible spaces.

- Homeowners who do fuel reduction activities that remove or dispose of vegetation are required to comply with all federal, state or local environmental protection laws and obtain permits when necessary. Environmental protection laws include, but are not limited to, threatened and endangered species, water quality, air quality, and cultural/archeological resources. For example, trees removed for fuel reduction that are used for commercial purposes require permits from the...
The methods used to manage fuel can be important in the safe creation of defensible space. Care should be taken with the use of equipment when creating your defensible space zone. Internal combustion engines must have an approved spark arresters and metal cutting blades (lawn mowers or weed trimmers) should be used with caution to prevent starting fires during periods of high fire danger. A metal blade striking a rock can create a spark and start a fire, a common cause of fires during summertime.

Vegetation removal can also cause soil disturbance, soil erosion, regrowth of new vegetation, and introduce non-native invasive plants. Always keep soil disturbance to a minimum, especially on steep slopes. Erosion control techniques such as minimizing use of heavy equipment, avoiding stream or gully crossings, using mobile equipment during dry conditions, and covering exposed disturbed soil areas will help reduce soil erosion and plant regrowth.

Areas near water (riparian areas), such as streams or ponds, are a particular concern for protection of water quality. To help protect water quality in riparian areas, avoid removing vegetation associated with water, avoid using heavy equipment, and do not clear vegetation to bare mineral soil.

B. Definitions

Defensible space: The area within the perimeter of a parcel where basic wildfire protection practices are implemented, providing the key point of defense from an approaching wildfire or escaping structure fire. The area is characterized by the establishment and maintenance of emergency vehicle access, emergency water reserves, street names and building identification, and fuel modification measures.

Aerial fuels: All live and dead vegetation in the forest canopy or above surface fuels, including tree branches, twigs and cones, snags, moss, and high brush. Examples include trees and large bushes.

Building or structure: Any structure used for support or shelter of any use or occupancy.

Flammable and combustible vegetation: Fuel as defined in these guidelines.

Fuel Vegetative material, live or dead, which is combustible during normal summer weather. For the purposes of these guidelines, it does not include fences, decks, woodpiles, trash, etc.

Homeowner: Any person who owns, leases, controls, operates, or maintains a building or structure in, upon, or adjoining any mountainous area, forest-covered lands, brush-covered lands, grass-covered lands, or any land that is covered with flammable material, and located within a State Responsibility Area.

Ladder Fuels: Fuels that can carry a fire vertically between or within a fuel type.

Reduced Fuel Zone: The area that extends out from 30 to 100 feet away from the building or structure (or to the property line, whichever is nearer to the building or structure).

Surface fuels: Loose surface litter on the soil surface, normally consisting of fallen leaves or needles, twigs, bark, cones, and small branches that have not yet decayed enough to lose their identity; also grasses, forbs, low and medium shrubs, tree seedlings, heavier branches and downed logs.
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.

General Guidelines:

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-space 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 (see Plant Spacing Guidelines and Case Examples below). 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 eight feet can be “grouped” and considered as one plant and spaced according to the Plant Spacing Guidelines in this document.
Grass generally should not exceed 4 inches in height. However, homeowners may keep grass and other forbs less than 18 inches in height above the ground when these grasses are isolated from other fuels or where necessary to stabilize the soil and prevent erosion.

Clearance requirements include:

- Horizontal clearance between aerial fuels, such as the outside edge of the tree crowns or high brush. Horizontal clearance helps stop the spread of fire from one fuel to the next.

- Vertical clearance between lower limbs of aerial fuels and the nearest surface fuels and grass/weeds. Vertical clearance removes ladder fuels and helps prevent a fire from moving from the shorter fuels to the taller fuels.

*Horizontal clearance between aerial fuels*

*Vertical clearance between aerial fuels*

*Effective vertical and horizontal fuel separation*
Plant Spacing Guidelines

Guidelines are designed to break the continuity of fuels and be used as a “rule of thumb” for achieving compliance with Regulation 14 CCR 1299.

<table>
<thead>
<tr>
<th>Trees</th>
<th>Minimum horizontal space from edge of one tree canopy to the edge of the next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>Spacing</td>
</tr>
<tr>
<td>0% to 20%</td>
<td>10 feet</td>
</tr>
<tr>
<td>20% to 40%</td>
<td>20 feet</td>
</tr>
<tr>
<td>Greater than 40%</td>
<td>30 feet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shrub</th>
<th>Minimum horizontal space between edges of shrub</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>Spacing</td>
</tr>
<tr>
<td>0% to 20%</td>
<td>2 times the height of the shrub</td>
</tr>
<tr>
<td>20% to 40%</td>
<td>4 times the height of the shrub</td>
</tr>
<tr>
<td>Greater than 40%</td>
<td>6 times the height of the shrub</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vertical Space</th>
<th>Minimum vertical space between top of shrub and bottom of lower tree branches:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 times the height of the shrub</td>
</tr>
</tbody>
</table>

Adapted from: Gilmer, M. 1994. California Wildfire Landscaping

Case Example of Fuel Separation: Sierra Nevada conifer forests

Conifer forests intermixed with rural housing present a hazardous fire situation. Dense vegetation, long fire seasons, and ample ignition sources related to human access and lightning, makes this home vulnerable to wildfires. This home is located on gentle slopes (less than 20%), and is surrounded by large mature tree overstory and intermixed small to medium size brush (three to four feet in height).

Application of the guideline under 4a. would result in horizontal spacing between large tree branches of 10 feet; removal of many of the smaller trees to create vertical space between large trees and smaller trees and horizontal spacing between brush of six to eight feet (calculated by using 2 times the height of brush).
Case Example of Fuel Separation: Southern California chaparral

Mature, dense and continuous chaparral brush fields on steep slopes found in Southern California represents one of the most hazardous fuel situations in the United States. Chaparral grows in an unbroken sea of dense vegetation creating a fuel-rich path which spreads fire rapidly. Chaparral shrubs burn hot and produce tall flames. From the flames come burning embers which can ignite homes and plants. (Gilmer, 1994). All these factors result in a setting where aggressive defensible space clearing requirements are necessary.

Steep slopes (greater than 40%) and tall, old brush (greater than 7 feet tall), need significant modification. These settings require aggressive clearing to create defensible space, and would require maximum spacing. Application of the guidelines would result in 42 feet horizontal spacing (calculated as 6 times the height of the brush) between retained groups of chaparral.

Case Example of Fuel Separation: Oak Woodlands

Oak woodlands, the combination of oak trees and other hardwood tree species with a continuous grass ground cover, are found on more than 10 million acres in California. Wildfire in this setting is very common, with fire behavior dominated by rapid spread through burning grass.

Given a setting of moderate slopes (between 20% and 40%), wide spacing between trees, and continuous dense grass, treatment of the grass is the primary fuel reduction concern. Property owners using these guidelines would cut grass to a maximum 4 inches in height, remove the clippings, and consider creating 20 feet spacing between trees.
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.

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Defensible Space retaining continuous trees

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Photo Courtesy Plumas Fire Safe Council.

Defensible space with continuous tree canopy by clearing understory and pruning

To the Department of Regional Planning:

As a retired arborist and landscape planner who worked for many years throughout California, I was encouraged to learn that the County’s SEA Ordinance has attempted to establish native tree protections. Other parts of the SEA Ordinance were commented upon extensively, whereas this appears to have been added only recently. As such, I would like to comment on the management of encroachments.

You state that encroachment of more than 30% should be treated as a removal, without acknowledging that the location and type of encroachment are the most important factors, not a total percentage amount. I could encroach in about 5% of the protected zone of the tree by digging a trench around the trunk and kill the tree. Conversely, half of the protected zone could already be paved, and “encroachment” as you have defined it would have no marginal impact at all.

My concern with your approach (apart from complaints from landowners observing that their neighbors’ trees encroached to a far greater extent are doing just fine) is that you are departing fairly significantly from the literature in something that is going to be interpreted as a matter of law. As it concerns encroachment of the root zone, the important thing is typically that it occurs on a single side and that it does not occur within the “critical root zone,” which is defined as a distance out to 3 or (preferably) 5 times the trunk diameter. The City of La Canada Flintridge recently enacted Tree Protection guidelines that reflect this, defining the critical root zone between 2.5 and 3.5x the trunk diameter: https://docs.google.com/a/lcf.ca.gov/viewer?a=v&pid=sites&srcid=bGNmLmNhLmdvdnxjaXR5LW9mLWxhLWNhbmFkYS1mbGludHJpZGdlXNpdGV8Z3g6N2MxZGU5OWE4MGI5ZDQ1OQ.

I would formulate criteria for removal as follows:

“Any marginal encroachment within a “critical root zone” extending out to five times the trunk diameter at breast height, or in more than two adjacent quadrants of the protected zone, shall be treated as a removal.” That would be at most about 35% of the protected zone of a typical tree, but you’re qualifying that the encroachment should be on a single side and that it should not encroach on the critical root zone where the structural core of the tree extends out and downwards.

I also find it confusing to have one criterion in which you reference the protected zone and another in which you reference the dripline. First, this is a bad idea. There are some asymmetric trees for which the dripline is entirely on one side of the trunk. You could encroach all the way up into the critical root zone and not violate the law as written, but you would be encroaching in more than 30% of the protected zone, since this is defined as the lesser of the dripline and 15 feet. There’s a reason to have both of these criteria together.

I would suggest you abandon the dripline criterion (i.e. 4 trees can encroach into 10% or less of the dripline) and instead define this lower amount of impact as being encroachment into a single quadrant of the protected zone, beyond the critical root zone. This could be no more than about 15-20% of the protected zone, which may be 10-15% of the dripline in a more typical symmetric tree, close to the
amount that you have proposed. Because roots typically extend out beyond the
dripline by as much as a factor of twice the radius of the dripline, limiting the
radial swath of encroachment is more important. If you want to define a “minor”
encroachment that you tolerate in a greater number of trees, this is a better way to
do so.

Please consider this more sensible approach, and at any rate reach out to
professional arborists to provide feedback.

Sincerely,

John Davis
International Society of Arboriculture Board Certified Master Arborist (retired)
In Reply Refer To:
FWS-LA-18B0173-18CPA0314

September 11, 2018
Sent by Email

Iris Chi
Regional Planner
Department of Regional Planning – Los Angeles County
320 West Temple Street
Los Angeles, California 90012

Subject: Significant Ecological Areas Ordinance Amendment, Los Angeles County, California

Dear Ms. Chi:

The U.S. Fish and Wildlife Service (Service) has reviewed Los Angeles County’s (County) proposed Significant Ecological Areas (SEA) Ordinance Amendment, dated March 14, 2018. Our comments are based on the information provided in the amendment, our knowledge of sensitive and declining vegetation communities, and our participation in regional conservation planning efforts.

The primary concern and mandate of the Service is the protection of public fish and wildlife resources and their habitats for the benefit of the American people. The Service has legal responsibility for the welfare of migratory birds, anadromous fish, and threatened and endangered animals and plants occurring in the United States. The Service is also responsible for administering the Federal Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 et seq.), including habitat conservation plans (HCP) developed under section 10(a)(1)(B) of the Act.

SEAs are areas where the County deems it important to facilitate a balance between development and biological resource conservation. The SEA Ordinance implements the goals and policies of the County’s General Plan by establishing permitting requirements, design standards, and review processes for development within SEAs. The goal of the SEA Ordinance is to guide development to the least impactful areas on a property in order to avoid adverse impacts to biological resources.

The development standards are consistent with our recommendations to conserve biological resources in the County. For example, the SEA Ordinance Amendment states “for land division projects, at least 75 percent of the net area of the development site shall be required preserved open space.” This amendment is consistent with our mission of protecting public fish and wildlife resources and their habitats for the benefit of the American people. If implemented, the amendment could streamline our review of projects where permits and consultation may be needed under the Act. We also support the revised definition of development to focus on impacts to habitat and vegetation rather than on specific land uses. We look forward to working with the County on projects that impact Category 1 resources and require a SEA Conditional Use Permit, including those projects which impact habitat for federally listed species.
We appreciate the County’s efforts to conserve, protect and enhance natural resources. The SEA Ordinance Amendment is an improvement over the existing ordinance to further those efforts, and we support its approval.

If you have any questions regarding this letter, please contact Colleen Draguesku of this office at (760) 431-9440, extension 241.

Sincerely,

Karen A. Goebel
Assistant Field Supervisor

cc:
Christopher Diel, U.S. Fish and Wildlife Service
Erinn Wilson, California Department of Fish and Wildlife