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Wildfire and the Season Ahead

September 6, 2018

Discussion Topics

- Introduction
  - Loss History for California
  - Losses in 2017
  - Insurance challenges
- Fires and Man – Is it All Unavoidable?
  - Fire risk
  - Fire spread
  - Location risk factors
  - Fires of 2017
- Capital Adequacy and Risk Modeling
  - Risk modeling for fire
  - Historic loss baselines and shortcomings
  - California aggregate wildfire risk

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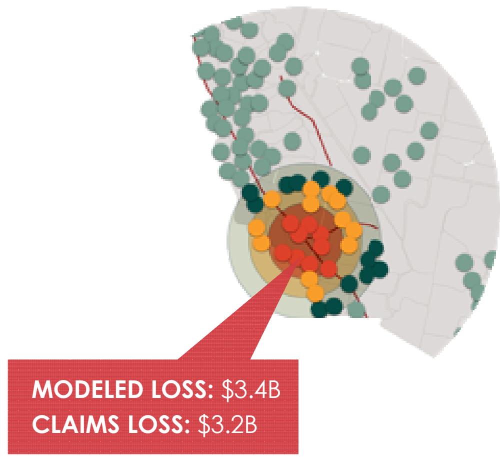
Introduction

Howard Kunst
Principal, Science & Analytics

Types of Models

DETERMINISTIC

What could happen?



PROBABILISTIC

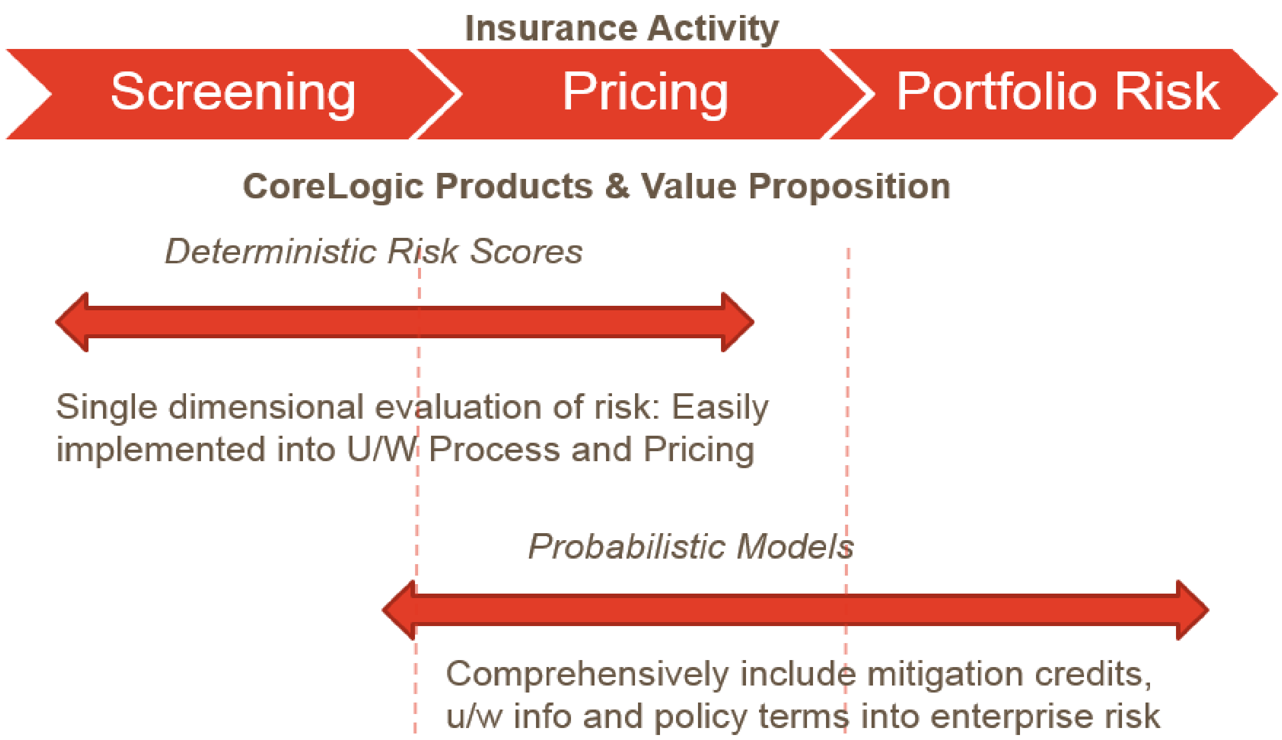
What if it happened?

FORENSIC

What did happen?

Natural Catastrophe Offerings to Insurers

A complete suite of products to cover the insurers' needs



Fire & Man: Is it All Unavoidable?

Fire Risk: Seasonality

- Historically, wildfire considered seasonal in the U.S.
- Comparatively in California: trending towards year-round risk
- Other states: summer/fall is the peak
  - Seasonal dryness
  - Lightning strike opportunities
  - Human activity outdoors

Extreme drought conditions create dead/dry fuel → increase fire opportunity → **larger and more intense fire events**

Fire Spread
Factors

1. Fuel type and density
   - Different vegetation burns at different rates/intensity
   - Density + fuel type = ability of a wildfire to propagate and spread
2. Fuel load (ground accumulation)
   - Build up of dry vegetation increases fuel load
   - Controlled/managed burns reduces the fuel load in many areas, but this isn't widespread
   - Areas of high fuel loads → increased risk of large and intense fires

Fire Spread

Factors (continued)

3. Fuel condition (dry vs. drought)

- Dry conditions linked to seasonality
- Dry summers and wet winters → linked to fire seasons
- **Drought conditions:** usually longer running periods without precipitation that cause excessively dry conditions that enable a build-up of dead and dry fuels → readily available to burn
- Even if drought not currently ongoing: build-up can lead to fires for a period of years after the drought

4. Meteorological factors (wind, humidity)

- Wind speed and wind direction
- Persistent high daily temperatures and low humidity
  → difference between a small benign fire and a large catastrophic fire
- Direction and speed of burn contributes to intensity

Fire Spread
Factors (continued)

5. Terrain (slope, aspect)

- Upslope burn = increase in intensity and speed
  - Pre-heated upslope fuels predisposed to burn
  - Vertical flames tend to ignite a larger area of fuels on a slope
- Embers, ash, burning material will "fall" downslope → ignite fuels downslope
- Fires generate wind patterns and increase wind intensity
- Fires along canyons → "chimney effect" to feed oxygen to the fire

  → Fire tornado/fire whirl (Carr Fire, CA)

Location risk factors

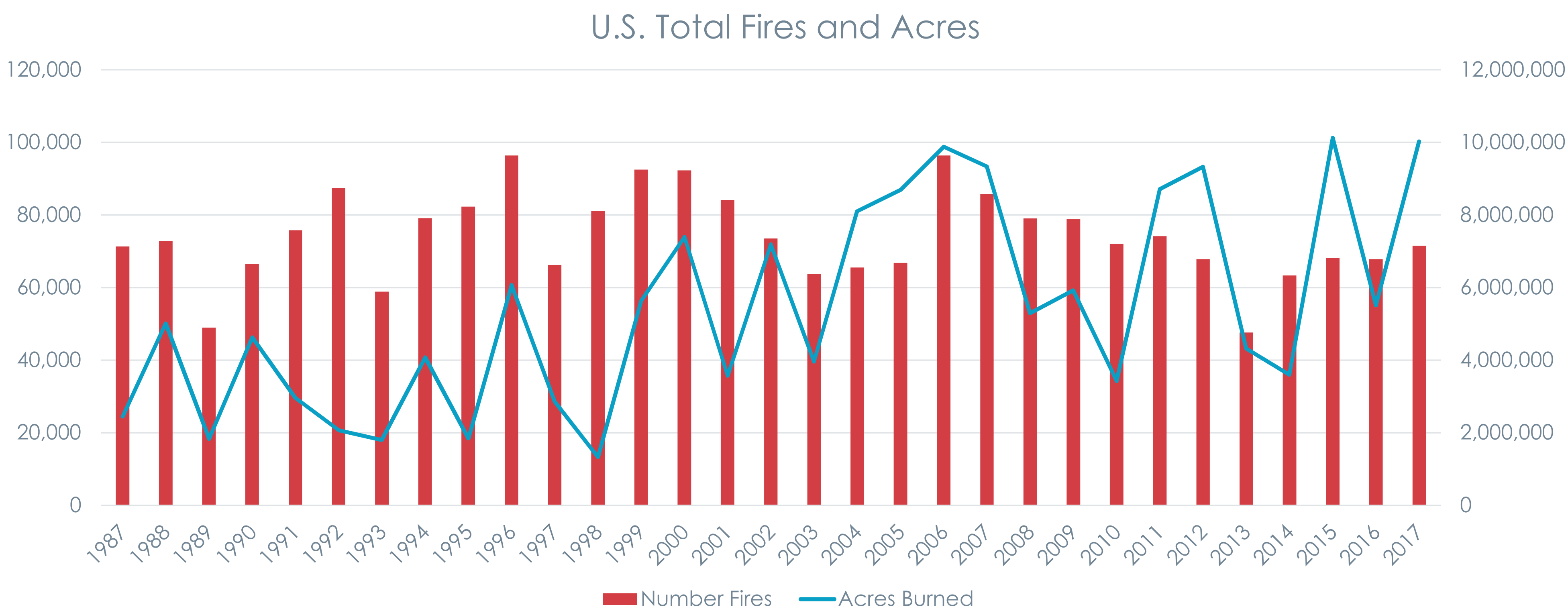
- Few of these factors act in isolation → combine for defense
- Location
  - Defensible space (HIZ – Home Ignition Zone)
  - Clearing the higher risk fuels within a buffered space around the structure
  - Maintaining a low level of natural fuels within 100 feet of the structure
- Architecture
  - Complex roof (dormers or multiple angles of the roof) make accumulation areas for embers or debris like pine needles
- Materials
  - Fire resistant siding, roofing, decking material, double pane glass, etc. → reduce risk of ignition
  - Fire doesn't need to actually burn up to a home to ignite → embers blown onto the property to ignite structure

Fire Risk: California

- Much of California suffered severe drought from 2011-2016
  - 2017 – Thomas Fire: largest fire in state history
  - 2018 – Mendocino Complex: new record for largest fire in state history

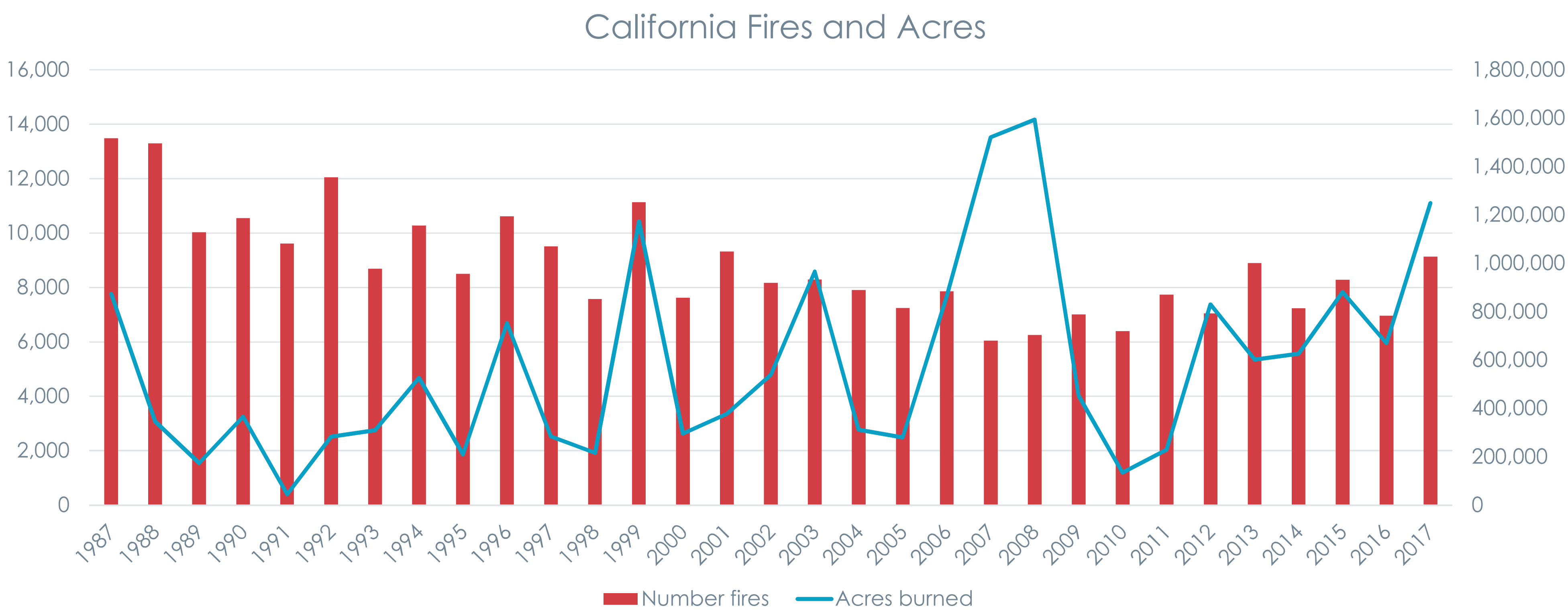
U.S. Total Fires and Acres

Source National Interagency Fire Center, 2018



California Fires and Acres

Source: California Department of Forestry and Fire Protection, 2018.



CA – 2017 vs average

NIFC data

California	2017	5 year average 2012-2016	10 year 2007-2016	15 year 2002-2016
Acres	1,266,224	691,299	656,135	599,012
# fires	9,560	8,363	7,871	7,996

California vs. top 5 states for wildfire, 2017

NIFC data

State	2017 Acres	2017 # fires	10 year average acres 2007-2016	10 year average # fires 2007-2016
Montana	1,366,498	2,422	306,739	1,745
Nevada	1,329,289	768	258,666	659
California	**1,266,224**	**9,560**	**656,135**	**7,871**
Texas	734,682	9,827	615,567	8,318
Oregon	714,520	2,049	476,151	1,901

Fires of 2017

- **Fuel Load**
  1. Dry conditions; drought from 2011-2016
  2. Record-setting precipitation in winter of 2016/2017
  3. New growth of fuels from precipitation
  4. Then dry summer 2017
  5. New growth + 6 years of drought/dead fuels = **increased the fuel load**
- **Ignition**
  - 80% of fires are human caused
  - 2017: Power line equipment
- **Weather**
  - Dry, hot, low humidity + **high winds**
  - Wind speeds averaging 20-40 mph and gusts reported up to 70+ mph
  - Sustained winds push fire faster and increase intensity
  - Gusts do the same + lift burning material

2017 October Fires

- **Cause:** sparks from PG&E power lines and equipment failure (concluded by CalFire)

- *According to the Cal Fire, faulty Pacific Gas and Electric power lines and equipment failure caused 12 of the October 2017 wildfires that tore through Northern California. The state agency blamed the utility corporation for the Norrbom, Partrick, Pythian, Adobe, and Pocket blazes.*

- *"The violations were found in fires that burned across Sonoma, Napa, Lake and Humboldt counties," reports Press Democrat. "In the other four fires, flames were ignited by power equipment but investigators found the utility company was not in violation of state regulations."*

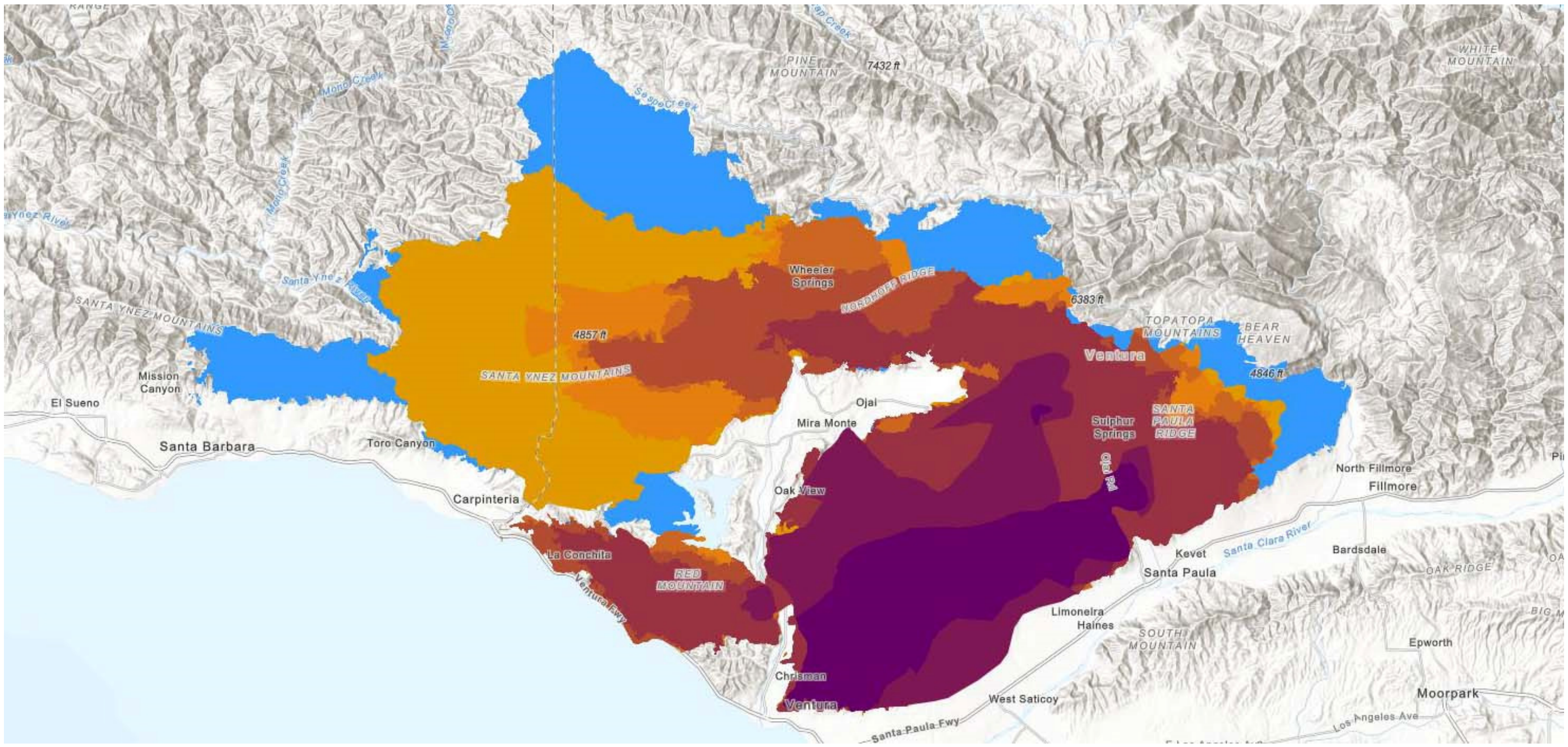
Fire case study: one event day by day

Thomas Fire

- 2 deaths
- 281,893 acres (most destructive until the Mendocino Complex in 2018 topped it)
- Over 1,000 structures destroyed (8th most destructive fire in CA history – as of August, 2018)
- Santa Ana winds
- At times: burned one acre/second.
- Official cause not yet released

The progression slides that follow run from Dec 5th through Dec 22nd. By the 22nd the fire was the largest in state history. It was not contained on the 22nd and was not classified as fully contained until January 12th. But very little total area burned between Dec. 22nd and January 12th

Thomas Fire Progression
Day 14 – Dec 17, 2017



Thomas Fire Progression

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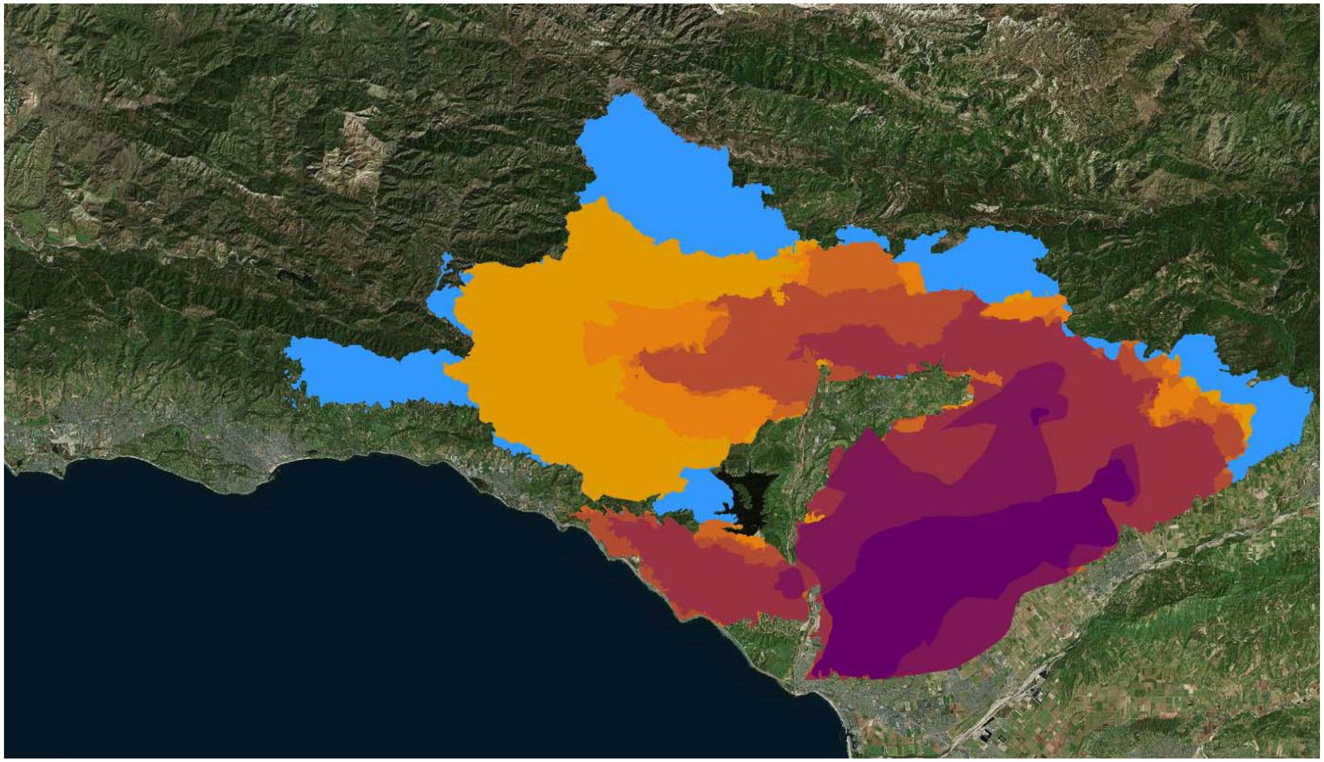

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Capital Adequacy and Risk Modeling

Tom Larsen
Principal, Industry Solutions

Wildland Fire: Understanding Loss Implications of fire

- A historical view of catastrophe wildland fire in the US
- Understanding the loss potential of a wildland fire
- Developing an intuition for loss potential – drivers of loss

Largest Fire Losses in the US

Fire	Location	Date	Loss Occurring	Loss, 2015$
1. The World Trade Center	NYC	2001-Sep	$33.4 billion	$44.7 billion
2. San Francisco EQ and Fire	SF, CA	1906-Apr	$350 million	$9.2 billion
3. Great Chicago Fire *	Chicago	1871-Oct	$168 million	$3.3 billion
4. Oakland Fire Storm	Oakland, CA	1991-Oct	$1.5 billion	$2.6 billion
5. The So. California Firestorm	San Diego, CA	2007-Oct	$1.8 billion	$2.1 billion
6. The Valley Fire	Lake County, CA	2015-Sep	$1.5 billion	$1.5 billion
7. Great Boston Fire	Boston, MA	1872-Nov	$75 million	$1.5 billion
8. Polyolefin Plant	Pasadena, TX	1989-Oct	$750 million	$1.4 billion
9. "Cerro Grande" Wildland Fire	Los Alamos, NM	2000-May	$1.0 billion	$1.4 billion
10. "Cedar" Wildland Fire	Julian, CA	2003-Oct	$1.1 billion	$1.3 billion
11. Baltimore Conflagration	Baltimore, MD	1904-Feb	$50 million	$1.3 billion
12. "Old" Wildland Fire	San Bernardino, CA	2003-Oct	$975 million	$1.3 billion
13. Los Angeles Civil Disturbance	Los Angeles, CA	1992-Apr	$567 million	$959 million
14. Power Plant	Dearborn, MI	1999-Feb	$650 million	$924 million
15. So. California Nov Wildfire	Sacramento, CA	2008-Nov	$800 million	$882 million
16. "Laguna Beach Fire"	Orange County, CA	1993-Oct	$528 million	$866 million
17. Textile Mill	Methuen, MA	1995-Dec	$500 million	$777 million
18. U.S.S. Lafayette	NY, NY	1942-Feb	$53 million	$771 million
19. Texas City	TX City, TX	1947-Apr	$67 million	$712 million
20. Petroleum Refinery	Norco, LA	1988-May	$330 million	$661 million
21. Cargo plane in-flight fire	Near Newburgh, NY	1996-Sep	$395 million	$597 million
22. Great Fire of New York	NY, NY	1835-Dec	$26 million	$595 million
23. Wildland Fire**	Florida	1998-May	$395 million	$573 million
24. One Meridian Plaza	Philadelphia, PA	1991-Feb	$325 million	$565 million
25. Forest Fire	Cloquet, MN	1918-Oct	$35 million	$549 million

National Fire Protection Association, Largest Fire Losses in the US
https://www.nfpa.org/News-and-Research/Fire-statistics-and-reports/Fire-statistics/Fires-in-the-US/Large-property-loss/Largest-fire-losses-in-the-United-States

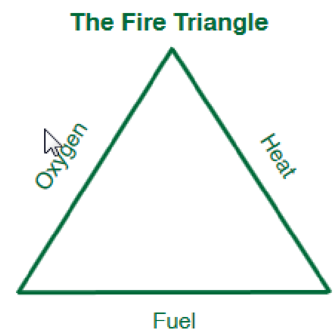
Severity
10 of the top 25 fire losses in the US were associated with wildland fires

Relevance
All of the large fire losses since 2001 have been wildland fires

Increasing Frequency
Six of the wildland fire losses have been since year 2000

Characteristics of large fires in California

Understanding the peril of extreme fires



- Late season
  - largest fires were between September and November
  - California dry summer weather pattern produces the fuel necessary for a fire
- High winds for multiple days
  - High winds provide the oxygen necessary for a large fire
- Suburban concentrations in and near wildland areas
  - Human activities provide the "heat" in the form of incidental ignitions

Losses to Property and Fire

- Property Insurance Loss Exposure
  - Buildings and other fixed property
  - Contents
  - Additional Living Expense; Business Interruption
- Other lines of insurance exposed
  - Liability
  - Workers compensation
- Causes of loss
  - Direct fire destruction
  - Smoke
  - Ingress / Egress

Wildland Fire – not like other loss perils

Wildland fire is a full loss peril

- Fires destroy the entire building and stresses the 100% reconstruction cost for the policy
  - Not even hurricanes or earthquakes cause widespread 100% loss severity
  - Under-insurance will be exposed in a wildfire
- California Dept of Insurance (CDI) may be increasing costs for contents and ALE coverage[1] beyond historic claims
- Coverage C loss exposure remains ambiguous
  - Valuation methods not as rigorous as for Coverage A

Larkfield area, Santa Rosa Fires, 2017

1-http://www.insurance.ca.gov/0400-news/0100-press-releases/2018/upload/nr086NoticeExpeditedClaimsProcedures.pdf

Wildland Fire – not like other loss perils

Emerging Risk – Smoke and Ash

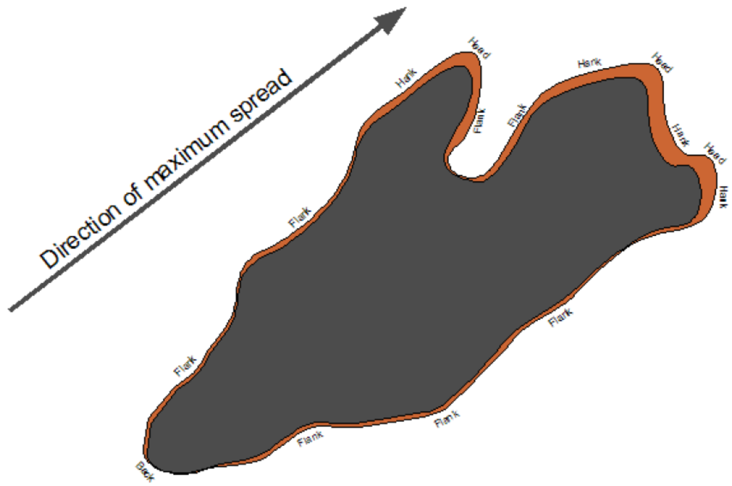
- The awareness of the health and safety hazards of smoke and ash are increasing the likelihood for claims in future wildland fires
  - This is a trend not generally seen in historic claims but appears to be growing
  - Even if claim is denied – claims adjustment expenses will increase

https://www.cdc.gov/features/wildfires/index.html

Anticipating ultimate fire losses

How big will the fire get? Lessons from tactical fire-fighting models

- Wildland fires are distinct from smaller fires
  - Driven by winds
  - Influenced by fuel loads and topography
- The shape and eventual extent of the fire are driven by many localized geographic and climate factors



Scott, Joe H. 2012. Introduction to Wildfire Behavior Modeling. National Interagency Fuels, Fire, & Vegetation Technology Transfer. Available: www.niftt.gov.

Anticipating ultimate fire losses

How big will the fire get? Introducing key metrics

- Wildland fires are distinct from smaller fires
  - Driven by winds
  - Influenced by fuel loads and topography
- The shape and eventual extent of the fire are driven by many localized geographic and climate factors
- The ultimate extent of a fire may not be realizable for several days

Increasing fireline intensity equates to increasing difficulty to fight fire

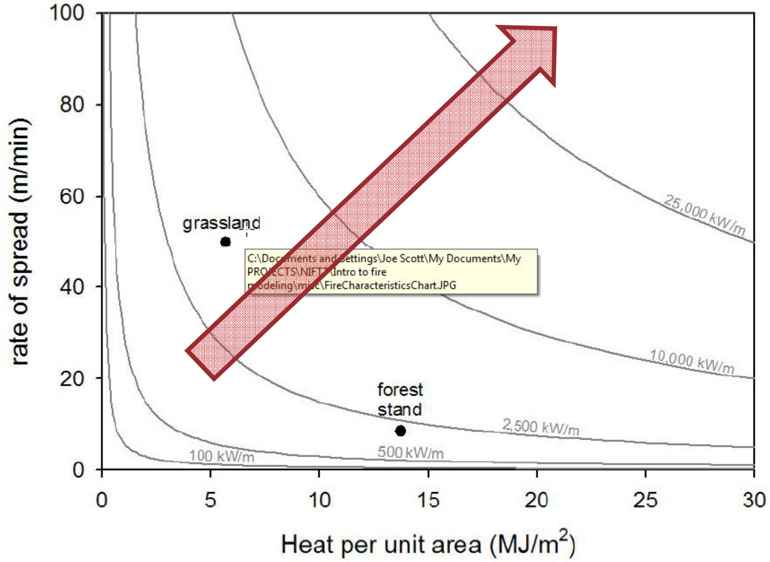


Figure 1-14 – A fire behavior characteristics chart can depict three quantitative fire behavior characteristics at once. The Y-axis represents flaming front spread rate, the X-axis represents heat per unit area, and the curving lines represent fireline intensity.

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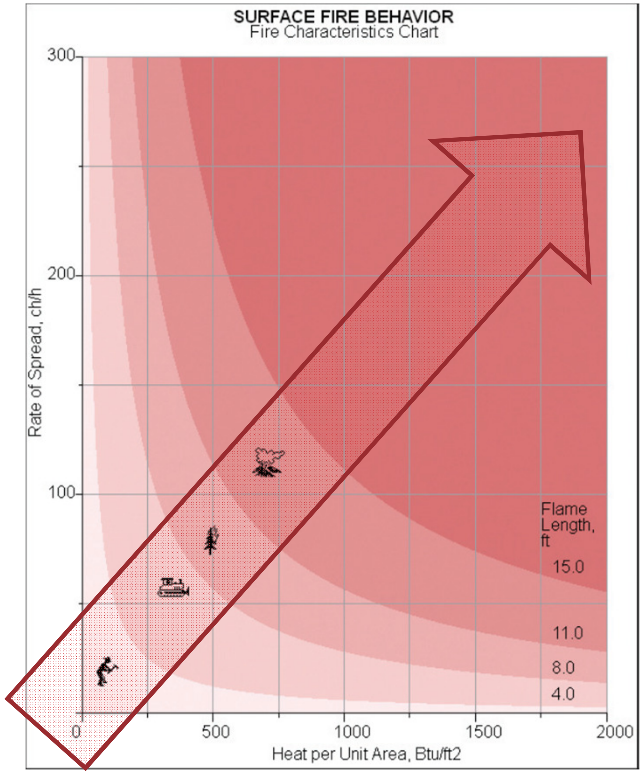
Anticipating ultimate fire losses

How big will the fire get? Containing the fire

- Wildland fires are distinct from smaller fires
  - Driven by winds
  - Influenced by fuel loads and topography
- The shape and eventual extent of the fire are driven by many localized geographic and climate factors

- As fireline intensity increases, the ability to constrain the fire decreases.
  - Hand crews can only fight fires to a certain size
- Slope plays a secondary impact
  - The inability to maneuver heavy equipment can impede fire fighting



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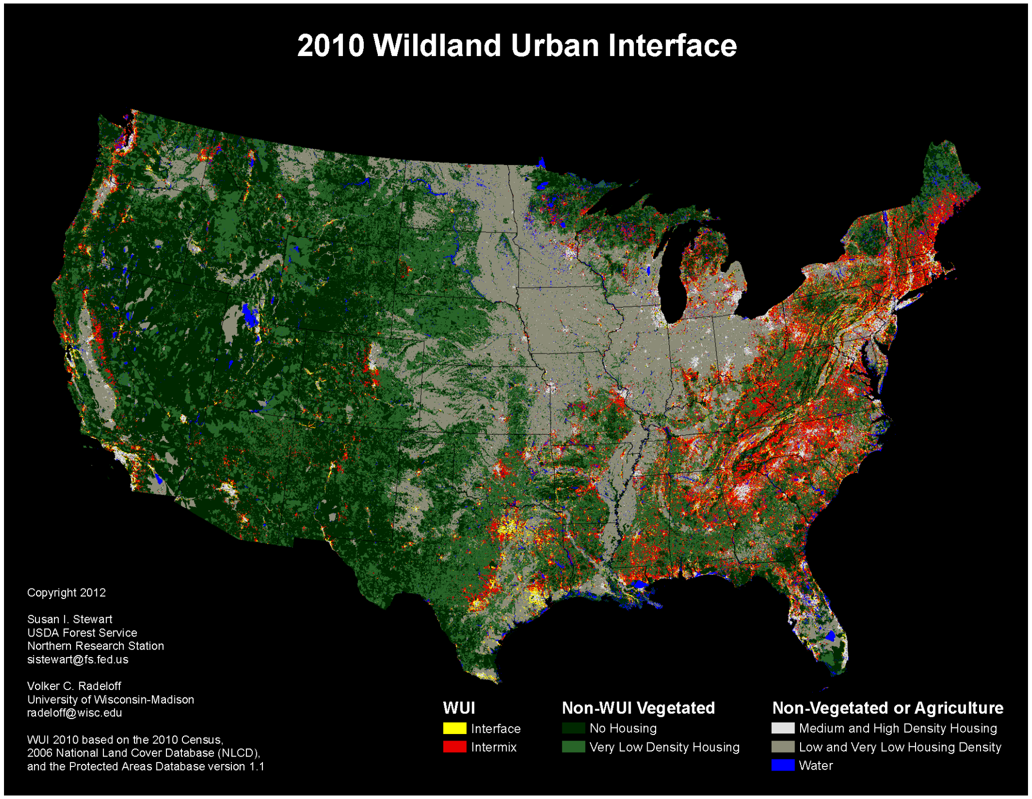
Risk in the US – the wildland interface

Mapping the Wildland Urban Interface

- Challenge for underwriting is identifying the characteristics of the property you are rating

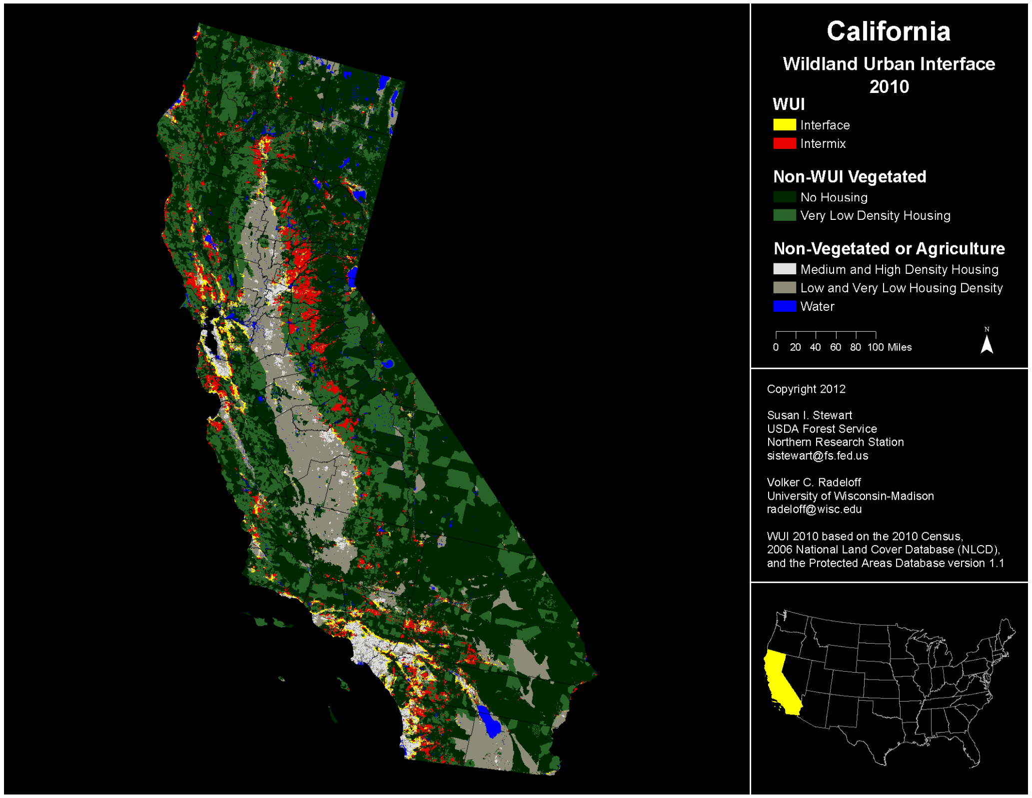
- For loss evaluation, the challenge is to identify the characteristics of all land in the vicinity of the fire to estimate fire growth



Radeloff, V.C., R.B. Hammer, S.I Stewart, J.S. Fried, S.S. Holcomb, and J.F. McKeefry. 2005. The Wildland Urban Interface in the United States. Ecological Applications 15: 799-805.

Risk in California – the Wildland Interface

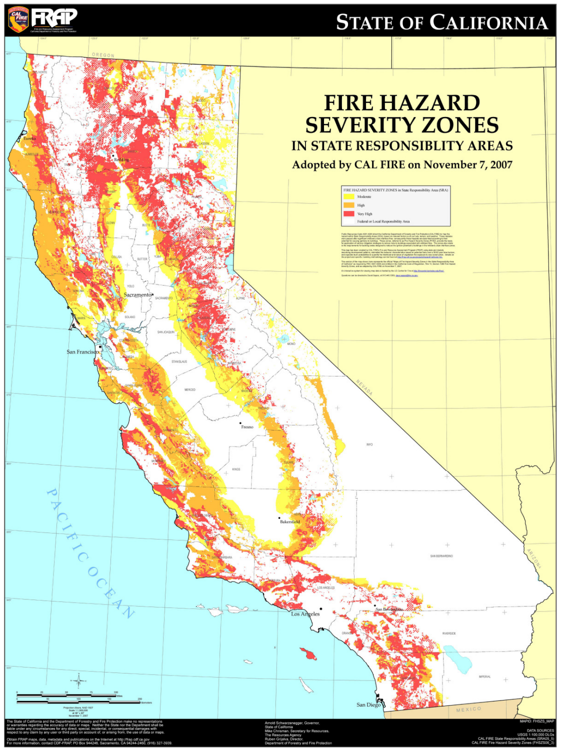
- Reviewing a map of the wildland Interface and Intermix regions in California is like reviewing a map of the fires of the last 10 years.
  - These are the areas that are most at risk for catastrophic fire losses.
- Not all wildland fires cause large property losses
- Not all big wildland fire losses are caused by geographically large fires



Fire Hazard Severity

Adding in the effects of fuel, topography and weather

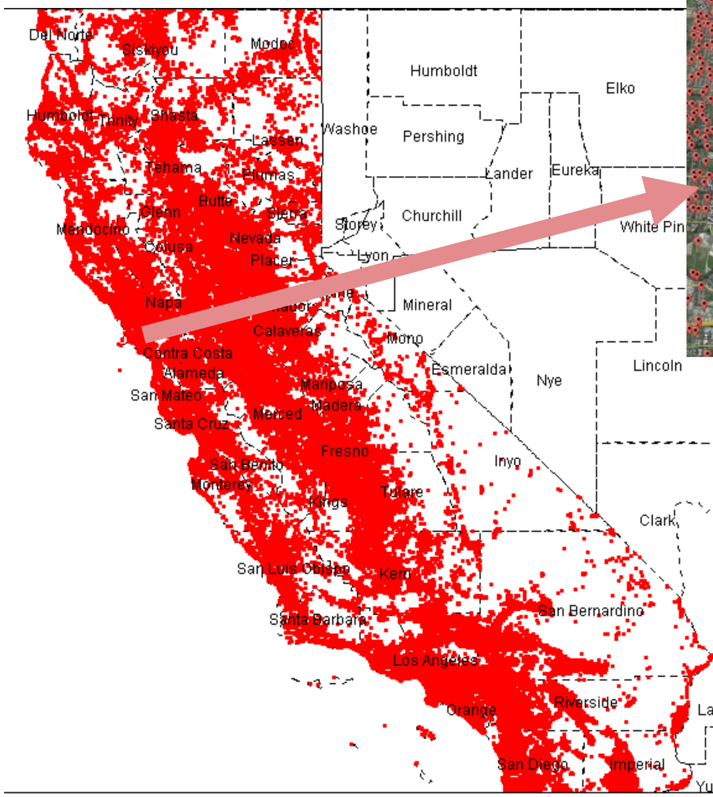
- Static risk territory maps identify the risk of a single location
- Fuel load (prior map) changes with seasons
- Fire hazard incorporates regional risk factors including wind and topography
- Note the granularity, especially in Southern California coastal regions



http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_statewide

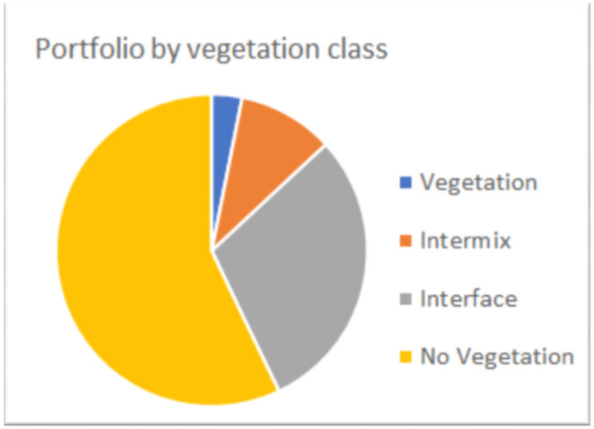
Evaluating the Wildfire Model

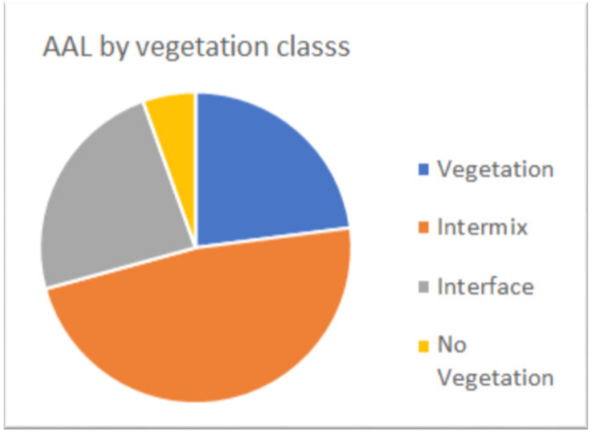
Granular Test Model



- Fuels vary spatially producing high risk gradient
- Topography influences fire spread, requiring detailed risk analysis to produce appropriate event losses
- Test Portfolio based on 2010 Census Block
  - 400,000+ distinct locations

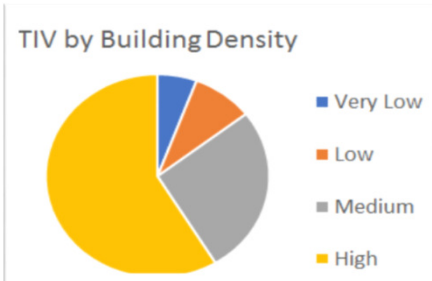
What drives the risk
Vegetation Class

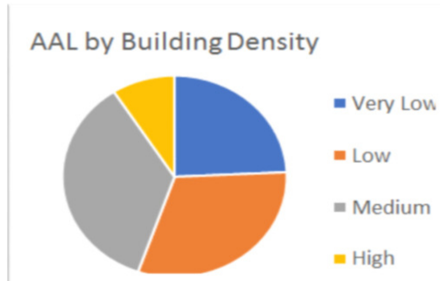


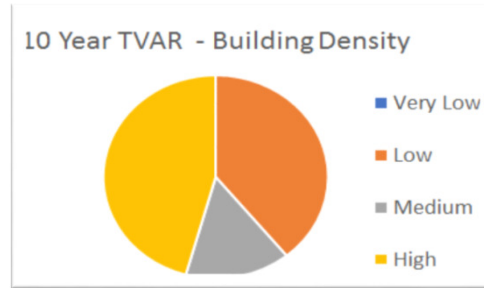


Vegetation zone	Wildland areas
Intermix zone	Housing and vegetation intermingle
Interface zone	Within 1.5 miles of area with >75% vegetation
No/minimal vegetation	Typical city area

What drives the risk
Building Density







- The bulk of homes in California are suburban
- AAL is driven by the riskiness of the location
- Portfolio risk is dominated by infrequent, high-severity fires as seen in 2017

Using a Wildfire Catastrophe Model to estimate live cat

Learning from other catastrophe model regions

- Loss estimation for an active fire
  The contradictions

- **It can't be done**
  - Weather, climate and fire-fighting variables are too high

- **It has to be done**
  - Management expects this
  - Investors, Ratings and Regulators exert pressure

- Techniques borrowed from live catastrophe evaluations for other natural catastrophes can be borrowed to reduce the uncertainty in what can happen

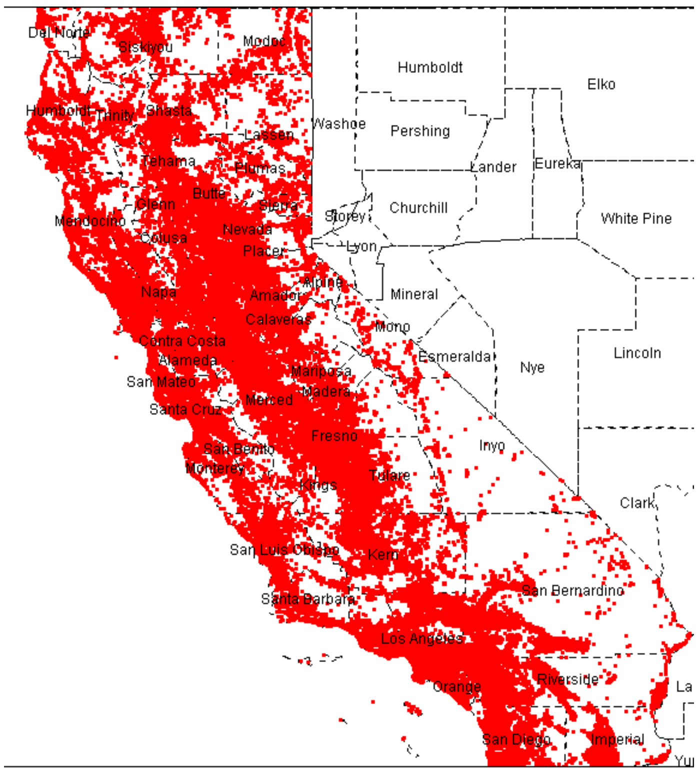
- The basis of the loss estimation method is based upon ensemble loss range bounds within a region

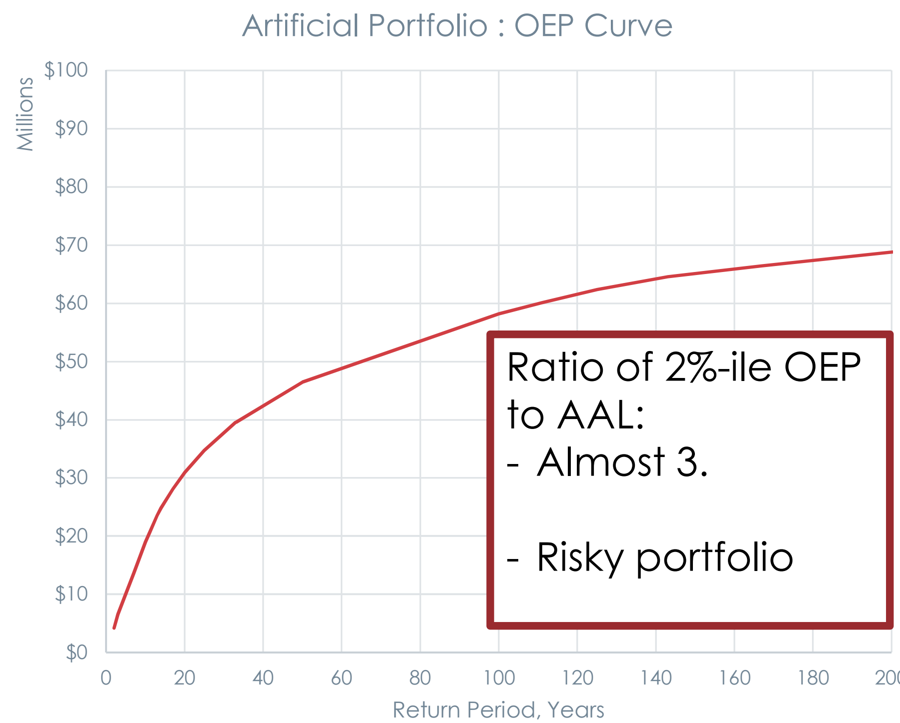
- This method will help you to develop ranges on what is likely to happen

Potential loss bounding – artificial portfolio

Characteristics of the portfolio

Portfolio:California Census Blocks





Ratio of 2%-ile OEP to AAL:

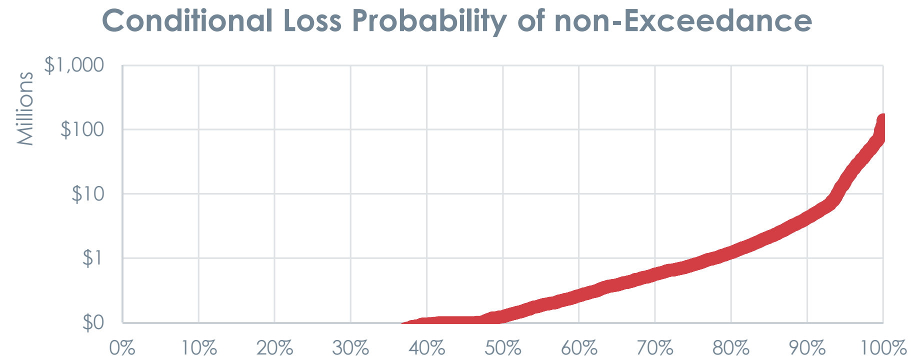
- Almost 3.

- Risky portfolio

Modeling for the event

Regional boxes can help in development of conditional loss curves

Select a geographic area for the fire.
Here, a box in Northern CA
About 20 miles by 30 miles



The RQE model includes 1788 event simulations.

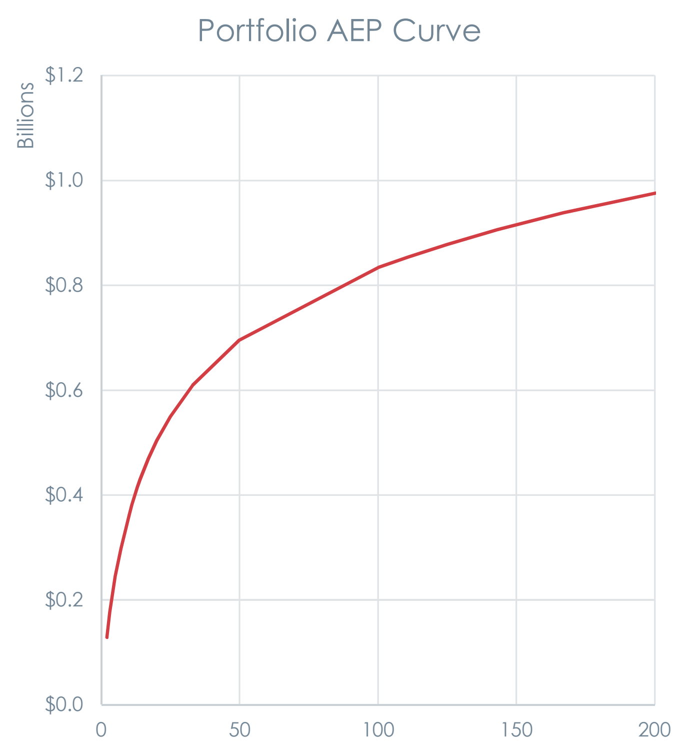
- A large portion of events produce <$1M losses
- About 3% of events produce losses exceeding portfolio 2%-ile

Iterations on geographic area can help refine loss estimates

The CoreLogic Wildland Fire Model

RQE 19 – Summer 2018

- Discrete fire-event simulation model to better capture event severity
- Incorporates lessons from 2017 fire season, especially destruction of homes far outside interface zone
- Produces rational results for risk rating and catastrophe management



Reserving Applications

Portfolio Risk – Probabilistic Models

- Probabilistic model results
  - AAL's and PML's provide necessary information for Senior management at companies to make a number of financial decisions
  - Scenario testing – identifying the events that have the highest potential impact to the company's financials, and making decisions that impact the company's portfolio of insureds
  - Capital allocation is sometimes based on the potential for extreme losses; i.e. portfolios with higher PML's for a selected return period may draw more Capital to support
- Optimize reinsurance
  - Purchase proper levels of reinsurance to cover events at a specified return period, above the primary retention
  - Understand how to allocate reinsurance costs based on where the "extreme" events are occurring
- Post Event management
  - Find an event in the event database that is similar
  - Once event is complete, the footprint can be loaded into the model and tested against an in-force portfolio

Post event Management

Forensic and Probabilistic Models

- Overlay the event footprints over an established portfolio of addresses, to determine (both tabular and visually) the extent of the estimated damage
  - Triage claims: send adjusters to the locations closest to those affected insureds
  - Early estimates of ultimate event losses can be made

QUESTIONS?

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