Appendix C

Ember Behavior: Why the 1.5 mile WUI is Excessive

The likelihood of an ember travelling 1.5 miles from a flaming front and igniting any single given house (or any other given small, discretely located type of potential receptive fuel) downwind is likely quite small. However, ignition by a single ember is usually not how most houses burn down.

If a structure lies downwind of a weather-driven wildfire, chances are excellent that a large number of shorter range embers will ignite everything that can burn between here and there, creating more embers all along the way, and allowing the head fire to blow hopscotch over, across, and through just about anything to reach that house. The collective fire spreading effect of all the embers makes the head fire's downwind progress all but unstoppable while the fire weather lasts.

Tracked in real time, the instantaneous rates of ember production and subsequent transport by turbulent, gusty winds must be very transient and highly dynamic. In general, averaged over time, it is likely most embers fall near the flaming front in a decay curve as you move further and further downwind of the instantaneous location of any flaming front. At 1.5 miles, the tail of the decay curve is likely quite small. Chances are a structure will burn when the flaming front is close and the site is under the “thicker” part of that ember distribution curve.

The rationale for fuel treatments in areas a long way upwind of a community is that they will produce some additional fire safety even if they can't stop the fire because they will reduce the density of embers falling on a structure or community. **Such a claim is conjectural at best.**

Since fires produce embers by the millions, and ignition probabilities likely approach 100% in very dry fire weather, it is not at all clear what value reducing ember density might actually have in protecting structures or helping firefighters reduce fire spread.

We are unaware of any recorded quantitative data on ember density-by-distance.

Firefighter experience and the research have shown that weather-driven wildfires tend to spread across landscapes with very little regard to fuel type, or age (Mortiz et al. 2004). This spread is mostly through a large number of separate spotting events that start a large number of new fires running out ahead of any fire's flaming front. If structures are in the way, then fire will spread up to them, go over, and around them, and then move on downwind.

Like the onset of a coming rainstorm, at a given location one might experience a single ember, then another, then two, then more and more, until the main flaming front comes through and the ember density gets heavy. Ember density will decline as the fire passes by and continues downwind.

Once there is a modest amount of defensible space around a structure to make the surface fire stop short of direct flame impingement (varies with terrain, often no more than 30ft) and to

prevent ignition by radiant heating (100ft max), and to be safe in case of potential turbulent convective heating so firefighters can feel safe enough to stay and defend (up to 150ft?), then it's all about ember ignition. Whether any given structure burns or not has everything to do with **how receptive it is to ignition by windborne embers** when that unstoppable fire comes through.

That NIST report on structure loss during the 2007 Witch Creek Fire, and much of their subsequent work, documents very clearly that lots of structures with good defensible space of up to 100 or more feet can and do get ignited by embers. Firefighters or civilians onsite defending a structure do so primarily by extinguishing spot fires on and in the structure before they can get big.

http://www.nist.gov/el/fire_research/wildland/project_wui_data.cfm

http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1796.pdf

This is exactly why risk reduction must work from the “house out.” All fire science points to this. Many county fire programs support this concept as well. Cal Fire promotes the "house out" strategy too, and has since at least 2007.

http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_faqs#gen01

Unfortunately, vegetation management gets the primary focus (please see Appendix B: An Appeal to California’s Fire Agencies).

Fire agencies, firefighters, fire scientists, and environmental groups are on the same page about this. What we've been fighting about all these years are questions about the efficacy of doing anything to “fuels” beyond the home ignition zone and beyond the largest plausible defensible space buffer.

The WUI as a concept should be determined by fire operation concerns of fighting fire at the edge of town. So WUI as a concept is all about defensible space and how much of that do we need.

USFS fire scientist Jack Cohen has clearly demonstrated that about 100ft is all any structure needs to avoid ignition by radiant heating from even the hottest wildfire on flat ground with little wind. Add those factors drive heat and convection horizontally and more space will be needed.

Let’s assume for discussion that a 300 ft defensible space would be desirable for doing point protection versus long, completely sideways flames that might be expected in the very most hazardous fire terrain imaginable. Three hundred feet of defensible space would be very excessive in all but the most pathological cases of structures built in terrain where no one should be living and no firefighters should be asked to make a stand against fire.

Three hundred feet is only 5% of the way to the 8,000ft (=1.5miles) that the DPEIR currently proposes everywhere.

So the 1.5 mile definition of WUI everywhere is excessive.

Ember travel distance

As far as we know, the longest distance spotting event documented in fire literature occurred on Feb 7, 2009 ("Black Saturday") during the 2009 Victoria, Australia firestorms. Spot fire ignitions from Bunyip Park were documented at 20km (approx 12 miles).

Below are two annotated references concerning that event and another from the recent Fort McMurray Fire in Alberta, Canada.

Campbell, Peter. 2010. 2009 Victorian bushfires.
Greenlivingpedia.org
http://www.greenlivingpedia.org/2009_Victorian_bushfires

Local weather stations on "Black Saturday" 2/7/2009 recorded sustained winds of approximately 30mph blowing nonstop from the N and NW for about 12 hours during the worst of the fires. The winds reversed direction during the course of the incident, blowing from the SE. This would be quite typical for a major Santa Ana wind event in southern California. In fact, Santa Ana winds often blow even stronger than this. The duration and the reversal are also typical of Santa Ana winds.

Daily high temperature was a record-setting 46.4degC (114degF). Relative humidity was as low as 5%. This is a higher temperature than we are ever likely to see in southern California, but our relative humidity often goes lower than this (to near zero) during our worst fire weather.

The area of Victoria State, Australia, had gone for a record-setting 38 days without any rain. Southern California's seasonal drought is commonly 5-6 months.

Widespread and very long distance spotting was observed. Fire spread rates of up to 100km/hr (62 miles/hr) were observed. Fire spread through all types of land cover, including farmland, and forests where extensive fuel modification by Rx burning had been performed for fire safety. Fire officials emphasized that this fire was driven primarily by weather, not fuels.

The main fire at Bunyip Park was started by lightning. Several other fires in the area were confirmed or suspected to be arson.

Egan, Carmel and Steve Holland. 2009. Inferno terrorizes communities as it rages out of control. The Age, Feb 8, 2009.
http://www.theage.com.au/national/inferno-terrorises-communities-as-it-rages-out-of-control-20090207-80fw.html

> *The Bunyip Ridge inferno lived up to its menacing threat yesterday, bearing down on one tiny Gippsland community after another and forcing firefighters to retreat ahead of its towering fire head.*
>
> *More than 300 firefighters battled the three-kilometre-wide fire front before being forced to pull back as it made its run out of the state forest around 4pm towards the*

villages and towns of Labertouche, Tonimbuk, Longwarry, Drouin and Jindivick.

By 6pm, fanned by gale-force north-westerly winds, it had burnt 2400 hectares of forest and farmland and unknown numbers of homes and outbuildings.

Flaming embers started spot fires up to 20 kilometres to the south and threatened homes as far away as Warragul.

Ha, Tu Thanh. 2016. The perfect storm of conditions: here's how the blaze reached Fort McMurray, and why it spread so fast. The Globe and Mail. http://www.theglobeandmail.com/news/alberta/albertas-highway-of-fire/article29863650/

The fire that jumped over the Athabasca River was a spot fire, Mr. Schmitte said.

Mr. Burnett said he had seen situations where spotting enabled a forest fire to leap eight to 10 kilometres ahead of its main line.

Spot fires are also troublesome when they are near urban areas, he said, because embers ignite rooftops or rain gutters clogged with dead leaves and pine needles.

Cited Reference

Moritz, M.A., J.E. Keeley, E.A. Johnson, and A.A. Schaffner. 2004. Testing a basic assumption of shrubland fire management: Does the hazard of burning increase with the age of fuels? Frontiers in Ecology and the Environment. 2:67-72.