Oregon State University
College of Forestry

Introduction to Quantitative Wildfire Risk Assessments and Community Exposure

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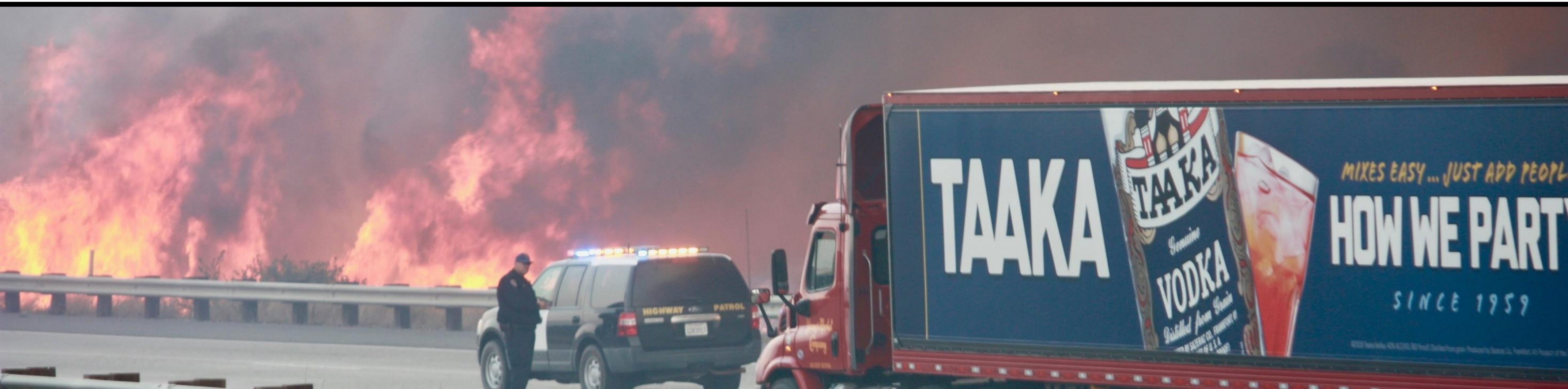


Objectives of today's discussion

1. Introduce common terminology in wildfire risk sciences

2. Develop a working knowledge of how quantitative wildfire risk assessments are conducted

3. Understand how climate, fuels, weather and topography are included in wildfire risk assessments

Roadmap

Part I: Introduction

- background
- process and terminology

Part II: 2017 PNW QWRA as an example

Part III: Linkages to the WUI

- Community exposure

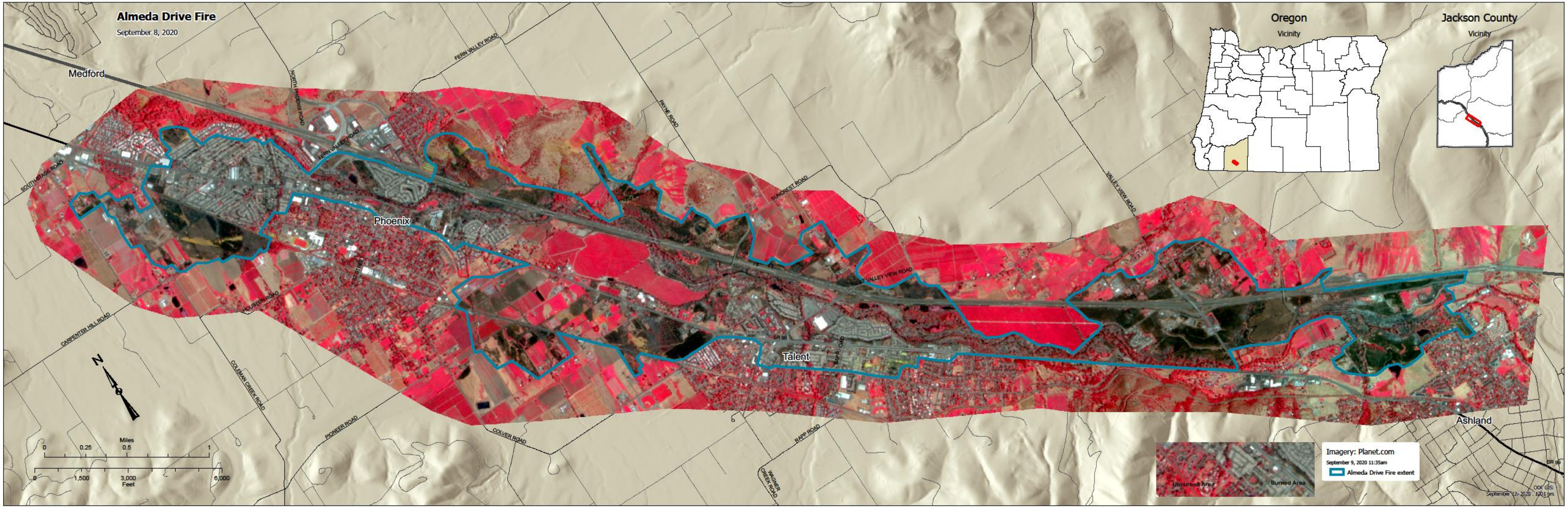
Part IV: Conclusions/Questions

Kari Greer

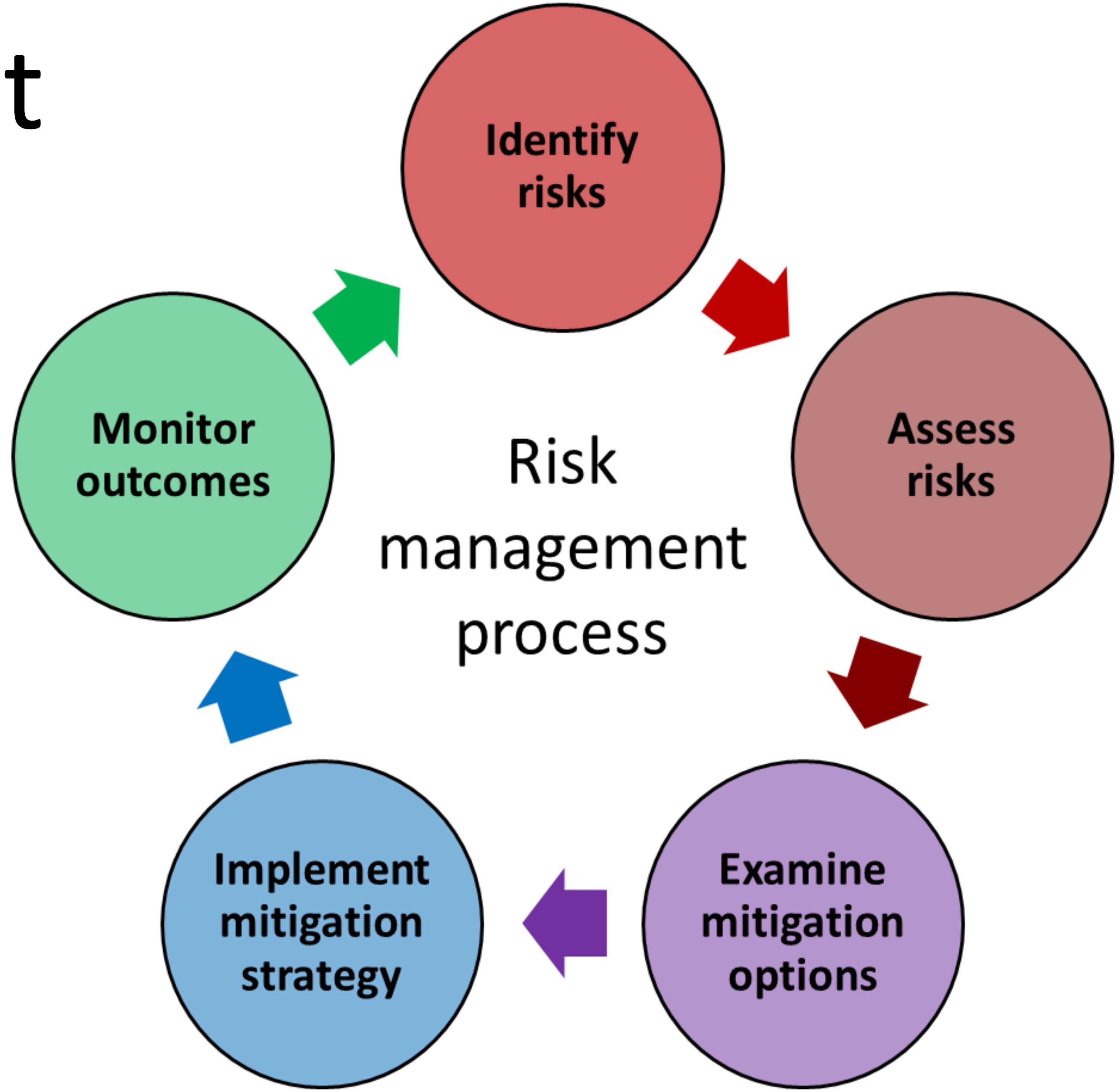
Where do we have decision space?

1. How often should we update the fire hazard assessment?
2. Do we assess today's conditions that reflect recent large fires, like Bootleg, which will show the community of Sycan Estates as having low burn probability for 5 – 10 years, or fuel conditions that will develop as the forest regenerates?
3. Is a structure evaluated at its location only, or within some specified distance around the structure.
4. Research has shown ember showers are a major contributor to structure ignition. Do we want to make an attempt to incorporate this exposure as well, specifically for those structure not directly exposed to a flaming front?
5. How do we handle fuels in areas like the Willamette Valley? There are many grass seed fields that used to be burned by farmers but that practice has diminished. Should we model these at their peak loadings before harvest, or after?
6. Do we determine exposure on burn probability only, or burn probability and fire intensity?
7. Do we want to assess fire intensity at peak levels or with the central tendency of fire intensity across all simulated fires?

2020 Holiday Farm fire


Almeda Drive Fire
September 8, 2020
Oregon
Vicinity
Jackson County
Vicinity
Medford
Phoenix
Talent
Ashland
FERN VALLEY ROAD
NORTH PHOENIX ROAD
PAYNE ROAD
SOUTH STAGE ROAD
CARPENTER HILL ROAD
HOUSTON ROAD
COLEMAN CREEK ROAD
PIONEER ROAD
COLVER ROAD
SUNCREST ROAD
VALLEY VIEW ROAD
WEST VALLEY VIEW ROAD
RAPP ROAD
WAGNER CREEK ROAD
SR 99
N
Miles
0 0.25 0.5 1
0 1,500 3,000 6,000
Feet
Unburned Area
Burned Area
Imagery: Planet.com
September 9, 2020 11:35am
Almeda Drive Fire extent

Risk management process

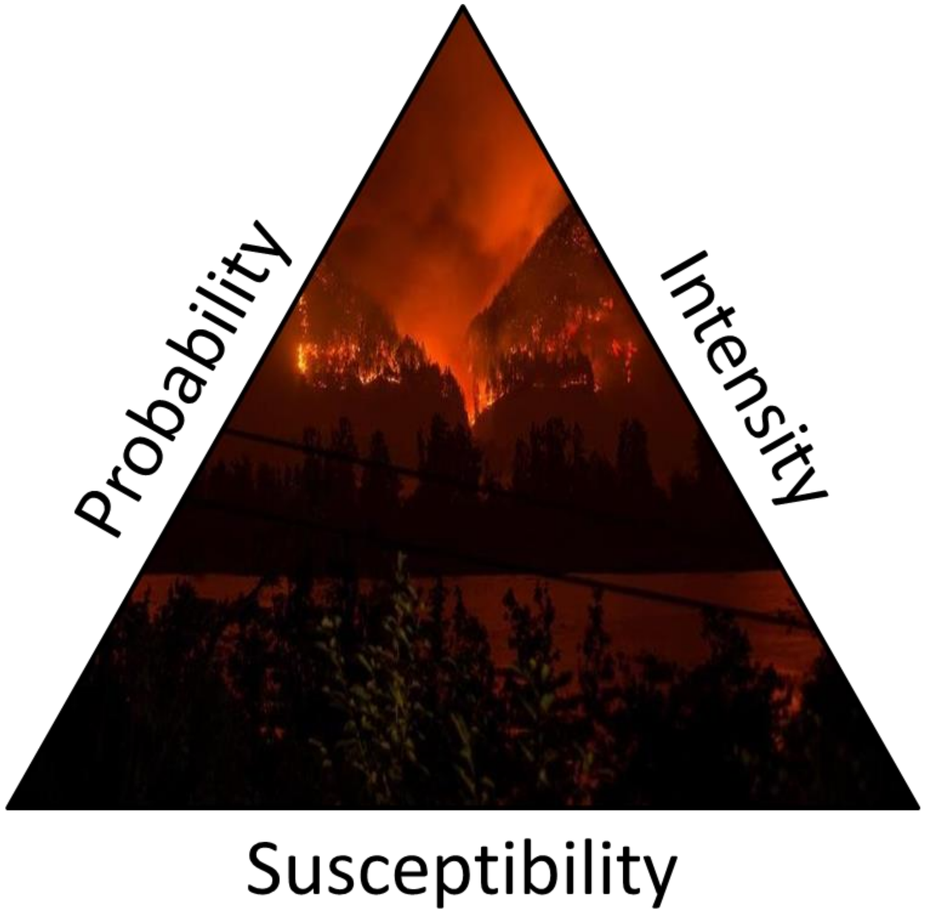


Fundamentals of wildfire risk assessments

Wildfire risk vs. hazard

- Hazard assessment vs.
  effects analysis/valuation
- Burn probability
- Fire intensity
- Susceptibility
  - Response functions
- Relative importance
- Conditional net value change (cNVC)
- Expected net value change (eNVC)

Home/community exposure



cNVC: a formal system for quantifying fire risk

Wildfire risk vs. hazard

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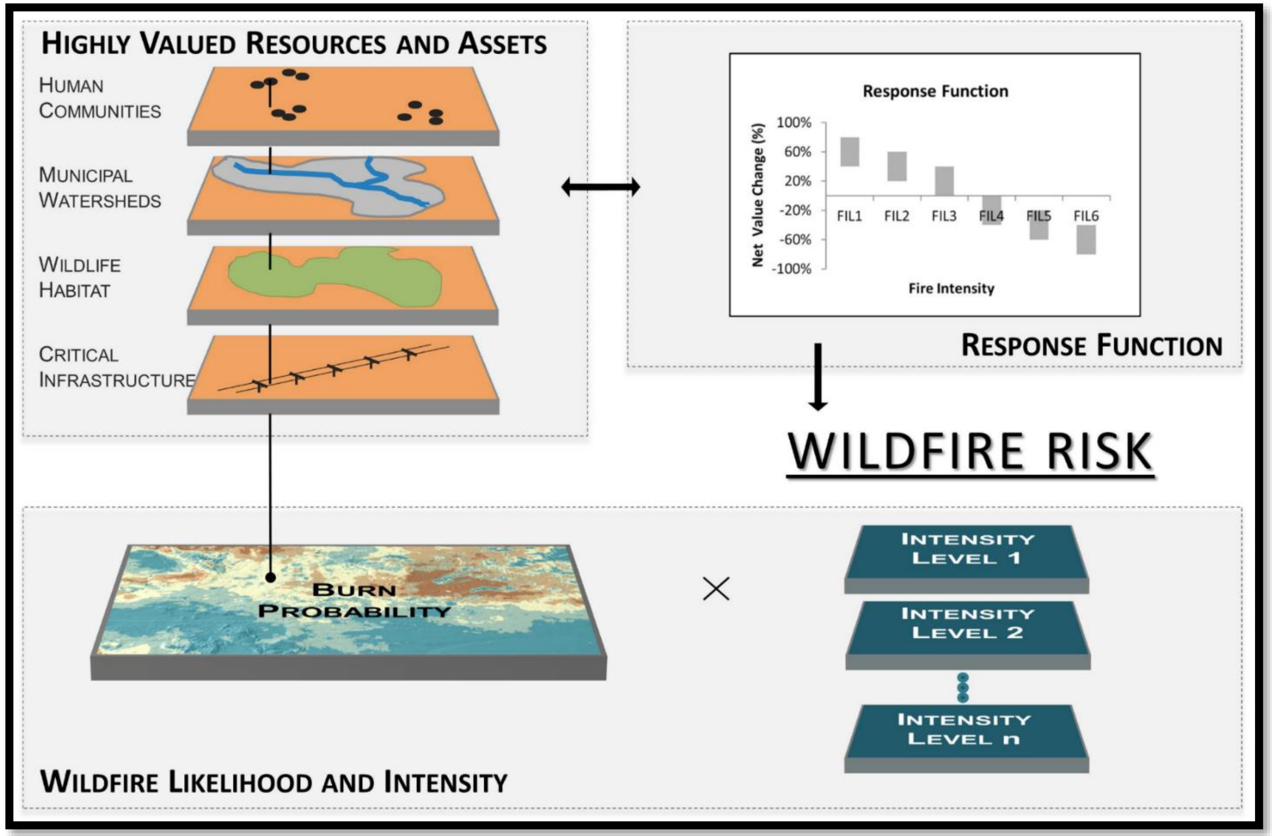
Home/community exposure



Scott et al. 2013

Part II: A relevant example to reinforce these concepts

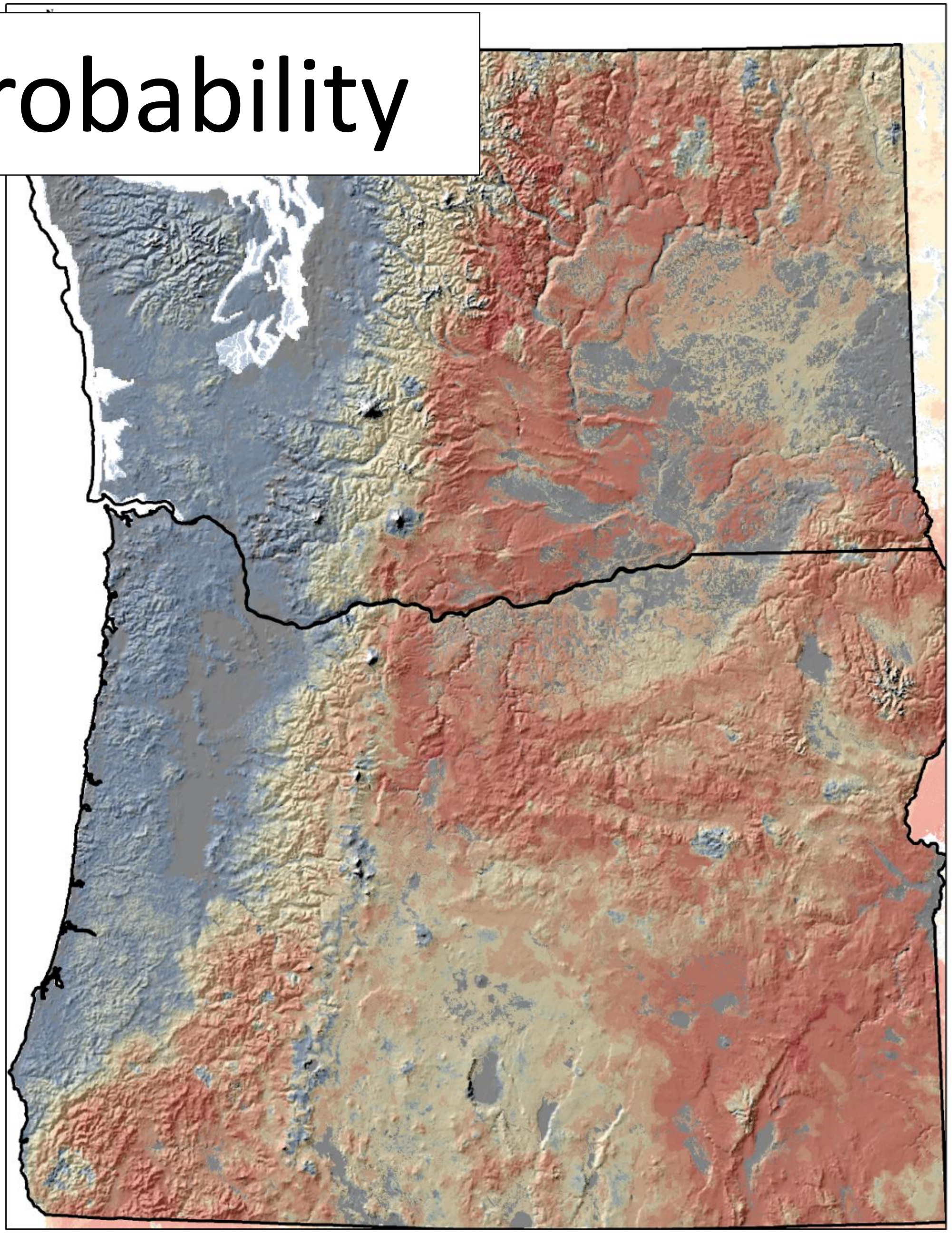
Pacific Northwest
Quantitative Wildfire Risk Assessment: Methods and Results

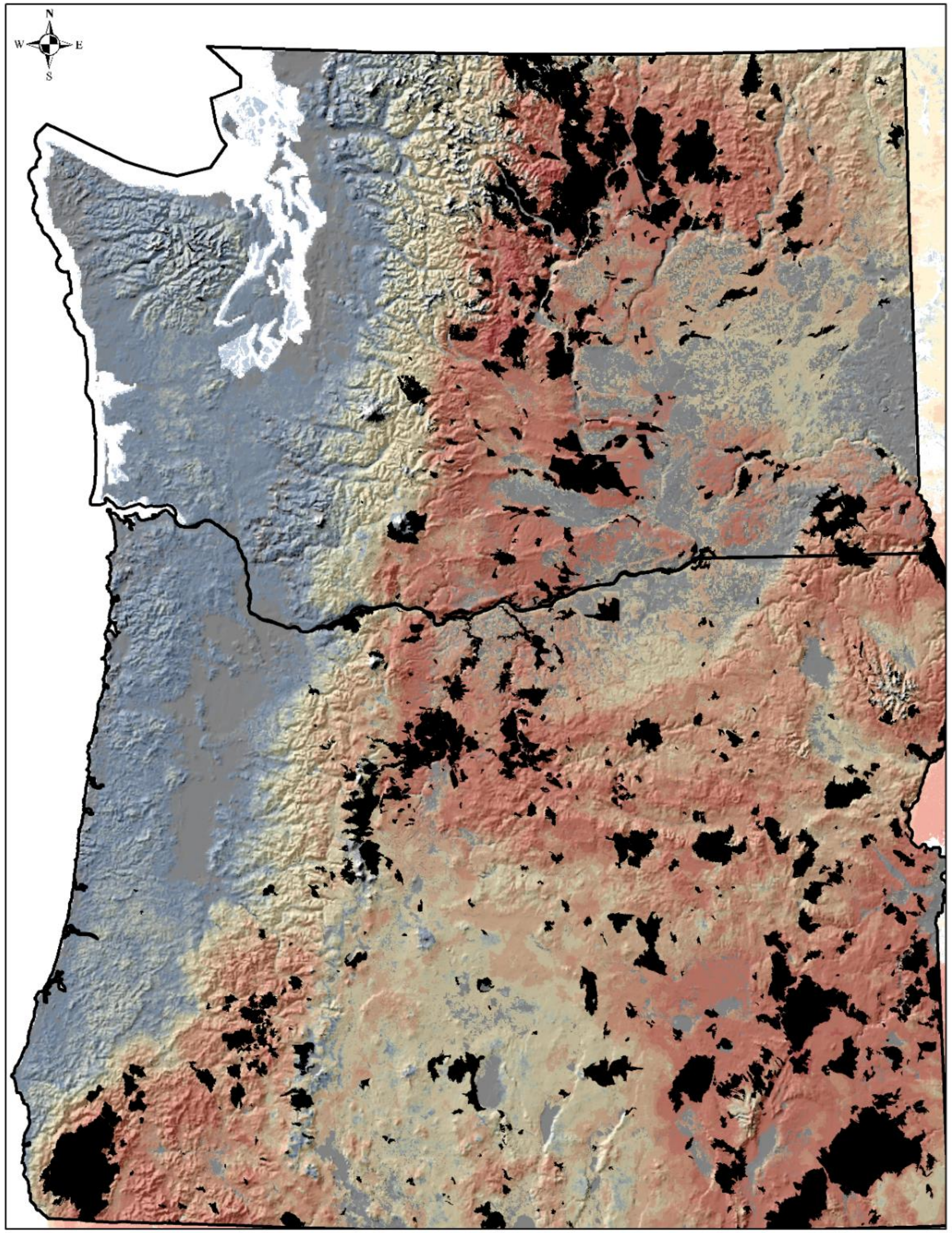
Prepared by:

Julie W. Gilbertson-Day, Joe H. Scott, Kevin C. Vogler, and April Brough
Pyrologix LLC

Part II: Ex. Burn probability

Burn Probability





Annual burn probability

- 0
- 0 - 0.0001
- 0.000100001 - 0.0003
- 0.0003 - 0.0006
- 0.0006 - 0.001
- 0.001000001 - 0.003
- 0.003 - 0.006
- 0.006 - 0.01
- 0.010000001 - 0.03
- 0.03 - 0.047348

Fire intensity

– measured by flame length

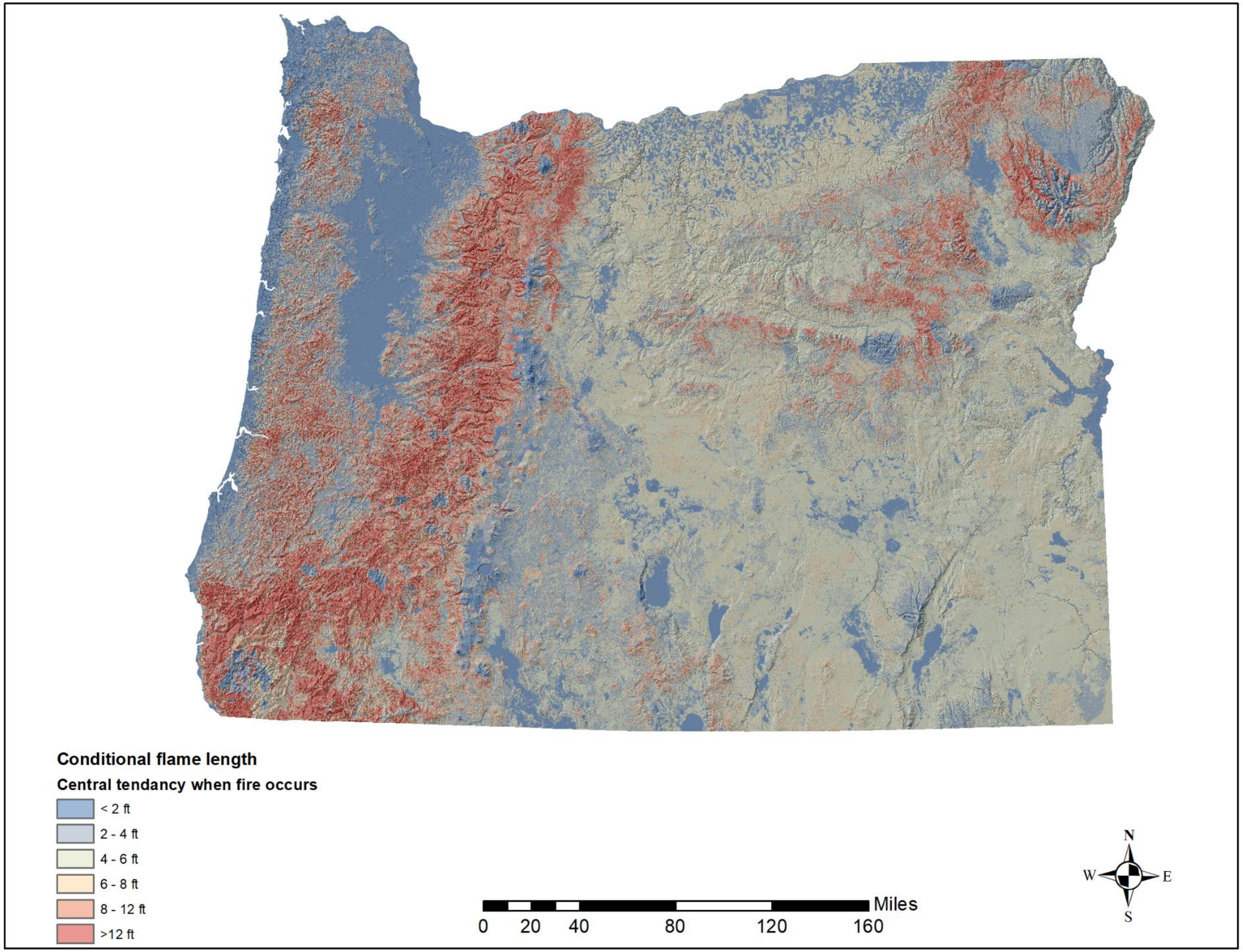


Table 4. HVRA and sub-HVRA identified for the Pacific Northwest Region wildfire risk assessment and associated data sources.

HVRA & Sub-HVRA	Data source
Infrastructure	
Electric transmission lines – high & low voltage	Electric Power Transmission Lines extracted from the Homeland Security Infrastructure Program (HSIP) database.
Railroads	Railroad features extracted from the Homeland Security Infrastructure Program (HSIP) database.
Roads – Interstates and State highways	Interstates and highways extracted from the Homeland Security Infrastructure Program (HSIP) database. Removed smaller roads (SHIELD_CL=0) from highways.
Communication sites and cell towers	Communication sites, towers, and antennas and cell towers extracted from the Homeland Security Infrastructure Program (HSIP) database.
Seed orchards	Extracted from the Pacific Northwest Region Corporate database to represent seed orchard assets across the Region.
Sawmills	Wood Product Manufacturing Facilities extracted from the Homeland Security Infrastructure Program (HSIP) database.
High and low developed rec sites	Recreation sites/structures mapped by USFS, USFWS, NPS, BLM, ODF, and DNR and including state, county, and local parks and campgrounds. High vs. low investment level assigned based on dataset attributes.
Ski Areas	OR and WA ski area boundaries, digitized outer edge and infrastructure using Google Earth imagery
Historic buildings	Historic buildings as recorded by the National Register of Historic Places
People and Property	
Where People Live (WPL) by density class	Housing density classes as developed by the West Wide Wildfire Risk Assessment project
USFS Private Inholdings	Private inholdings on USFS lands extracted from the Basic Ownership layer by querying "NON-FS". NPS lands were removed from the NON-FS lands before including in this dataset. Refined to private ownership using BLM Ownership (OWNERSHIP_POLY) and BLM Surface Management Agency (BLM_SMA_FS_update).

Timber	
USFS Active Management and NWFP Matrix Lands	A Spatial Database for Restoration Management Capability on National Forests in the Pacific Northwest USA, (Ringo *et al.*, 2016). Matrix lands in OR and WA from Northwest Forest Plan.
Tribal Owned/Colville Reservation Commercial Timber	American Indian/Alaska Native/Native Hawaiian (AIANNH) Areas Shapefile from U.S. Census Bureau as Tribal ownership overlay along with Colville Reservation Commercial forestland
Private Industrial	Privately owned, industrial timber lands extracted from the Atterbury Consultants ownership maps for Oregon and Washington (selected attributes containing IFPC, REIT, and TIMO)
BLM Harvestable/Potential	Harvest Land Base from the ROD for western OR, O&C lands, Coos Bay Wagon Rd, Public Domain lands, and the BLM-owned polygons from the E. WA Resource Management Plan.
State owned for Oregon and Washington	State-owned lands in OR and WA excluding State Parks, State Fish and Wildlife lands, and Parks and Recreation lands.
Fire Regime Groups 1,3,4/5	R6 Forest Structure Restoration Needs Update Analysis – (DeMeo *et al.*, In Press)
Size classes <10in., 10-20in., >20in.	R6 Forest Structure Restoration Needs Update Analysis – (DeMeo *et al.*, In Press)
Vegetation Condition	
Seral state departure by FRG group	R6 Forest Structure Restoration Needs Update Analysis – (DeMeo *et al.*, In Press)

Table 4. (Continued) HVRA and sub-HVRA identified for the Pacific Northwest Region wildfire risk assessment and associated data sources.

Watersheds	
Watersheds	Washington Drinking Water System Boundaries for watershed boundaries and surface water intake locations Oregon Surface Drinking Water Source Areas and intake locations from EPA Safe Drinking Water Information System (SDWIS)
Erosion potential	Developed by USFS Remote Sensing Applications Center (RSAC)
Wildlife	
Marbled murrelet	U.S. Fish and Wildlife Service, Endangered Species Program, ECOS Joint Development Team
Northern spotted owl	Predicted habitat suitability map (Glenn *et al.*, 2017)
Sage grouse habitat	Wildland Fire Decision Support System (WFDSS) - 2015 greater sage grouse (GRSG) Land Use Plan (LUPs) Allocations
Resistance/Resilience class	USDA - Natural Resources Conservation Service, Index of Relative Ecosystem Resilience and Resistance across Sage-Grouse Management Zones
Bull trout	StreamNet Generalized Fish Distribution, Bull Trout (January 2012)
Chinook salmon	U.S. Fish and Wildlife Service, Endangered Species Program, ECOS Joint Development Team
Coho salmon	U.S. Fish and Wildlife Service, Endangered Species Program, ECOS Joint Development Team
Steelhead trout	U.S. Fish and Wildlife Service, Endangered Species Program, ECOS Joint Development Team
Redband trout	Non-Anadromous Redband Trout (RBT) Range-wide Database - ODFW
Coastal cutthroat trout	StreamNet Generalized Fish Distribution, Coastal Cutthroat Trout (January 2012) -
Lahontan cutthroat trout	StreamNet Generalized Fish Distribution, Lahontan Cutthroat Trout (January 2012)

Table 6. Response functions for the Infrastructure HVRA to highlight electric transmission lines.

Sub-HVRA	FIL1	FIL2	FIL3	FIL4	FIL5	FIL6	Share of RI[1]	Acres
Trans-Line- High voltage	10	0	0	-10	-50	-70	40.86%	905,585
Trans-Line- Low voltage	-10	-20	-50	-70	-80	-90	16.79%	743,972
Railroads	-10	-20	-30	-40	-50	-50	16.57%	612,073
Interstates	0	-5	-10	-15	-20	-30	4.74%	175,191
State Highways	0	-5	-10	-15	-20	-30	12.98%	958,745
Communication Sites/Cell Towers	-10	-30	-60	-80	-100	-100	3.65%	80,924
Seed Orchards	-50	-90	-100	-100	-100	-100	0.02%	2,704
Sawmills	-10	-20	-30	-40	-60	-80	0.10%	1,448
Ski Areas	0	-10	-20	-40	-60	-80	0.44%	16,175
Recreation High Developed	-10	-30	-70	-90	-100	-100	1.93%	26,793
Recreation Low Developed	-10	-30	-70	-90	-100	-100	1.17%	129,886
Historic Structures	-30	-50	-70	-100	-100	-100	0.73%	8,140

[1] Within-HVRA relative importance.

The share of HVRA importance is based on relative importance per unit area and mapped extent.

Integrating HVRAs with differing units of measure (for example, habitat vs. homes) requires relative importance (RI) values for each HVRA/sub-HVRA. These values were identified in the RI workshop, as discussed in Section 3. The final importance weight used in the risk calculations is a function of overall HVRA importance, sub-HVRA importance, and relative extent (pixel count) of each sub-HVRA. This value is therefore called relative importance per pixel (RIPP).

The RF and RIPP values were combined with estimates of the flame-length probability (FLP) in each of the six flame-length classes to estimate conditional NVC (cNVC) as the sum-product of flame-length probability (FLP) and response function value (RF) over all the six flame-length classes, with a weighting factor adjustment for the relative importance per unit area of each HVRA, as follows:

$$cNVC_j = \sum_{i}^{n} FLP_i * RF_{ij} * RIPP_j$$

where i refers to flame length class (n = 6), j refers to each HVRA, and RIPP is the weighting factor based on the relative importance and relative extent (number of pixels) of each HVRA. The cNVC calculation shown above places each pixel of each resource on a common scale (relative importance), allowing them to be summed across all resources to produce the total cNVC at a given pixel:

$$cNVC = \sum_{j}^{m} cNVC_j$$

where cNVC is calculated for each pixel in the analysis area. Finally, eNVC for each pixel is calculated as the product of cNVC and annual BP:

$$eNVC = cNVC * BP$$

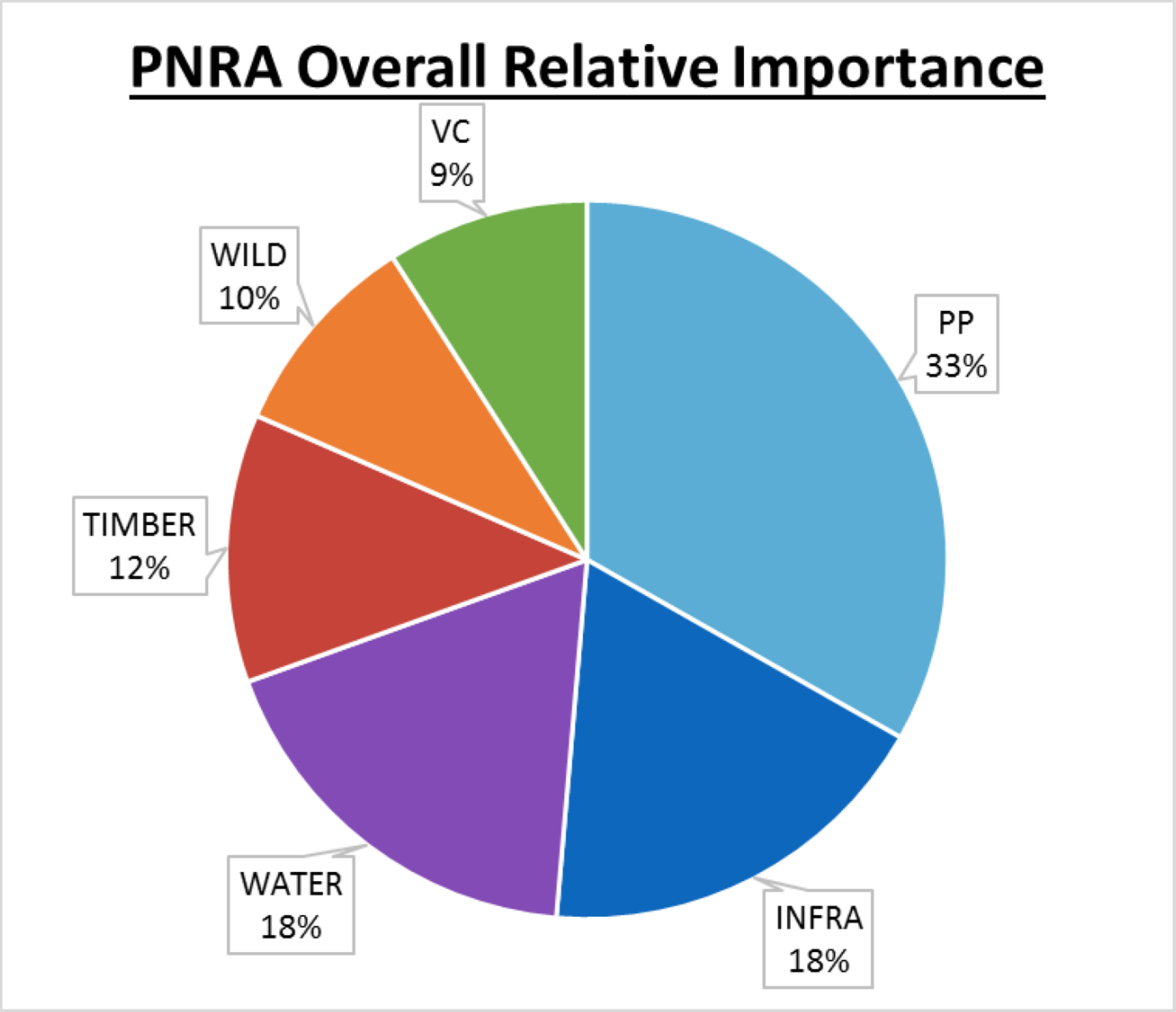
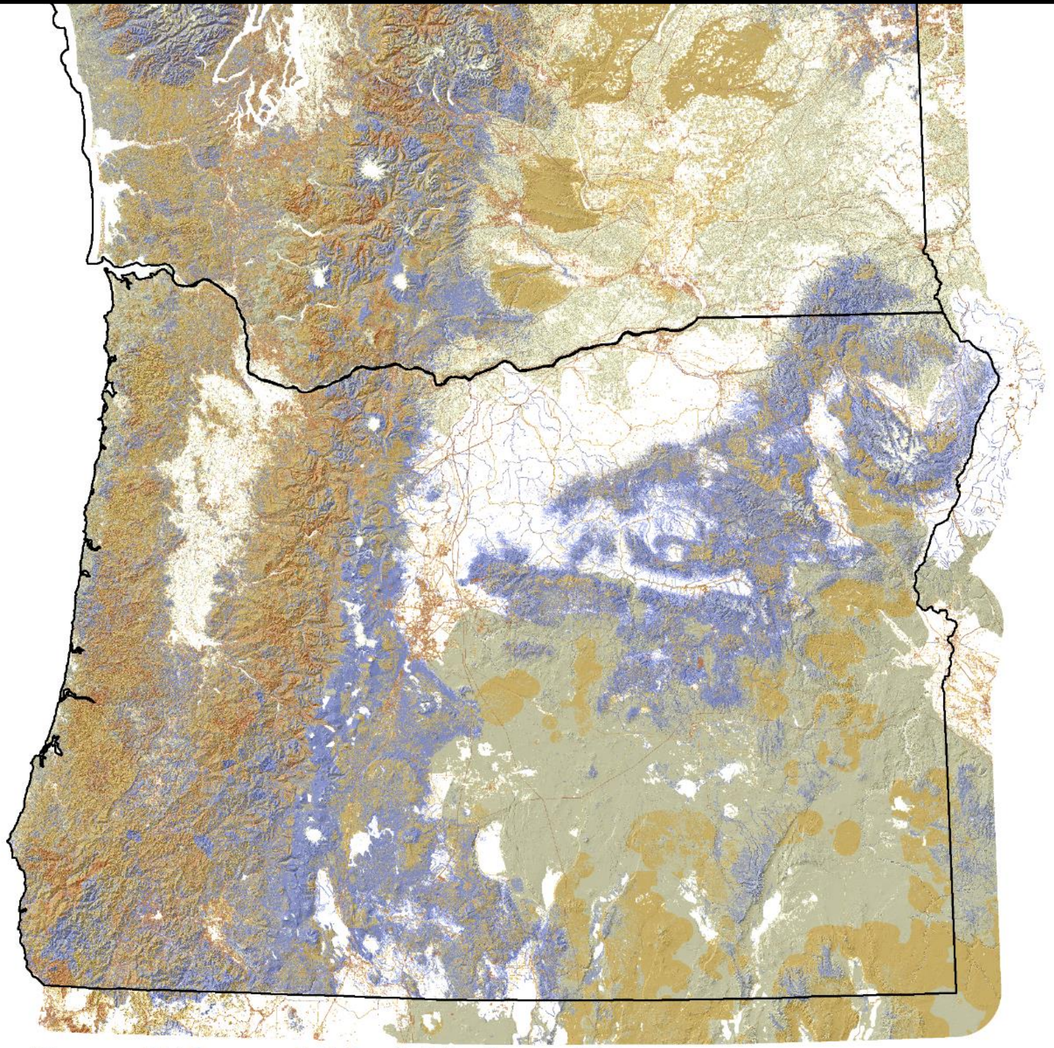


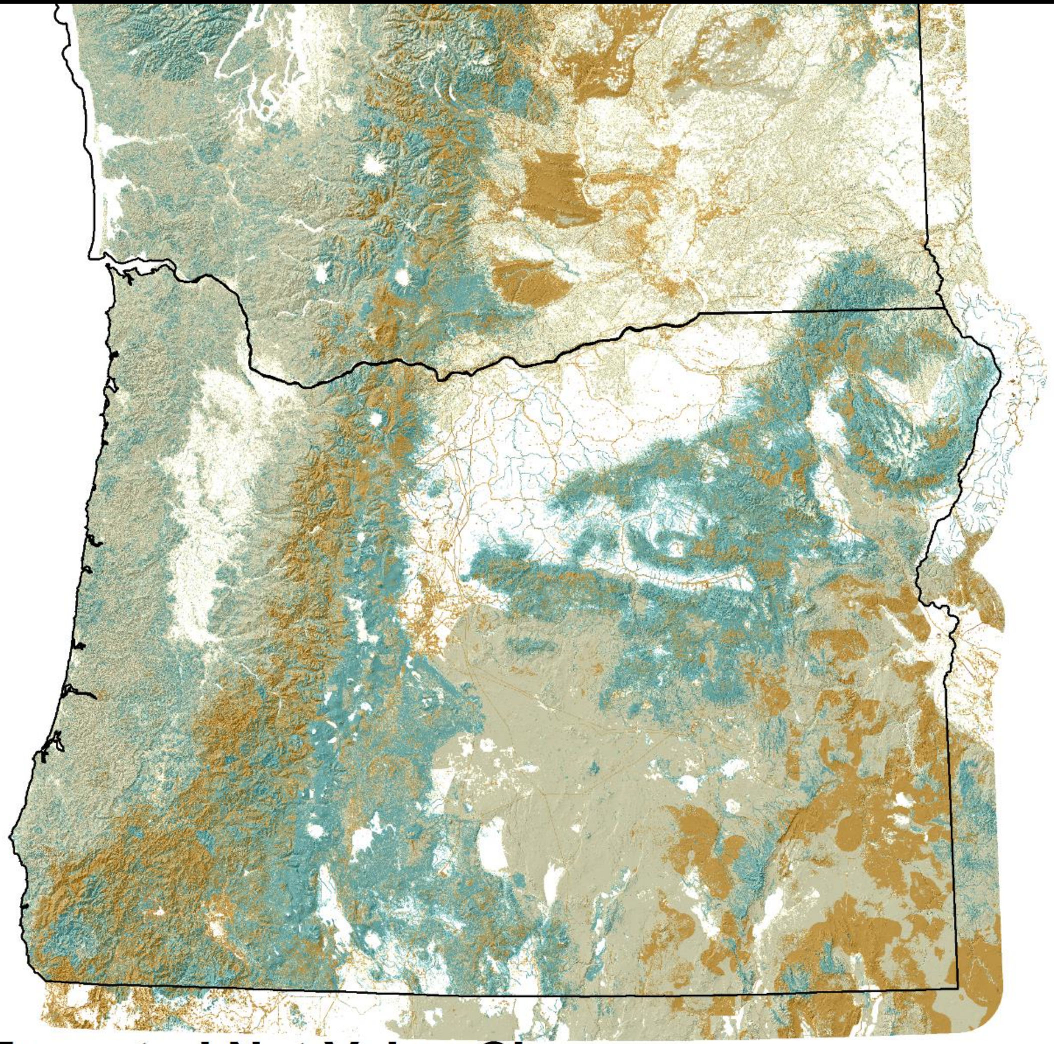
Figure 8. Overall HVRA Relative Importance for the primary HVRAs included in PNRA

PP = people and property
INFRA = infrastructure
WATER = H_2O
TIMBER = timber
WILD = wildlife habitat
VC = vegetation condition



Conditional Net Value Change

- -284.97 - -18.12
- -18.12 - -0.32
- -0.32 - -0.1
- >-0.1 - -0.01
- >-0.01 - 0
- >0 - 0.01
- >0.01 - 0.10
- >0.10 - 0.32



Expected Net Value Change

- -0.23 - -0.10
- -0.10 - -0.01
- -0.01 - -0.005
- -0.005 - -0.0001
- -0.0001 - 0
- 0
- 0 - 0.001
- 0.001 - 0.0033
- 0.0033 - 0.005

Part III: Linkages to the wildland-urban interface

Exposure to wildfire

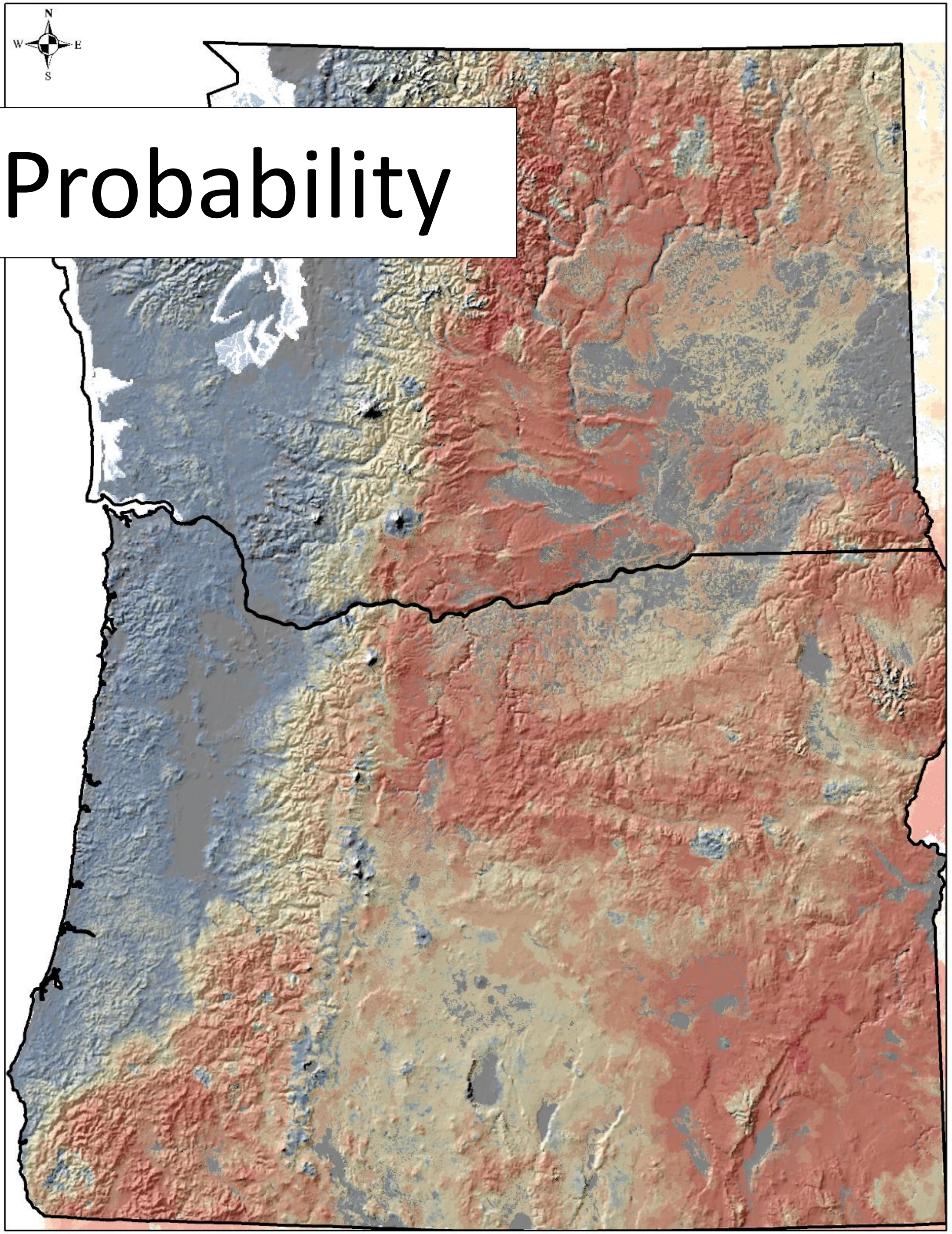
Any structure/community with a greater than zero burn probability has exposure

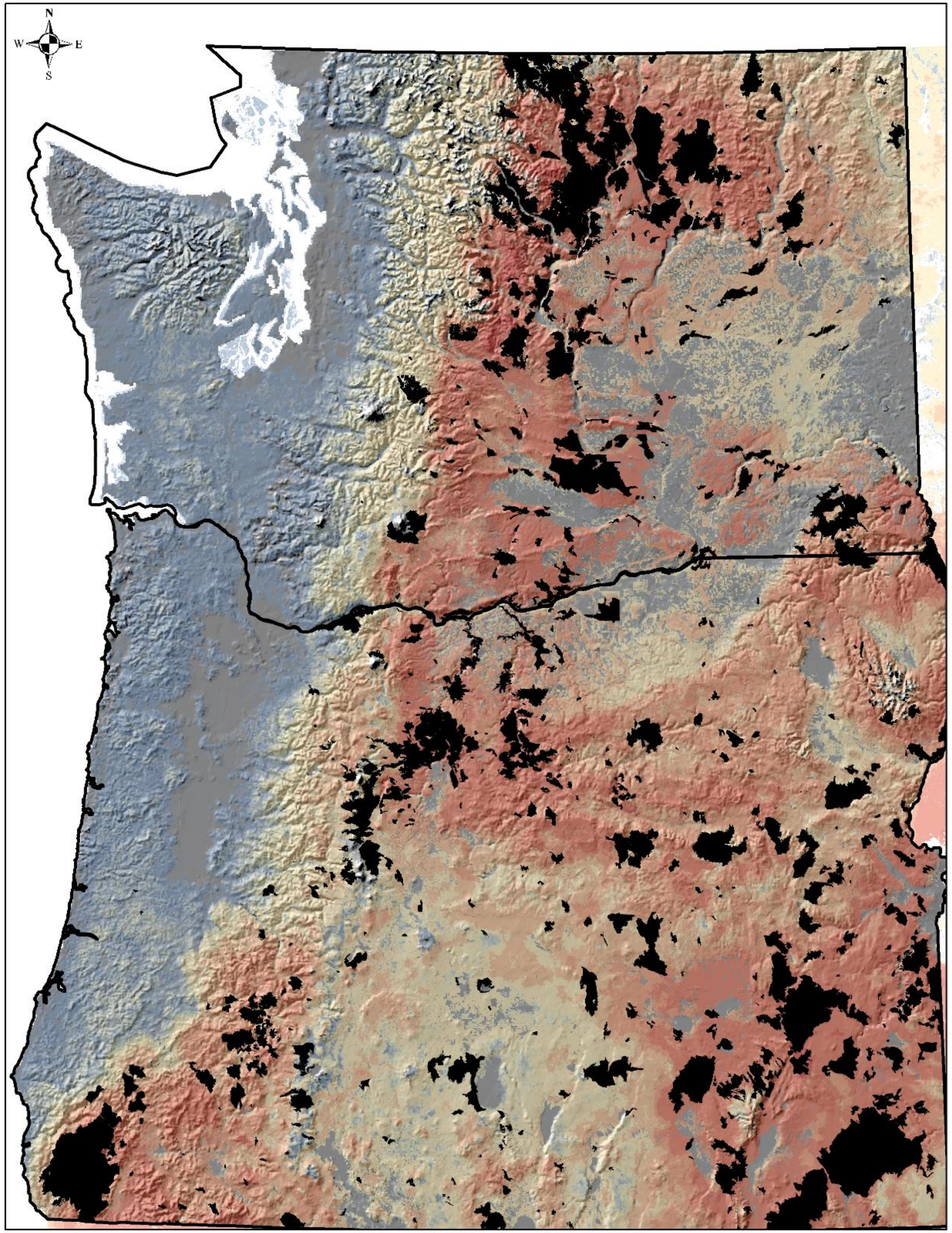
Can stratify exposure based on burn probability and fire intensity

Can stratify communities based on number of exposed homes and burn probability, or burn probability integrated with fire intensity

2018 Camp Fire

Burn Probability





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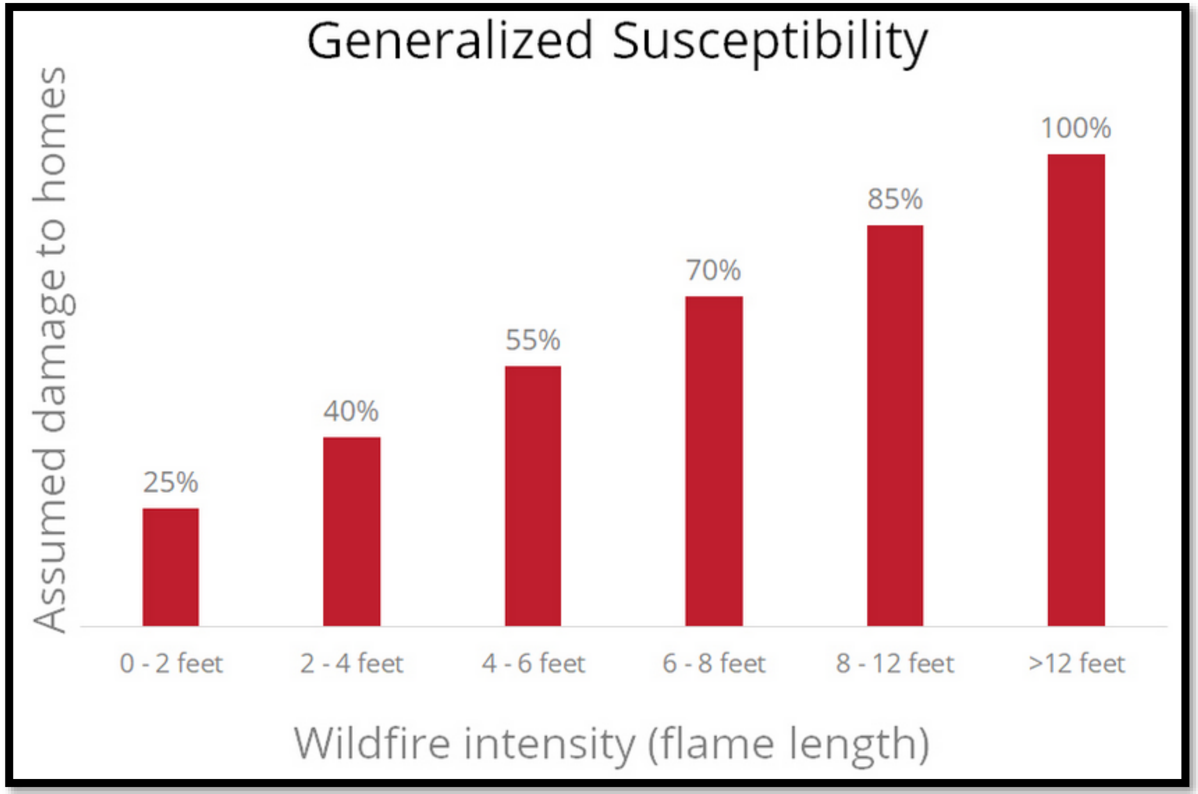
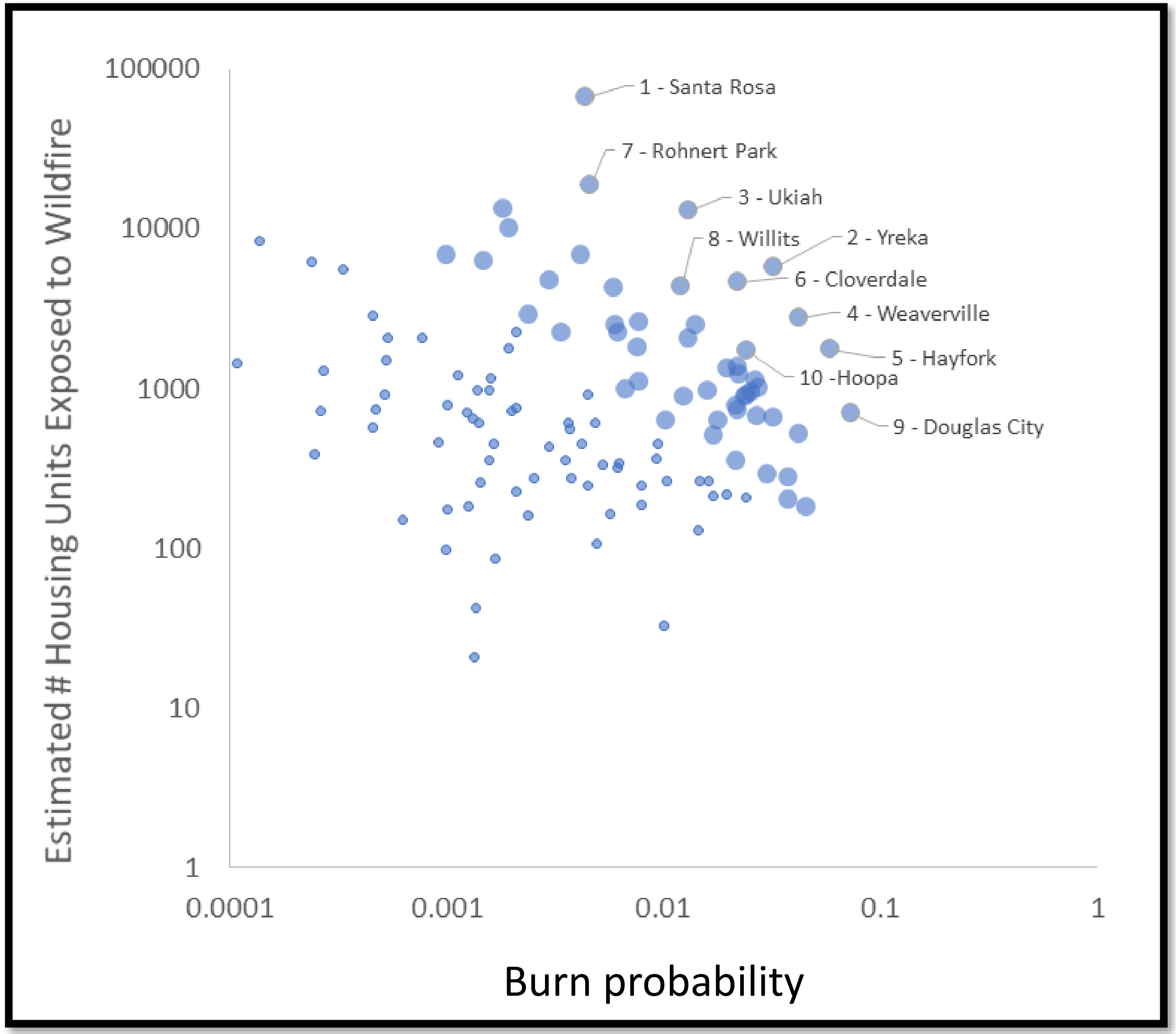
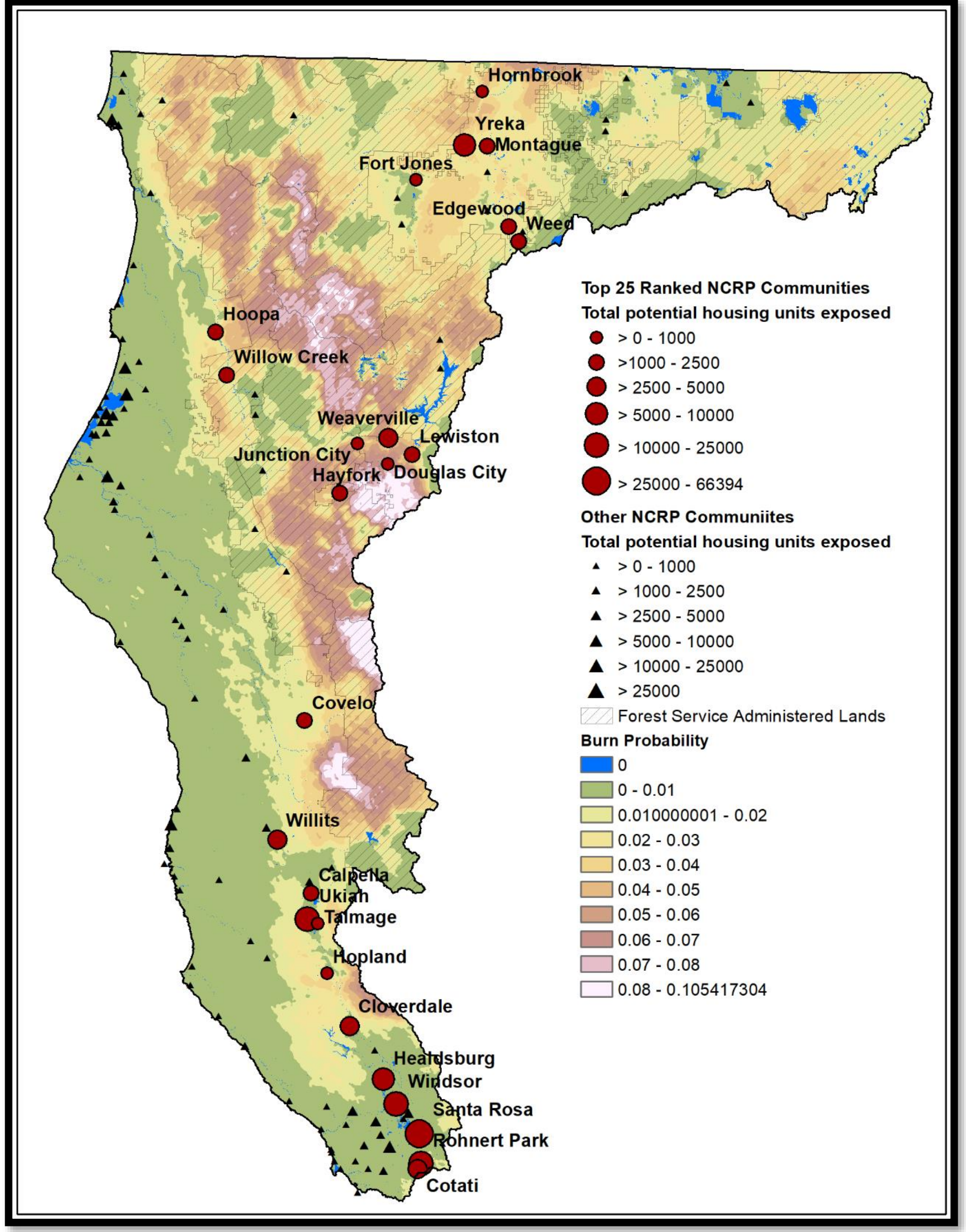


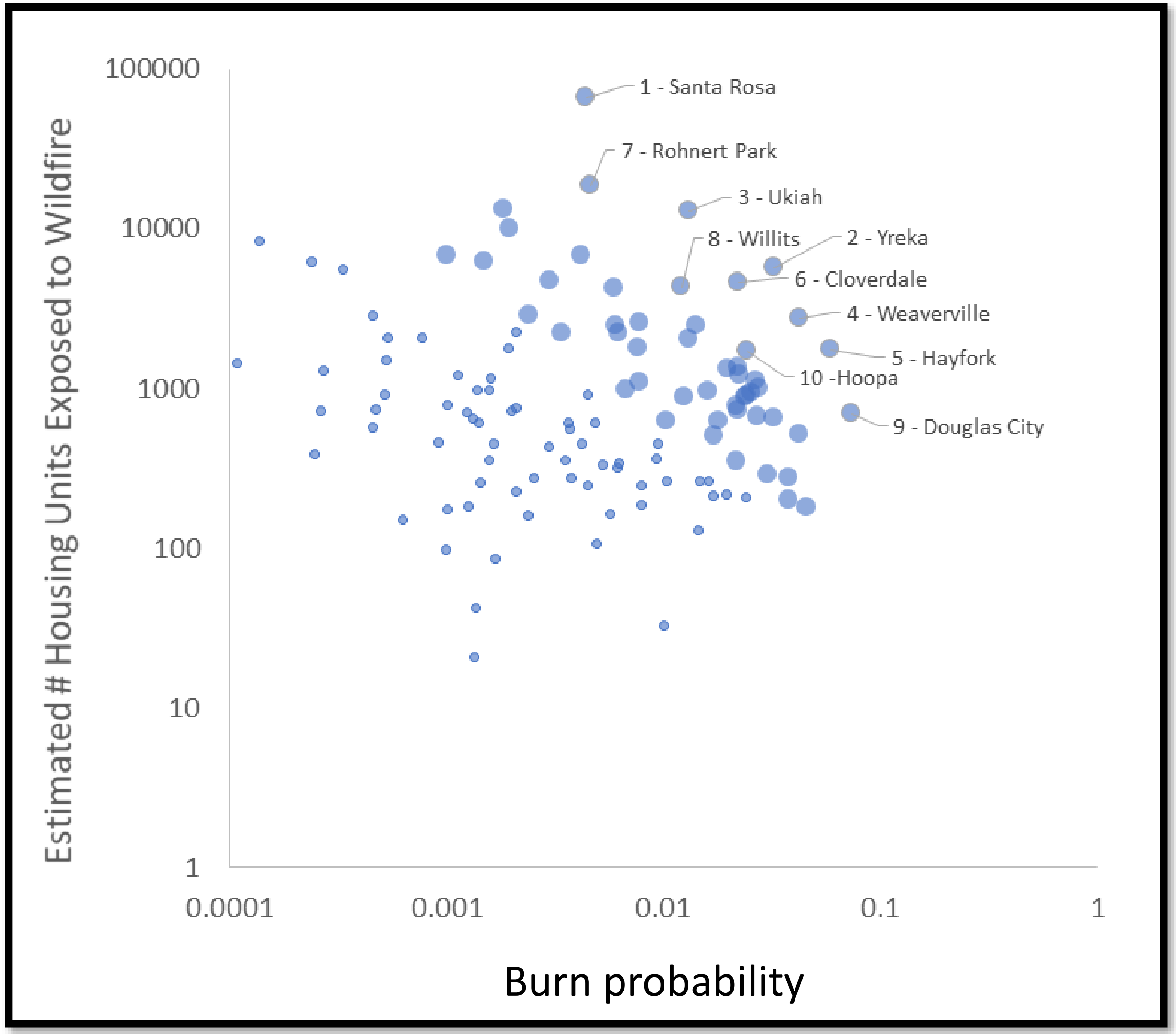
https://wildfirerisk.org

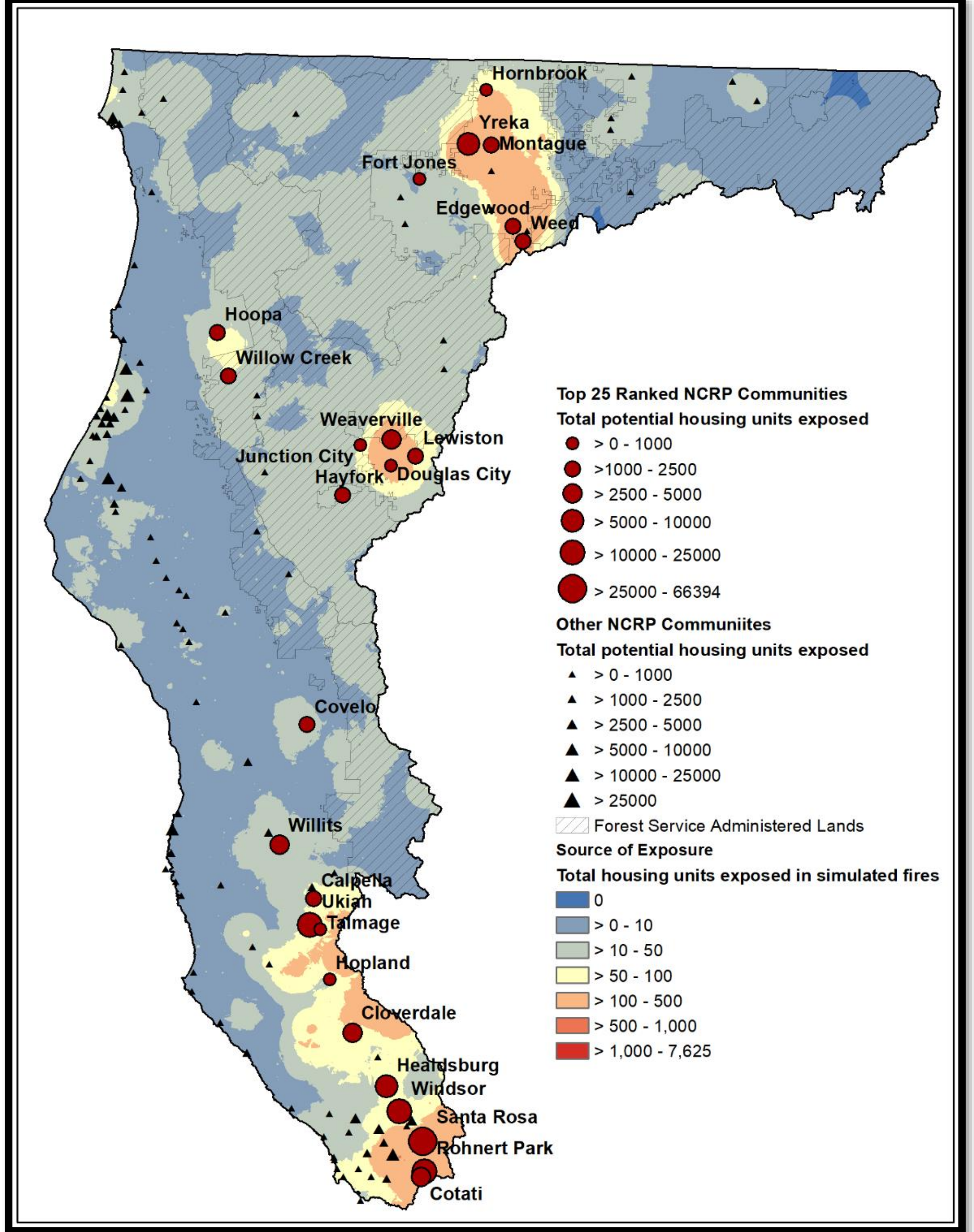
Community exposure





Community exposure





Where do we have decision space?

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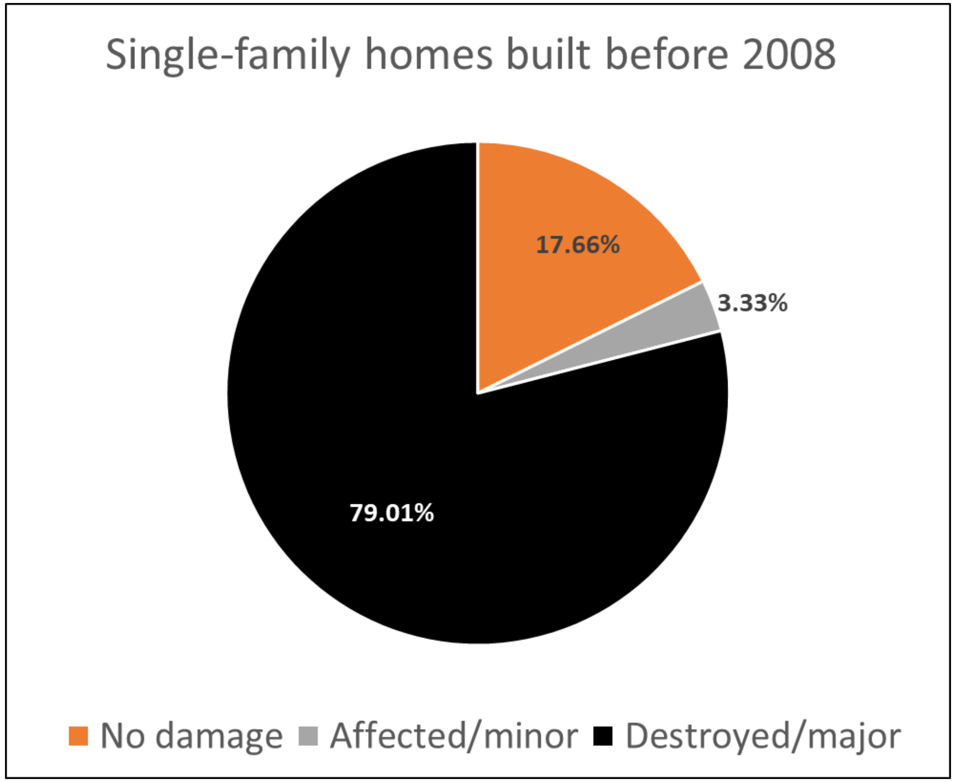
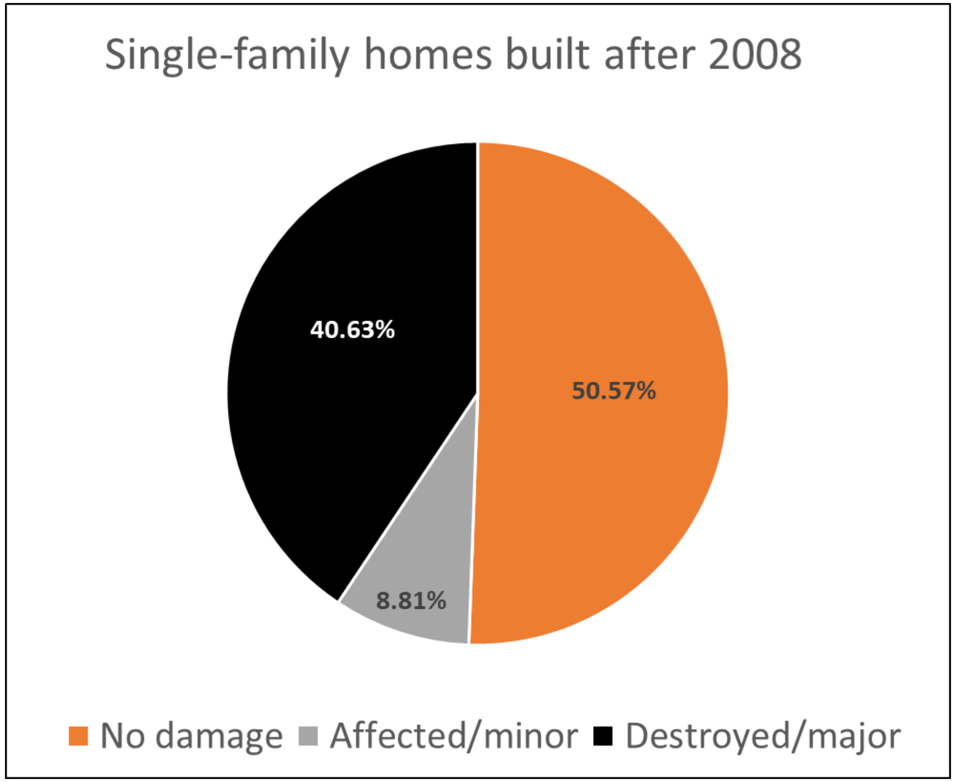
Our decision space

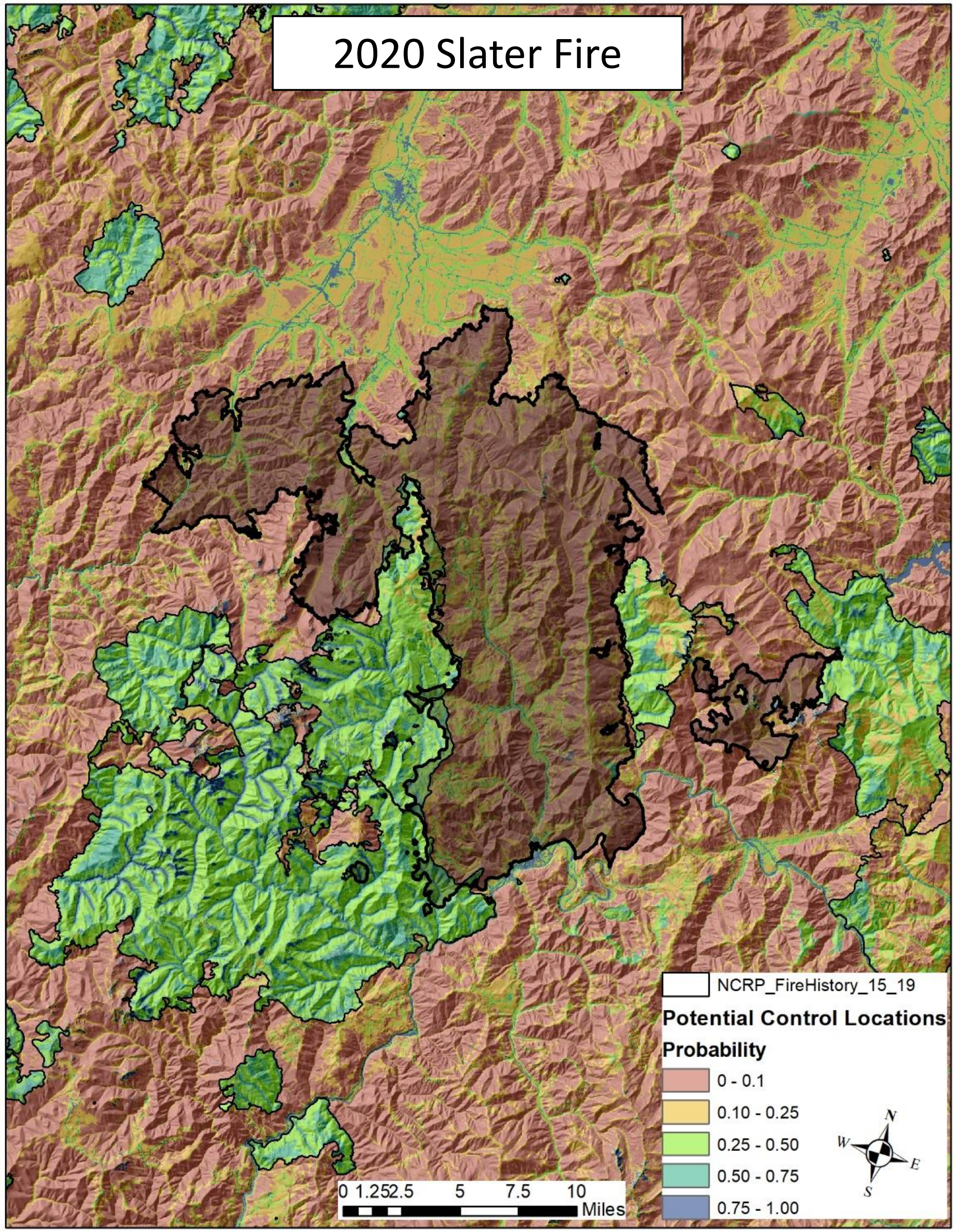
State of Washington adopted WUI code in 2004, updated to the 2018 International Wildland Urban Interface Code

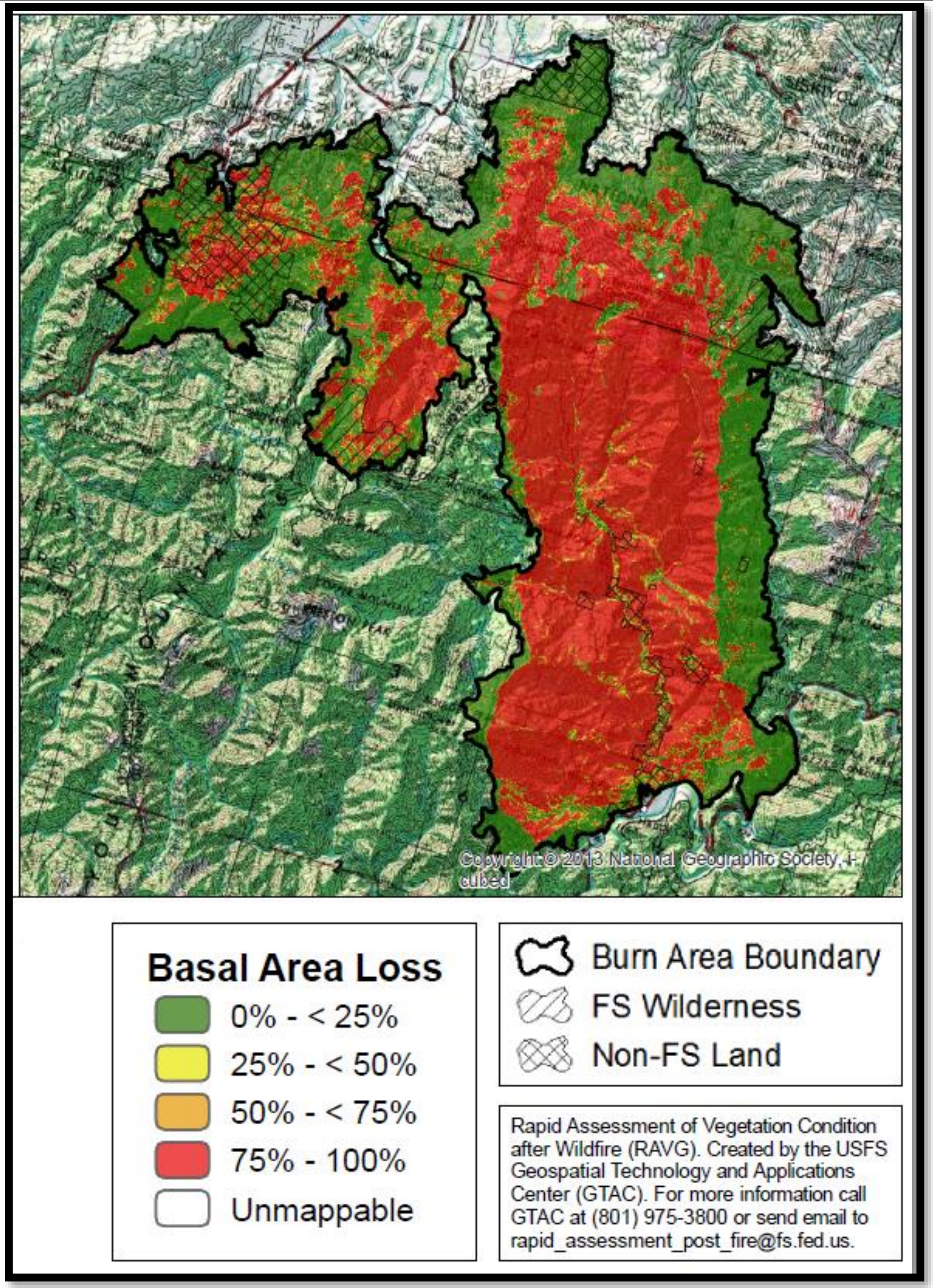
State of California adopted new codes in 2007, took effect on new construction in 2008





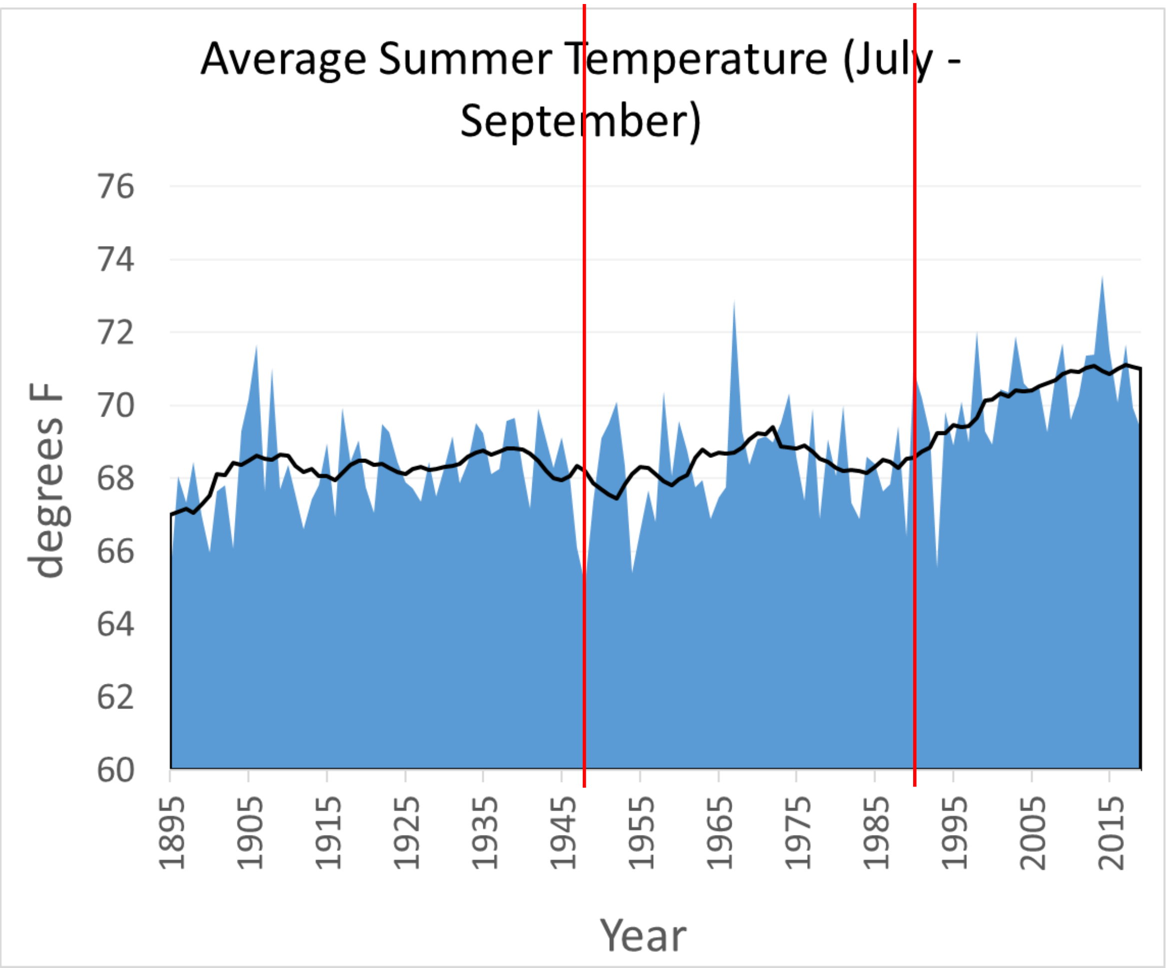
https://www.sacbee.com/news/california/fires/article227665284.html

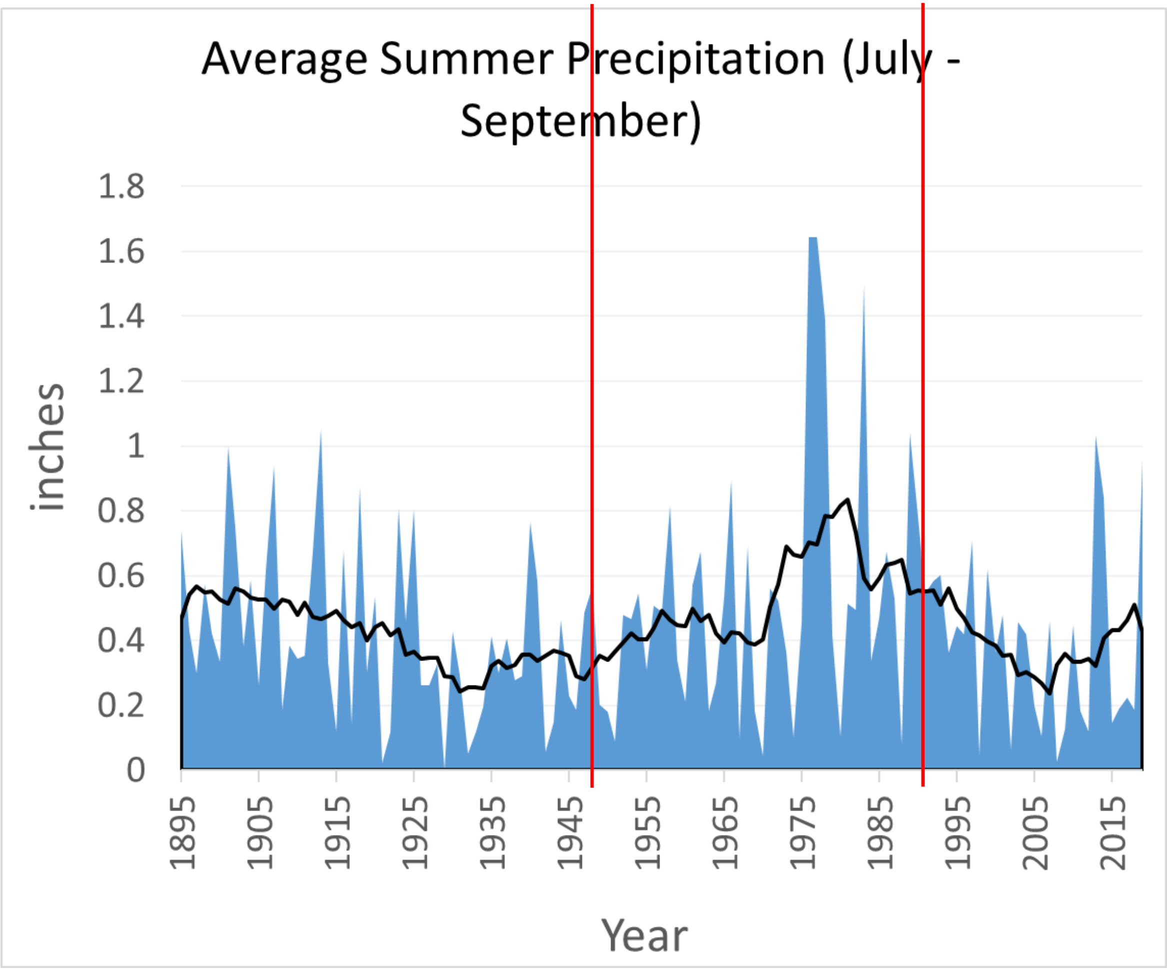

2020 Slater Fire
NCRP_FireHistory_15_19
Potential Control Locations
Probability
0 - 0.1
0.10 - 0.25
0.25 - 0.50
0.50 - 0.75
0.75 - 1.00
0 1.252.5 5 7.5 10
Miles
N
W
E
S


Copyright © 2013 National Geographic Society, i-cubed
Basal Area Loss
0% - < 25%
25% - < 50%
50% - < 75%
75% - 100%
Unmappable
Burn Area Boundary
FS Wilderness
Non-FS Land
Rapid Assessment of Vegetation Condition after Wildfire (RAVG). Created by the USFS Geospatial Technology and Applications Center (GTAC). For more information call GTAC at (801) 975-3800 or send email to rapid_assessment_post_fire@fs.fed.us.

2019 - 204 Cow Fire, Malheur NF – photo by D. Hannibal

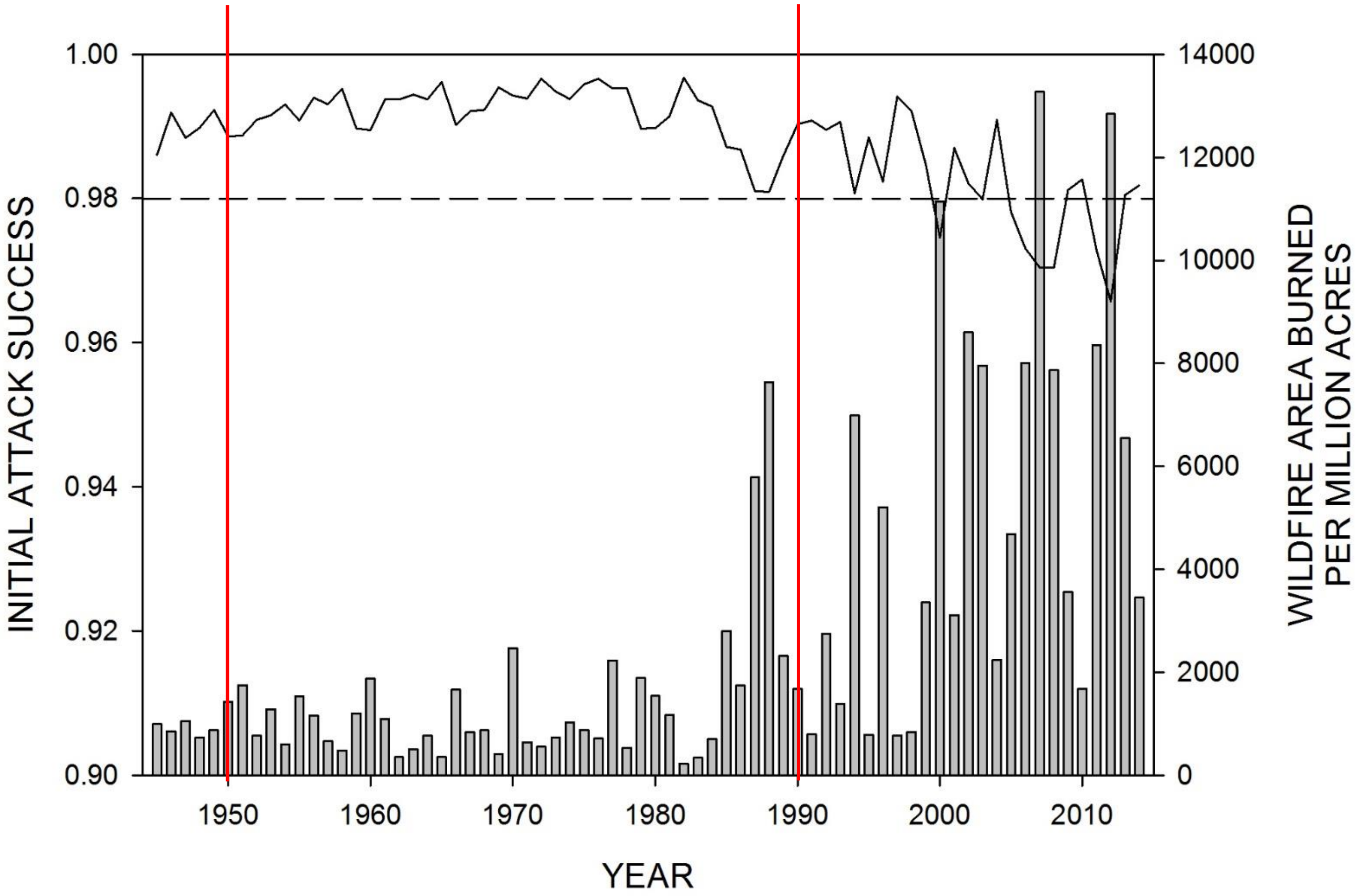
Contemporary climate





Prism Climate Group - http://www.prism.oregonstate.edu/

Initial attack (IA) "Success" & Implications



IA Efficiency largely unchanged, but:

- Fire are more expensive
- Fires now cause more damage
- Fuel conditions dramatically changed (stand-landscape)

IA success never be 100%. We will always have big fires.