Beyond Plant Lists:

Helping homeowners move their houses (and neighborhoods) off the fire freeway

Steven Swain

Environmental Horticulture Advisor, Marin & Sonoma Counties

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University of California
Agriculture and Natural Resources

First, a little context

- Is it really about the plants?
  - If we're trying to save a house, we often look beyond the house to assess what needs changing
  - LOOK AT THOSE EUCALYPTUS TREES! Nope.
- What if it's about the houses?
- What if tree survival is directly predicted by distance from houses?
- How close is everything?

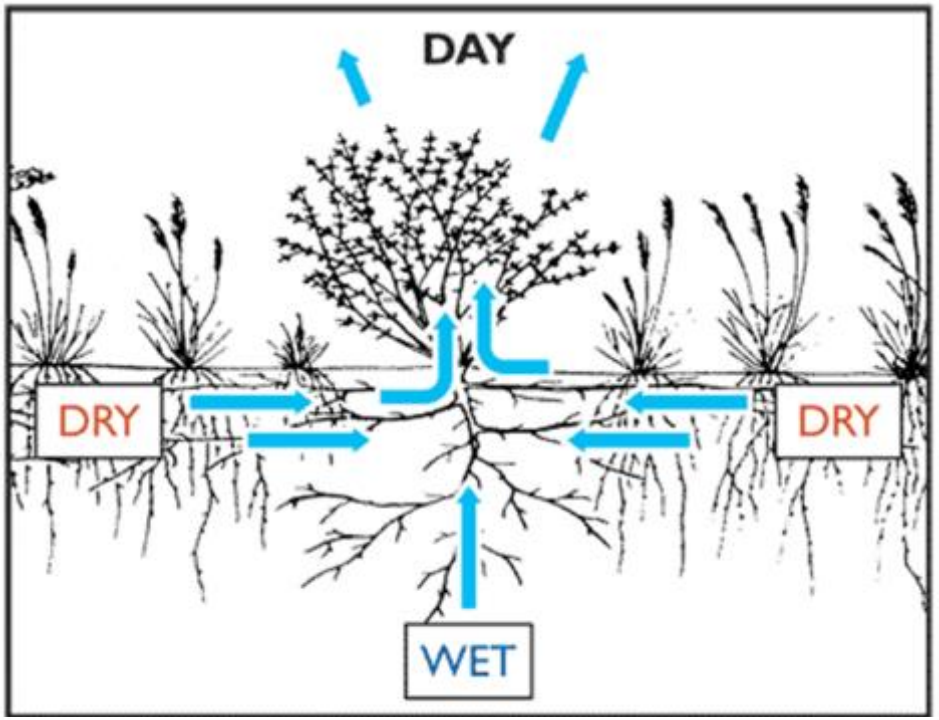
Image: LA Times

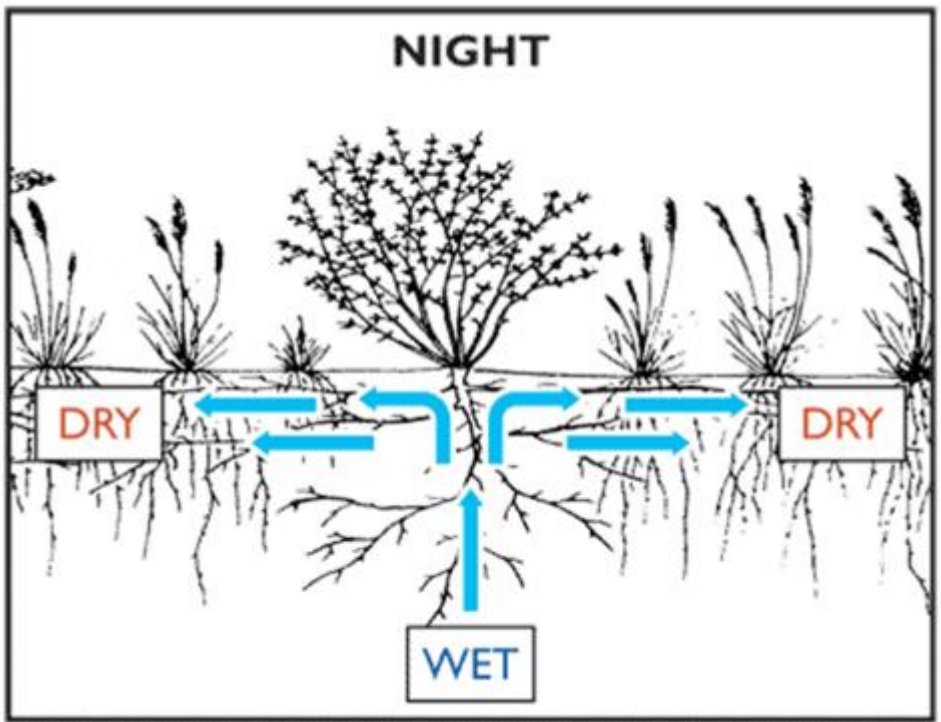
Community

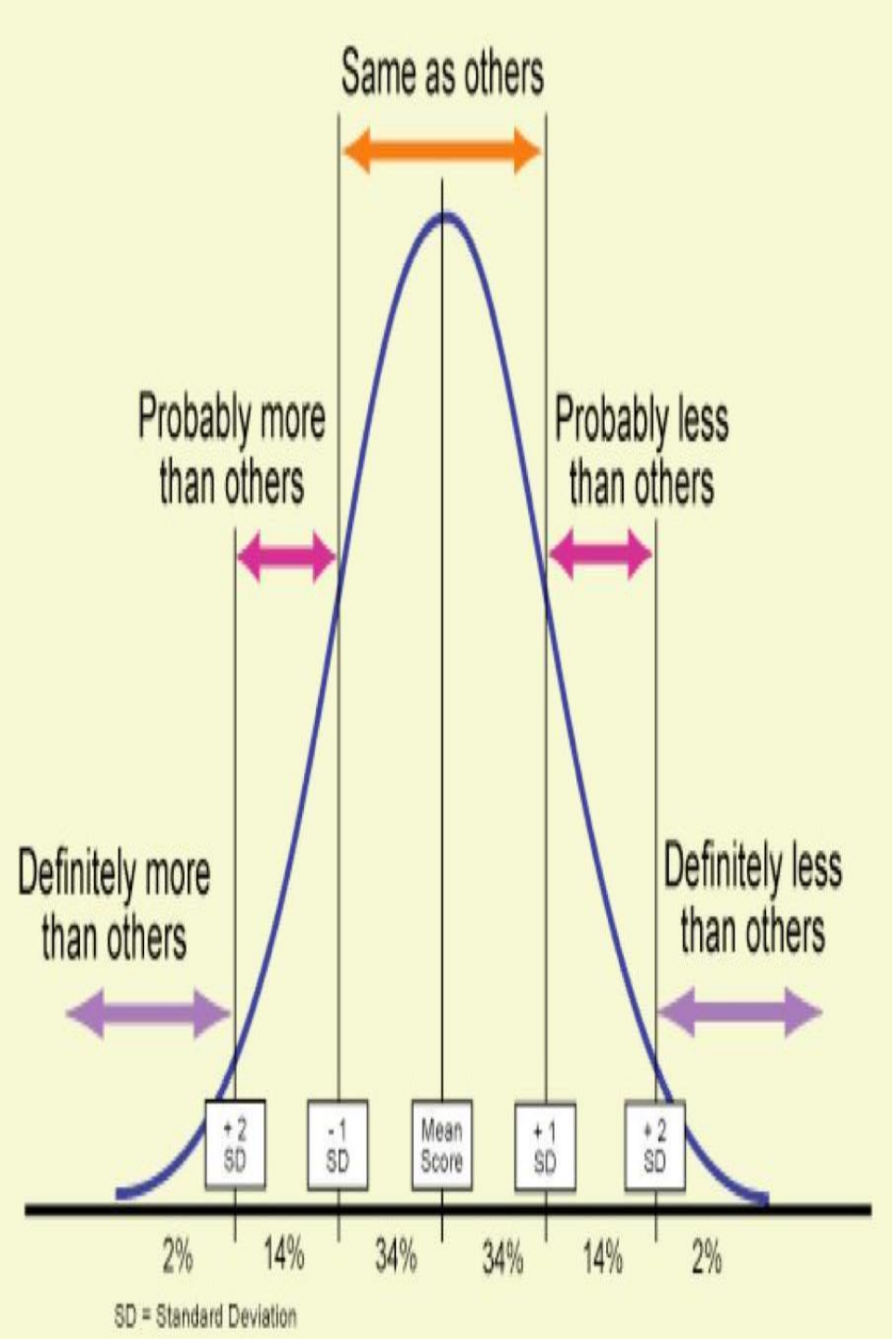
- Plant flammability lists mostly meaningless
  - Some based on wildland fire behavior
- Community structure important
- This is why design and maintenance are important
  - Landscape is a community
- Design: interruption of fuel ladders / conduits
  - Horizontal
  - Vertical
- Maintenance: think moist
  - Remove dead/dry fuels
  - Keep plants hydrated
    - Soils may be dry?
  - Plants manage water

Plants as water managers?

- The soil community
- By day, as we all learned in school
- At night, water flows to mycorrhizae
  - Transports sugars to fungi
  - Fungi take sugars, use water to digest
  - Water taken up by trees at sunrise







Plant selection

- We don't even know what to evaluate for fire
- We can see differences
  - Even then the lists don't agree
  - But they make a very short list
    - 2% of plant species or less
    - Succulents and forbs
    - Urban ecological disaster?
- Plants serve many roles in the landscape
  - Shade is a critical factor in C use
  - Vegetable gardens
- Natives stay hydrated with little water
  - Wildlife benefits
  - Established communities
  - Look south for plant lists

Quarles' Mulch Flammability Study

- Composted materials less flammable
- Finer materials don't burn as well as coarse materials
- The safest organic mulches are fine composts
- Decorative dyed wood chips burn really well
- Fir bark burns well too
  - Bonus – flaming embers blow in the wind!

The C challenge

- Urban trees have an outsized C impact – in a good way
- C sequestration in California summers?
  - Only if there's water (cities?)
  - $6CO_2 + 6H_2O$ > sunlight > $C_6H_{12}O_6 + 6O_2$
- It's about shade and wind
  - Location specific
  - Generally not on the north or south sides of house
  - Locations west of the house are typically the best
    - Locations east for can work well for deciduous trees

Image: Px fuel

Winter Shade

- Percent shade of deciduous trees: ~20%
- Reduced sunlight and heat
  - Minor effect
  - Sun is low and weak
    - Many long shadows
  - Days are short

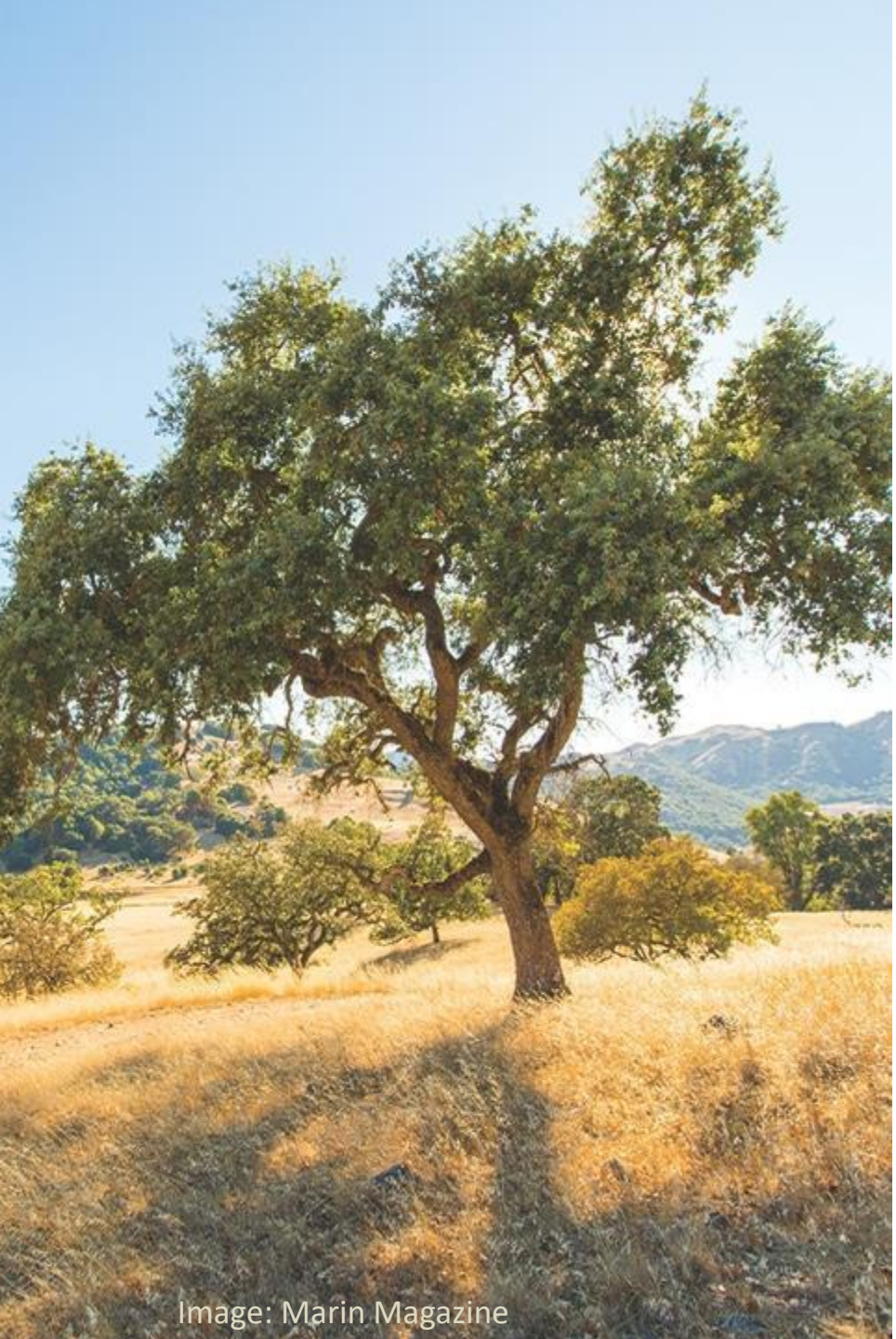


Image: Marin Magazine

Summer Shade

- Reduced sunlight (heat)
  - Major effect
  - Sun is high and intense
  - Noon shadows are small
  - But afternoon shadows are large
  - Days are long

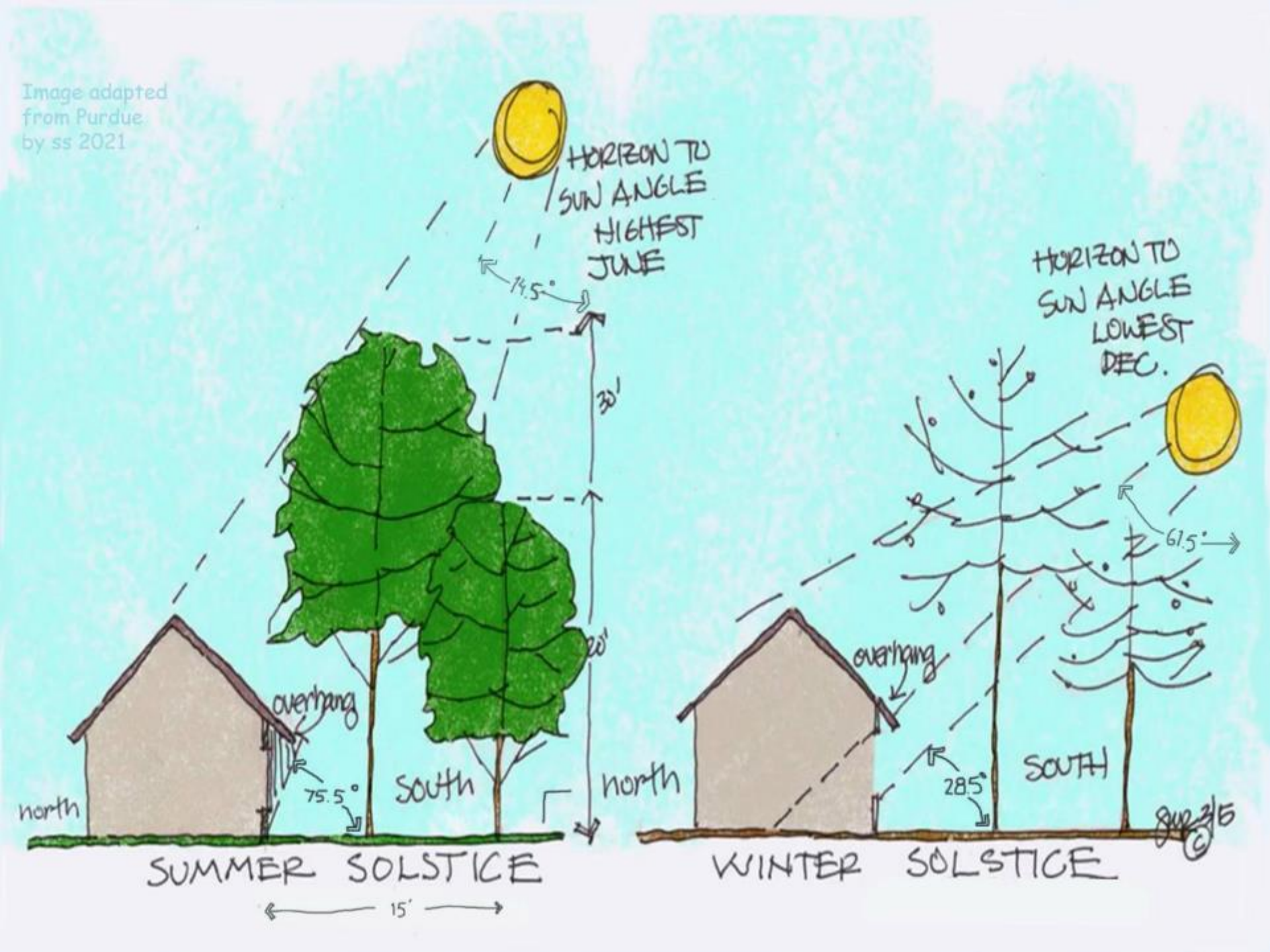


Image adapted
from Purdue
by ss 2021
HORIZON TO
SUN ANGLE
HIGHEST
JUNE
14.5°
30'
20'
overhang
75.5°
north
SOUTH
north
SUMMER SOLSTICE
15'
HORIZON TO
SUN ANGLE
LOWEST
DEC.
61.5°
overhang
28.5°
SOUTH
WINTER SOLSTICE

Tree location: sun

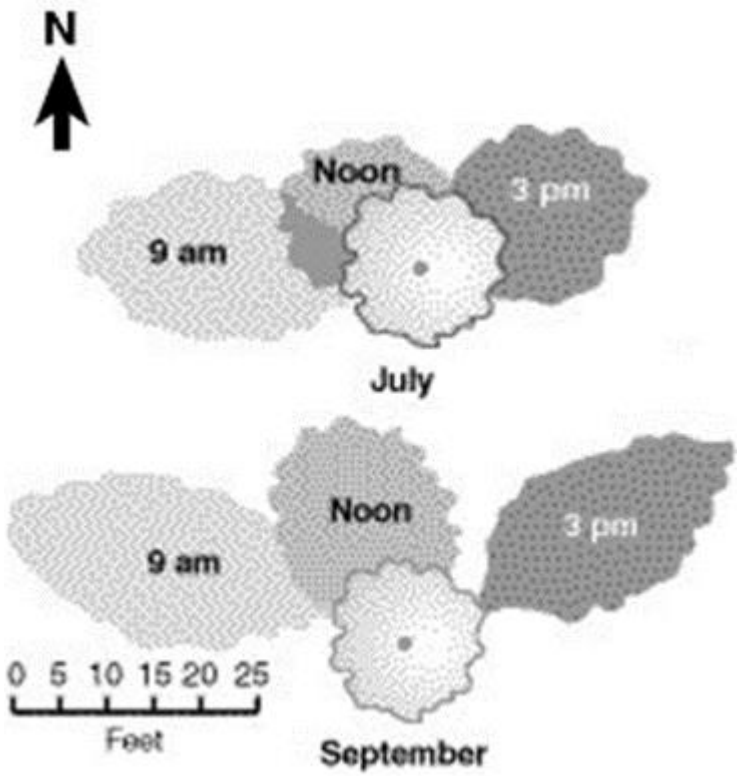
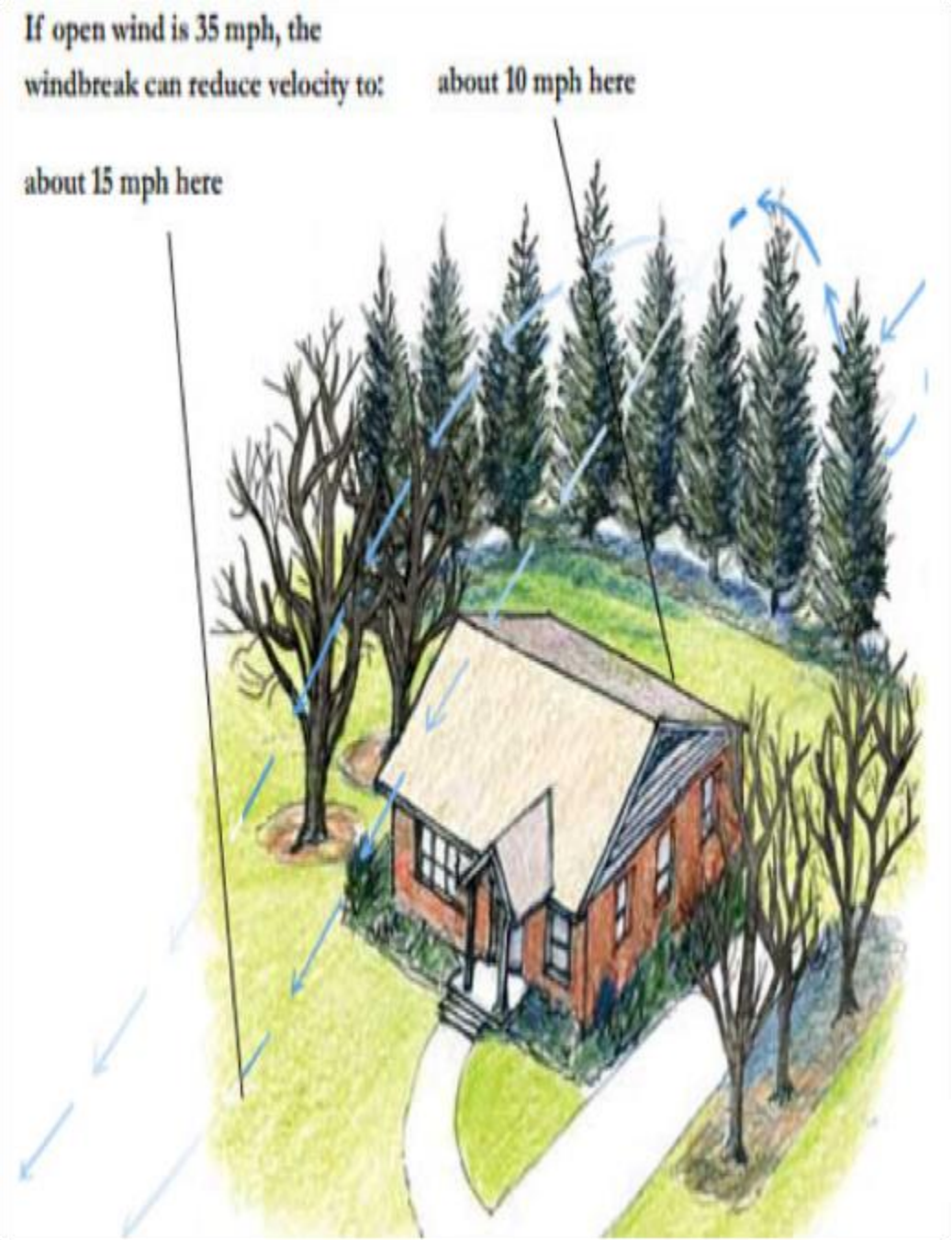


Image: Missouri Cooperative Extension

- North: no appreciable effect
- East: morning effect
- South, Winter: slight (-) effect for deciduous
- South, Summer: only (+) if close to house
  - Fire risk?
- **West: afternoon effect**

Image: Longwood Gardens



Tree location: wind

- Most Californian's live in locations with westerly prevailing winds
  - Coast
- Evergreens provide best wind abatement
- Horizontal wind abatement = 3x tree height @ ~35mph
- On the coast, this is mostly a winter effect
- Trees on north side of house have a slight negative energy effect
  - Wind channeled onto house

Carbon costs

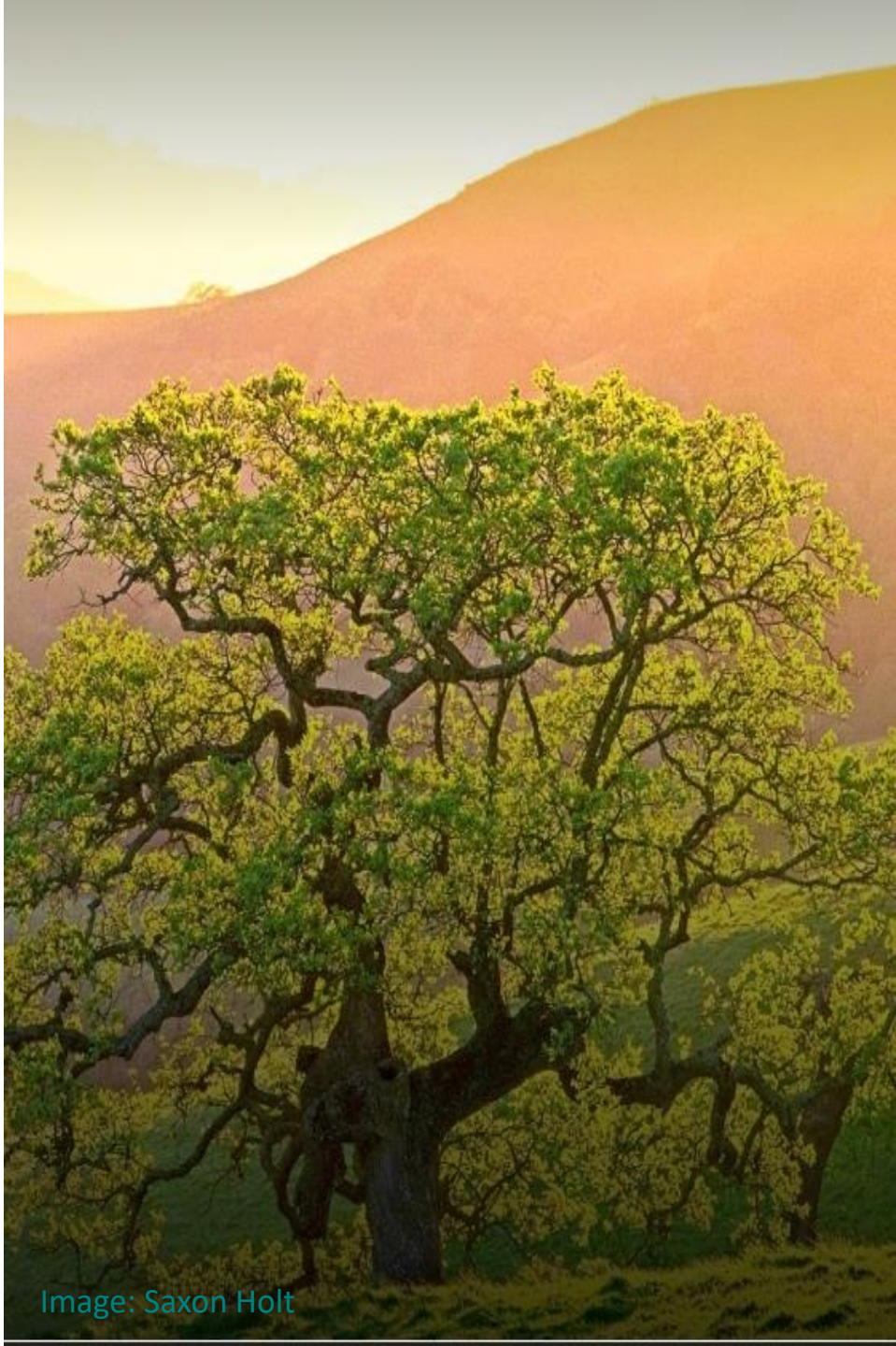
- Shade
  - Interior house temps reduced ~8-20˚ F.
    - 8˚ F reduction > 10% energy savings for AC
    - Bigger savings in milder climates
    - Heating calculations more complicated (up to 3% / degree F).
  - Reduce electricity usage > reduce carbon emissions
  - **The big benefit of urban trees is that they can reduce carbon emissions at 10x the rate that trees sequester carbon.**
  - **How effective a tree is at reducing heating & cooling costs is almost entirely dependent on where it's planted**

Carbon costs

- Big trees sequester a lot of carbon
  - Use a lot of water
  - Water pumping uses 25% of California's total electricity
  - Marin's #1 electricity user: Marin Water
  - Irrigation = carbon emissions
  - Just wait until we get desalination

What tree?

- A tree that will provide summer shade and/or wind screening *without* using irrigation water
  - Native California species
  - Endemic to your neighborhood
  - Well suited to your particular site



Climate change

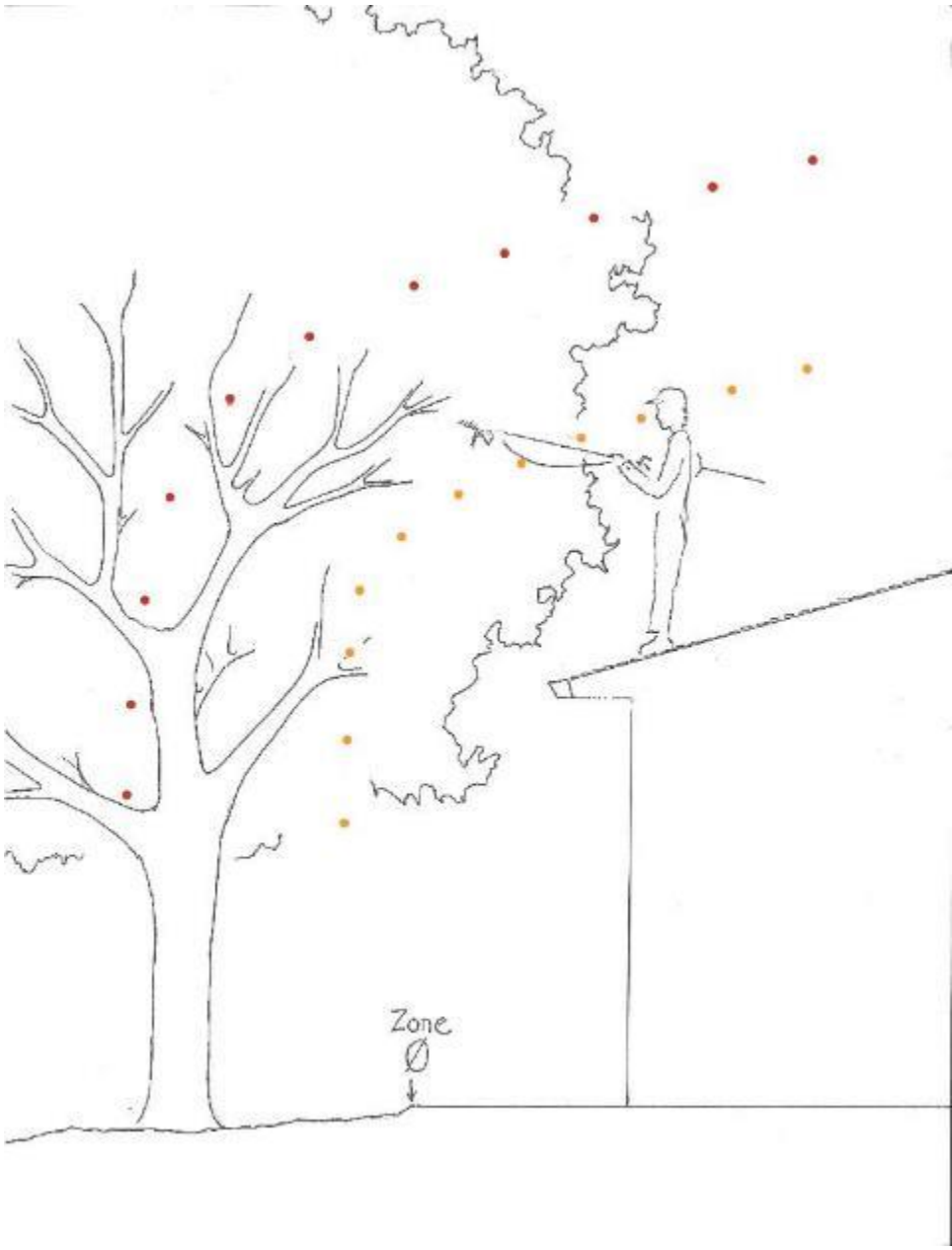
- Global warming
- How to pick plants for an uncertain future
  - Will our future climate be equivalent to a more southern city?
    - Santa Barbara as a proxy for the North Bay?
  - Will our future climate revert to a prehistoric regime?
    - Monsoon rainy season?
    - Engleman oaks?

Example plan

- Plans always site specific
  - Plant deciduous trees 30’ on E side and 10’ from house on S side
    - Summer shade
    - Winter sun
  - Plant evergreens 50’ from house on W side
    - Afternoon shade year round
    - Winter wind break reduces heating costs
  - No trees on N side
    - Or plant >30’ from house

Roof clearance

- 10 feet of horizontal clearance from chimneys
  - Supporting data?
  - Probably okay
- Some sources say 10 feet from roof edge
  - Ever tried to prune 10 feet from the top of a roof?
  - Five foot gutter radius should be sufficient
  - We need to be able to clean gutters regularly



Roof clearance

- 2019 study by Syphard and Keeley is sometimes cited as justification for no branches over roofs
- Alexandra Syphard has directly disavowed this interpretation
  - Ellie Insley, Pers comm., 2020
  - Balance between benefits and liabilities
  - Want to be comfortable and save money? Keep your trees and **clean your gutters**

Trees: summary

- Trees are valuable assets to property
- Huge economic and ecological value
  - Sun
  - Shade
  - Windbreak
- Proper placement is fundamental to performance
- Proper maintenance of trees and gutters is critical for fire safety

Gutter guards

- Doesn’t stop sand from composite roofs
  - Sand buildup in gutters
  - Moss growth on sand
  - Paperwasps, etc.
  - **Much harder to clean**
- No gutters?
  - Gravel area in zone 0?

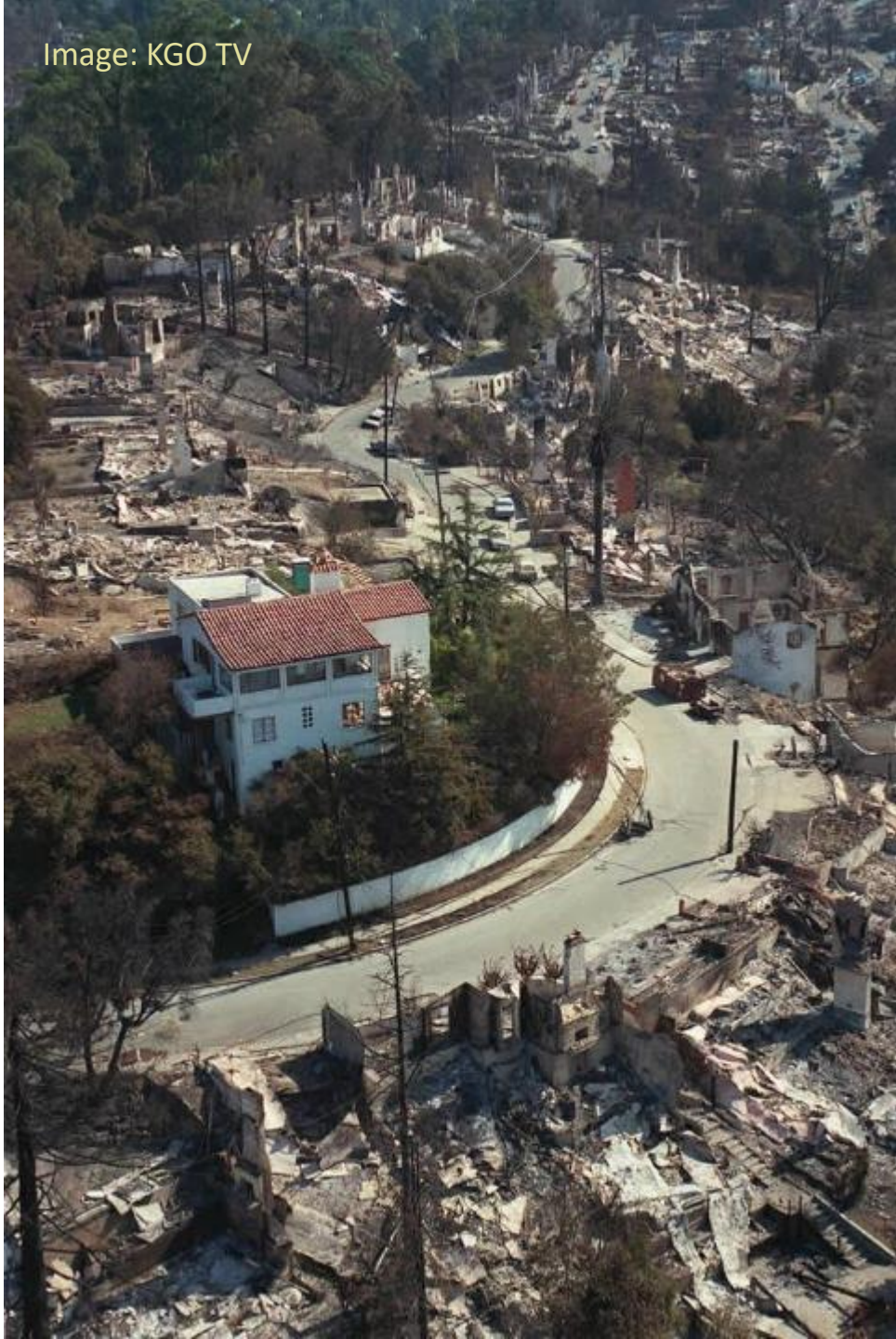
Image: FireSafe Marin

Where does the fire start?

- So, if you want to save your house, don't start with the plants
  - Start with the house.
- Because the biggest threat to the average home isn't the plants.
- It's the (your) house itself. Really.
  - https://ucanr.edu/sites/fire/Prepare/Building/
  - And if it isn't your house …
  - *It's your neighbor's house.*

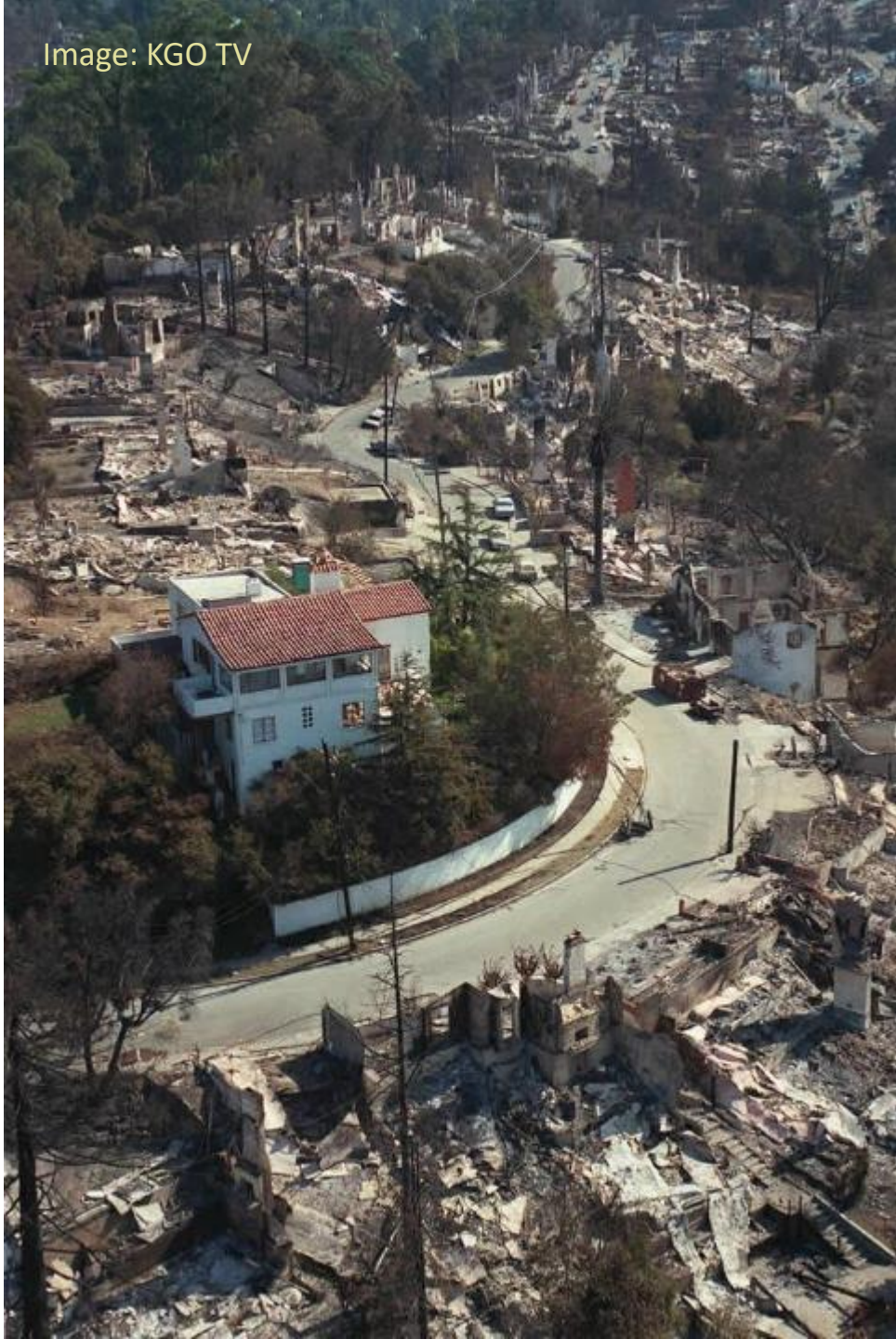
It's about community

- The biggest threat from a wildfire?
  - Embers
- The biggest threat from an *urban* fire?
  - Your neighbor's house?
  - How do we fight fires as neighborhoods?



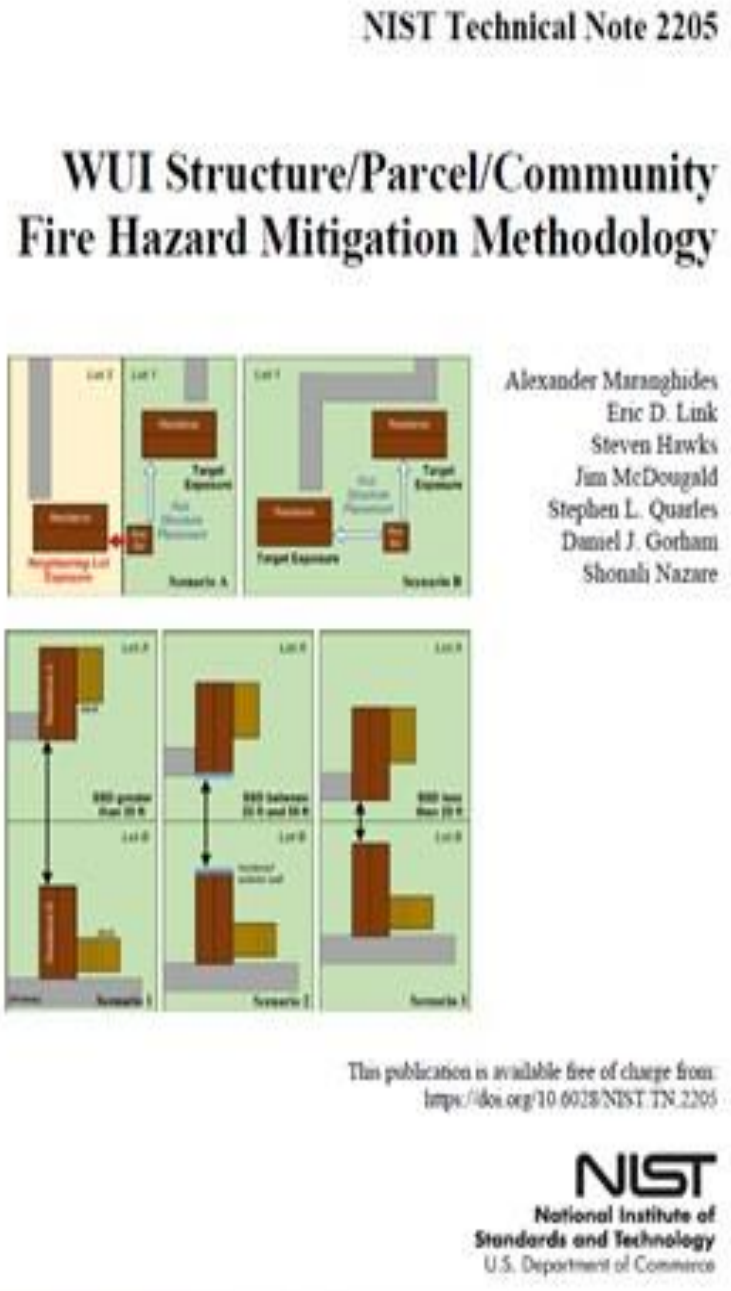
It’s about community

- Neighborhood planning
  - Neighborhood meetings
  - Community gutter cleaning?
  - Escape routes
    - More than one!
- City planning
  - Roads
  - Building standards
  - Permits



It's about density

- Low: Properties with >100 feet between buildings
  - Ember hardening
  - CalFire clearances
- Medium: Properties with 30-100 feet between buildings
  - Above, plus …
  - Radiant/flame hardening specific walls
- High: Properties with < 30 feet between buildings:
  - Develop or engage a community FireSafe Council
- Where you don't have enough space, consider moving stuff


NIST Technical Note 2205

WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology

Alexander Maranghides
Eric D. Link
Steven Hawks
Jim McDougald
Stephen L. Quarles
Daniel J. Gorham
Shonali Nazare

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Table 2. WUI Types classified by structure separation distance (SSD) and typical parcel size.

Type #	WUI Type Name	SSD (ft)	Typical Parcel Size (ac)	Typical Housing Density (struct/ac)
1	High Density Interface – Perimeter	6[a] to 30	< 0.5	2 to 8 +
2	High Density Interface – Interior[b]	6[a] to 30	< 0.5	2 to 8 +
3	Medium Density Interface – Perimeter	30 to 100	0.5 to 1+	< 2
4	Medium Density Interface – Interior[b]	30 to 100	0.5 to 1+	< 2
5	Medium Density Intermix	30 to 100	0.5 to 1+	< 2
6	Low Density Interface	100+	1+	< 1
7	Low Density Intermix	100+	1+	< 1

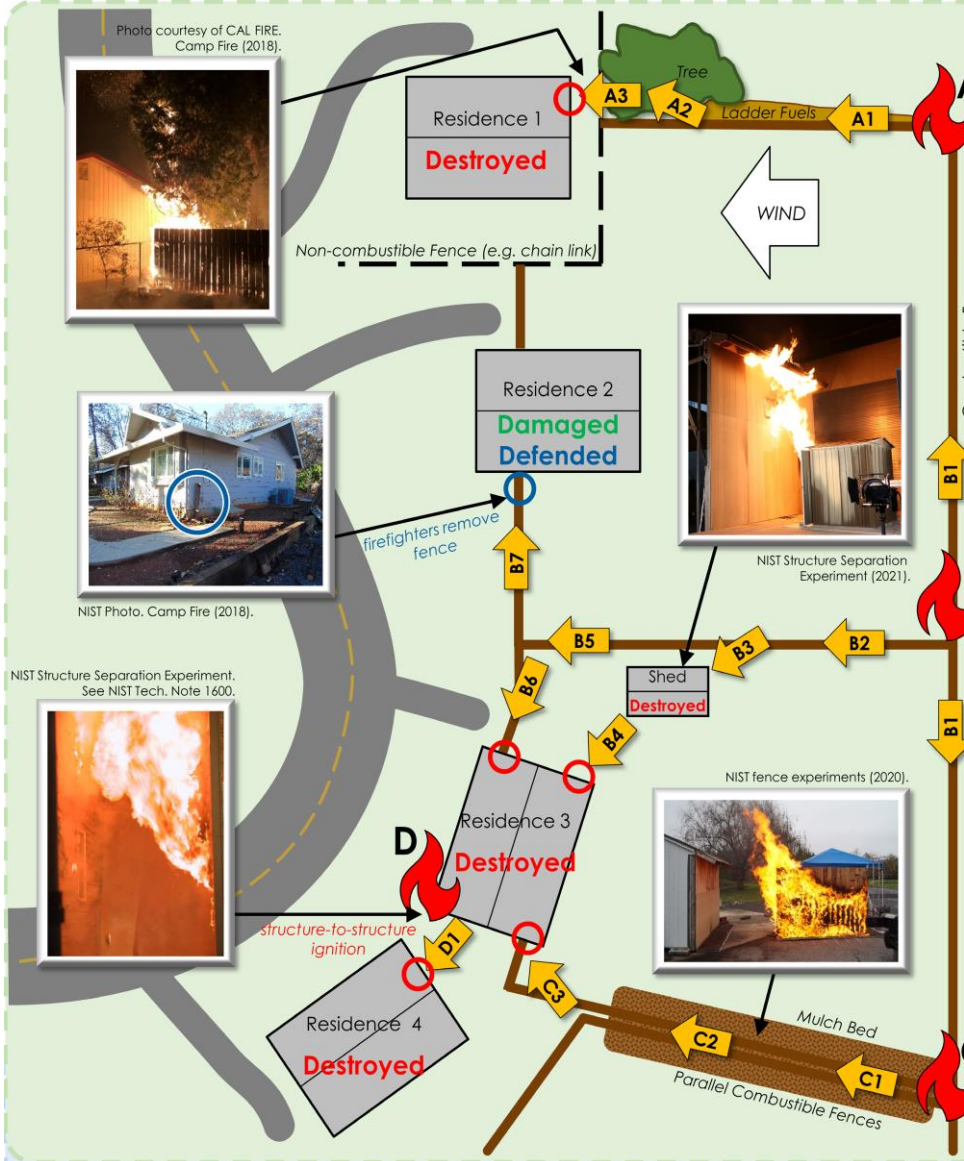
For SI: 1 ft = 0.305 m, 1 ac = 0.4 ha

[a] representative of parcels with a 3 ft setback (common for new construction of sprinklered residences)

[b] interior of community defined as > 0.25 mi (400 m) from wildlands

Structure Separation Distance (SSD)

- Houses
- Sheds and other outbuildings
- Significant woody vegetation
- RV's
- Woodpiles
- Other combustibles
- Maximize separation between these (at least 25 feet)
- Fences are conduits. Keep away from structures, or use non-flammable fence materials



Embers can bring fire into communities. Once fire has started, fire spreads along multiple pathways:

A: Spot fire ignites fence, burning along ladder fuels (*A1*) to larger vegetation (*A2*), and ignites Residence 1 on adjacent parcel (*A3*).

B: Fence ignition propagates fire on multiple parcels (*B1, B2*). Fence ignites shed (*B3*). Exposures from shed and fence ignite Residence 3 (*B4, B6*).

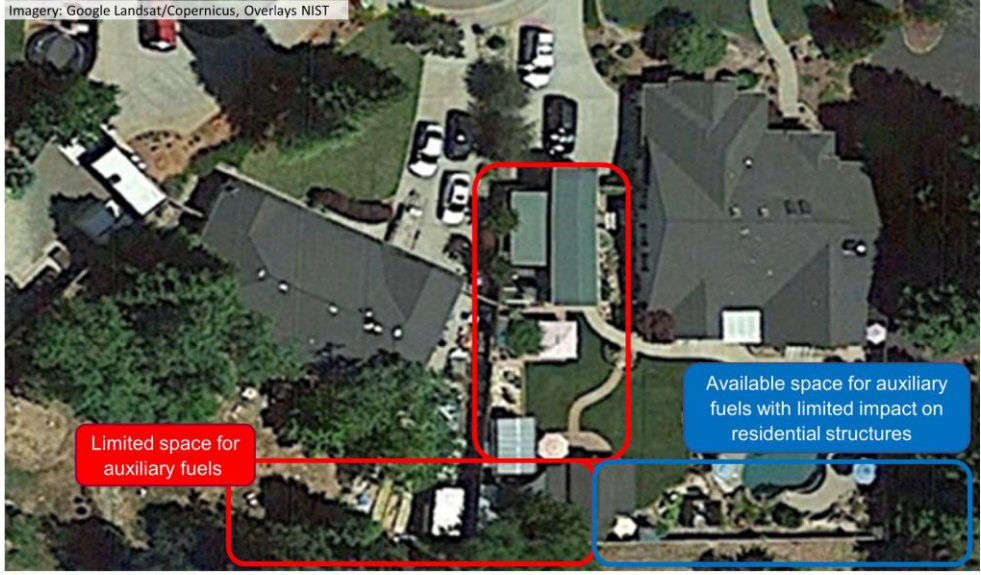
Fence ignites Residence 2 (*B7*). Defensive actions save Residence 2.

C: Parallel fences on adjacent parcels exponentially intensify fire exposure (*C1, C2*) which ignites Residence 3 (*C3*).

D: The exposure from burning Residence 3 ignites Residence 4 (*D1*).

Key terms

- Example: Interface / intermix
  - Subcategories of WUI (>0.2 HU/acre)
  - Used slightly differently by:
    - Feds
    - CalFire
    - Common interpretation
  - Defined in the document
  - Interface
    - Higher structure density (HU/acre)
    - Smaller SSD
    - Not usually native vegetation
    - Not urban / not high density (=> 8HU/acre)
  - Intermix
    - Lower structure density (acres/HU)
    - Greater Structure Separation Distance (SSD)
    - Usually native vegetation
    - Also not urban / not high density



Intermix

Imagery: Google, Landsat/Copernicus. Overlays by NIST.


Interface

Table 3. Structure and parcel hardening effectiveness.

#	WUI Type	Probability of Structure Survivability if Neighboring Structure Ignites	Potential Fire[a] Exposure from Burning Neighboring Structure	Exposure from Other Parcel Fuels	Exposure[b] from Wildlands	Impact of Structure Ignition on Fire spread in Community	Likely Effectiveness of Partial Structure/ Parcel Hardening	Community/ Neighborhood Participation
1	HD Interface – Perimeter	Low	High	*f*(fuels, dist.)[c]	Variable	High	Low	Necessary
2	HD Interface – Interior	Low	High	*f*(fuels, dist.)[c]	Low	High	Low	Necessary
3	MD Interface – Perimeter	*f*(hardening)	Moderate	*f*(fuels, dist.)[e]	Variable	Moderate	*f*(wildland fuels, parcel fuels)	Desired
4	MD Interface – Interior	*f*(hardening)	Moderate	*f*(fuels, dist.)[e]	Low	Moderate	*f*(parcel fuels)[d]	Desired
5	MD Intermix	*f*(hardening)	Moderate	*f*(fuels, dist.)[e]	Variable	Moderate	*f*(wildland fuels, parcel fuels)	Desired
6	LD Interface	*f*(hardening)	Low	*f*(fuels, dist.)[e]	Variable	Low[f]	*f*(parcel fuels)	Desired
7	LD Intermix	*f*(hardening)	Low	*f*(fuels, dist.)[e]	Variable	Low[f]	*f*(parcel fuels)	Desired

HD = high density, MD = medium density, LD = low density

f(*X*) indicates "a function of *X*" (e.g., the level of exposure from other parcel fuels is a function of the fuels and distance from the target structure)

[a] flames and radiation

[b] based on fire history, fuel loading, wind, and topography/aspect; wildland fuel treatments may not be at the control of the community

[c] parcel-level mitigation will have limited impact if nearby upwind structures catch on fire

[d] would be a function of wildland fuel treatment AND hardening of most/all perimeter structures and parcels

[e] parcel-level mitigation, including wildland fuel treatment, together with home hardening, will enhance structure ignition resistance

[f] ignitions due to embers from burning residential structures have been observed as far as 200 ft to 300 ft downwind

Puttin' the fence in defensible

- Hedges
  - Not really fire safe?
  - Why not?
- Fire safe zones
  - 0: 0-5 feet from house
    - Ember defense zone
    - "Law in 2023" > 2025?
  - 1: 5-30 feet from house
    - Lean, clean, & green
    - Well spaced smaller plants
    - This is sometimes all the space we have!
  - 2: 30-100 feet from house
    - Fuels reduction zone
    - Lucky you (?)

Zones

- 3 Landscaping zones
  - Design for maintenance
  - Non-continuous fuels
  - Fire-resistant plant lists not supported by science (Bethke, 2016)
  - Plants are not passive
    - But they need resources to work with
- Design & planting guidance
  - Water-wise
  - Ecologically relevant
  - Easy to implement
    - Or at least clear on what's required

Okay, so what DO we plant?

- There are a lot of factors to consider
  - Water use (local water districts)
  - Invasiveness (Cal IPC, ranchers, parks, water districts …)
  - Global warming

Natives?

- Already part of an established ecosystem
  - Including mycorrhizal fungi
  - Better network building
  - Many species don't grow anywhere else
- Adapted to local conditions
  - Check your microclimate and soils
  - Normally stay hydrated with average rainfall
  - Hydrated plants are more fire resistant than drought stressed plants
  - Local fauna depend on these species

Other Mediterranean plants?

- Already adapted to our climate
  - May displace natives
  - Not always part of the local ecosystem
    - Exotic Mediterranean plants may be fine in your garden
    - Don’t let them out into the WUI or beyond.
- So yes, we can grow just about anything, including
  - Japanese knotweed
  - Blue gum eucalyptus
  - Gorse
  - French broom
  - Etc.
  - So just because we can, doesn’t mean we should

Which natives?

- California has myriad local microclimates
- Global warming is likely to shift these
  - Nobody knows for sure exactly how this will turn out
  - Just warming?
  - Weather pattern shifts
    - Monsoon was the weather pattern for much of California 25k years ago …
    - Disaster for California agriculture?
    - Would be great news for Engelmann oaks and other relictual species

The southern proxy model

- Proxies a southern city to model a shift in climate
- Marin is projected to look like San Luis Obispo area
  - Still zones 14-17
- Coastal influence thins, inland areas go to zone 7

Rare species

- Challenges
  - Limited populations
  - Restricted gene pools
  - Less adaptive
  - Legal issues
- Assisted migration
- Consider rare species in San Luis Obispo?

The new plant palette?

- Water: We need to adapt our plant palette to San Luis Obispo / Santa Maria / Santa Barbara
- Fire: Native species adapted to a future climate
  - better adapted to handle fire
  - Best bets for defensible space
- Native Plants: Focus on the conversion, finding the right plants for the right place

Is the climate model right?

- Nobody's certain
  - Models are just guesses based on best available data
  - Proofing required
  - We'll know what models were right when we get there
- There are a lot of unknowns
  - Historical precedent
  - Monsoon rain patterns?
  - Increased vulcanism?

Fire & Landscape Talking Points

- **Home hardening is THE most important step**
  - Roof: Class A
  - Gutters: Steel. Guards? – It's about keeping them CLEAN
  - Attic & basement ventilation: 1/8" mesh, Vulcan vents, etc.
  - Decks: Non flammable … and a whole lot more
  - Refer clients to their local fire department for home inspections
  - https://ucanr.edu/sites/fire/Preparedness/Building/
- We are home gardeners, not home hardeners
  - Please don't try to become experts on home hardening. This is not something that *Master Gardeners* should be doing
  - UC is self-insured …

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Fire & Landscape Talking Points

- **Landscape**
- At this point, there are no known science-based plant lists
  - We know that design and maintenance are bigger factors
- Zone 0 is almost part of the house (0-5 feet)
  - Ember resistant zone
    - Pay special attention to interior corners
  - Legal requirements still being worked out
  - Little to no fuel in this zone, no flammable mulch (?)
    - Or maybe put an inch or two down in November. By May it'll practically be gone.
  - Non-flammable fencing, especially gates
  - No outbuildings in this zone, especially at corners (> 8 feet clearance)
  - No hedges

Fire & Landscape Talking Points

- Zone 1 (5-30 feet)
  - Lean, clean, and green
  - Mulch: 3 inches or less, organic okay
  - Vegetation: in islands with vertical and horizontal separation
  - Island size: small enough that you can reach everything in it
    - E.g.: 4’ width if there’s access from 2 sides, 3’ width if access is 1 side only
  - Path (non flammable zone) size: big enough you can easily move a wheelbarrow through (about 3 feet)
- Zone 2 (30-100 feet)
  - Fuels reduction zone, irrigation not so critical here?
  - Outbuildings, firewood piles, etc. belong here, and 30 feet from each-other – PLUS they must be fire-hardened
  - Interruption of horizontal and vertical fire paths

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Fire & Landscape Talking Points

- Evacuation routes, as zone 2, 10 feet to side of road
- If you're in a low-density situation
  - Calfire clearances
  - Ember hardening of all structures
- If you're in medium-density situation, then as above, plus
  - Sheds, other structures 30 feet from house, 8 feet from fences
  - Armor (e.g.: hardy plank) sides of house within 30 feet of neighbors
- If you're in high-density situation, then as above, plus
  - Succeed or fail as a community
  - Establish or join your local fire-safe council
  - Sheds, other structures > 8 feet from house & non-flammable
  - Plan ahead: Go bags, know your escape route, get out early

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