

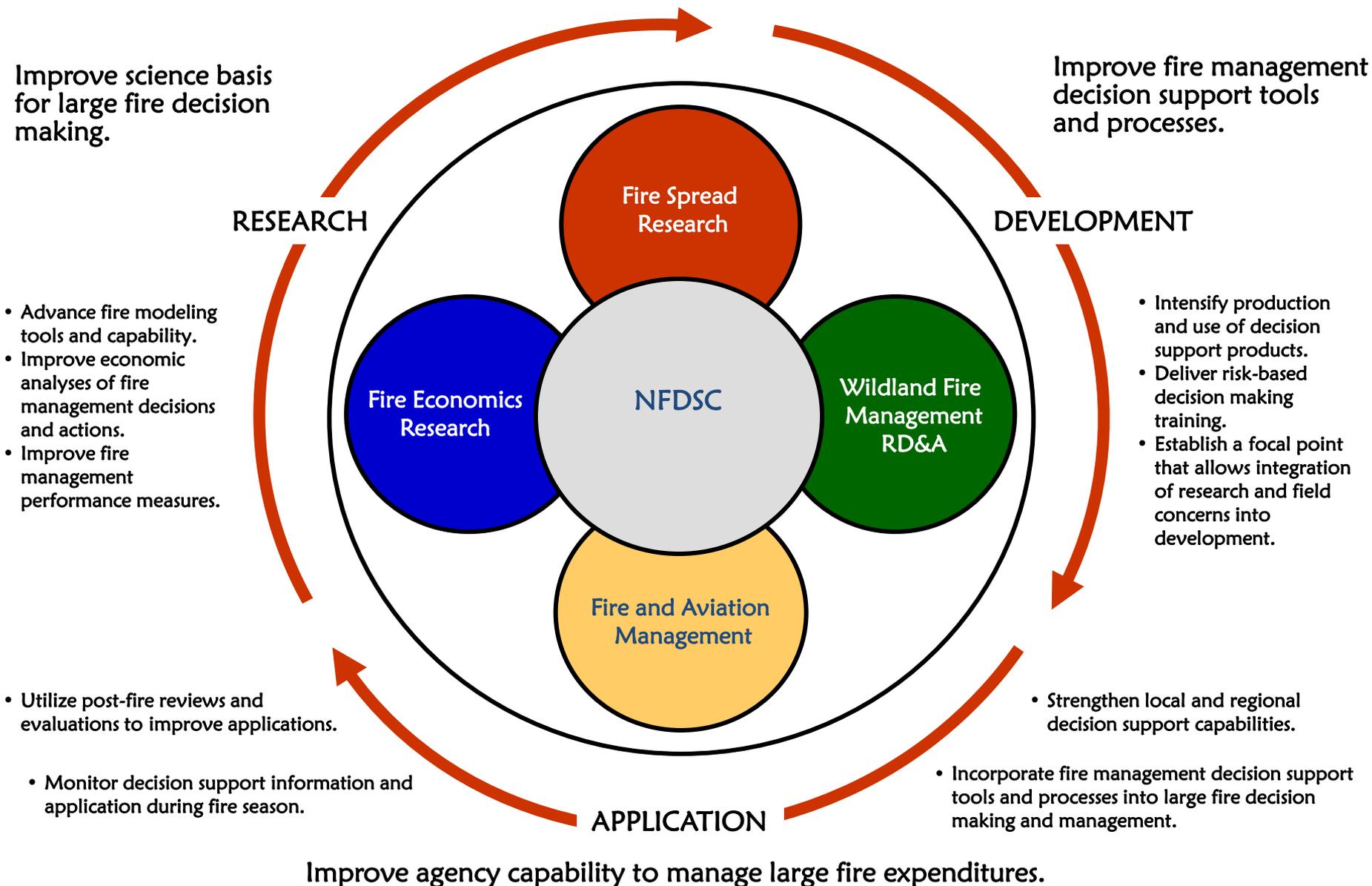
A large wildfire is shown, with thick white and grey smoke rising from a forest of dark trees. The fire is intense, with bright orange and yellow flames visible at the base of the trees. The smoke is billowing upwards, filling the sky. The overall scene is dramatic and powerful.

Risk Assessment and Economic Research Supporting US Wildfire Management

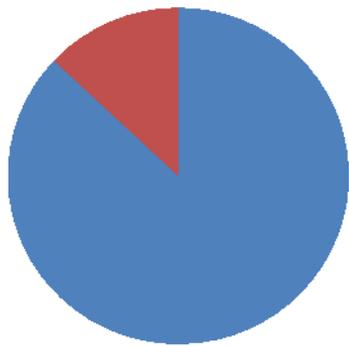
Dave Calkin, Rocky Mountain Research Station,
Missoula MT

Co-Authors: Matt Thompson, Mark Finney, Jessica Haas,
Alan Ager

National Fire Decision Support Center – Structure and Goals

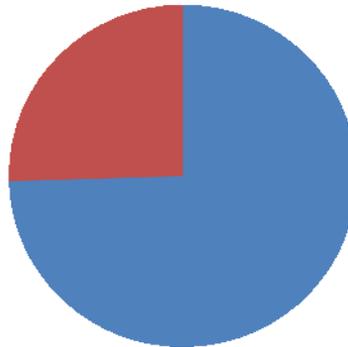


Proportion of USFS budget allocated to wildfire management



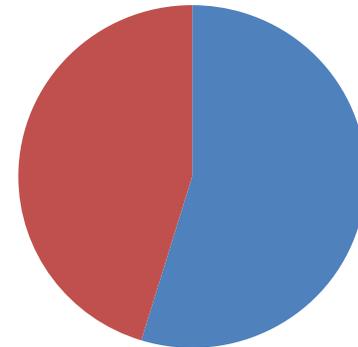
1991
(13%)

■ Non
■ Fire



2000
(21%)

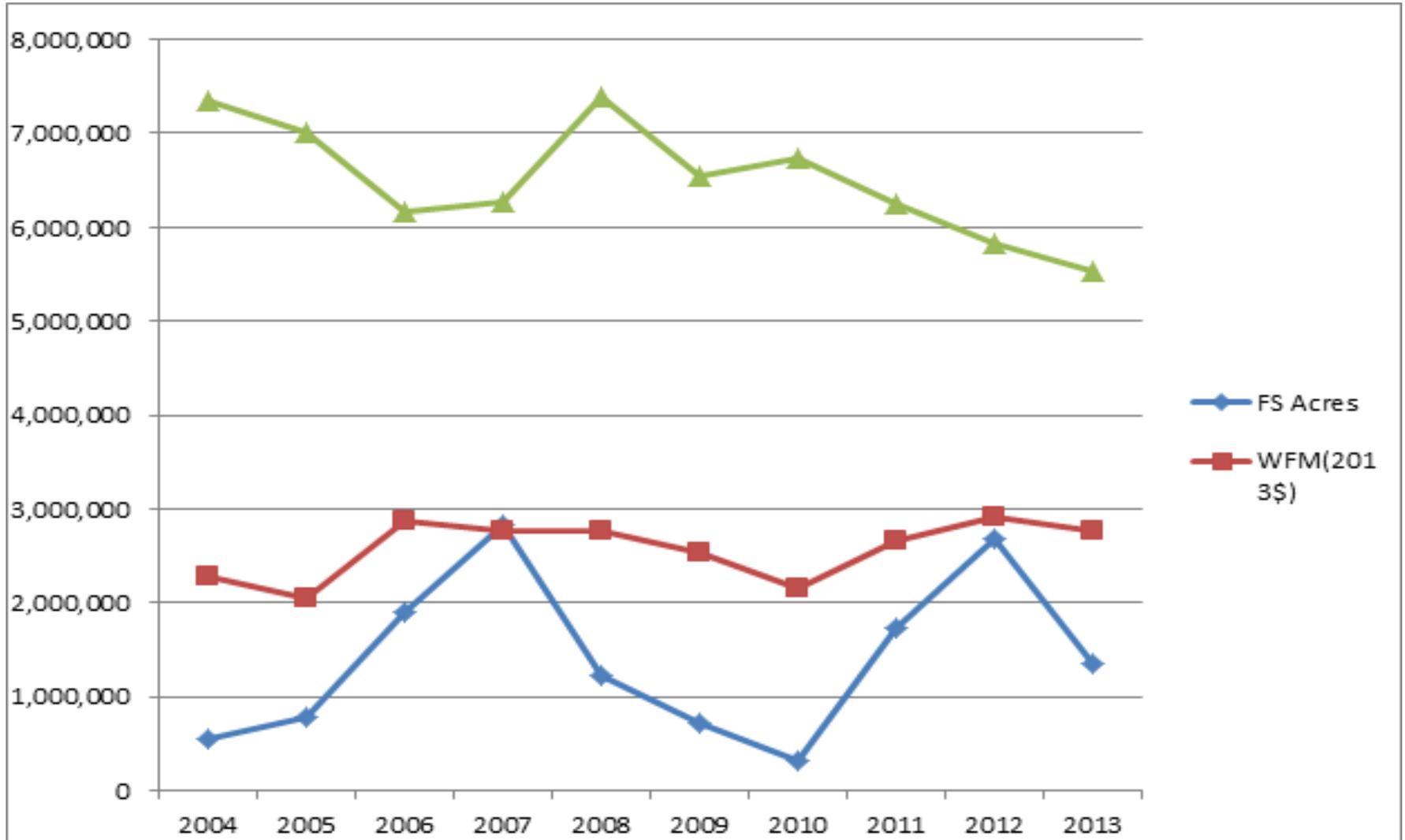
■ Non-fire
■ Fire



2012
(45%)

■ Non-Fire
■ Fire

USFS Budget, Fire Management Cost (2013 \$1000) and Acres Burned



Wildfire Paradox

- More we suppress wildfires under those conditions where suppression is successful the more difficult it becomes to suppress future wildfires under difficult weather conditions.
- The result is increasing wildfire area burned, intensity, management cost, and associated loss (ecological, developed resources, human life).
- “Firefighting Trap” – shortsighted problem solving while failing to address the underlying causes (Collins et al. 2013).

Role of Economics in Wildfire Management

- Quantifying economic effects to highly valued resources within a risk framework
- Economic effectiveness of fire management investments
- Incentives and decision making environment

Wildfire Risk Defined

- Finney (2005) outlined E(NVC) as appropriate framework for defining risk from wildland fire.

$$E[nvc] = \sum_{i=1}^N \sum_{j=1}^n p(F_i) [B_{ij} - L_{ij}]$$

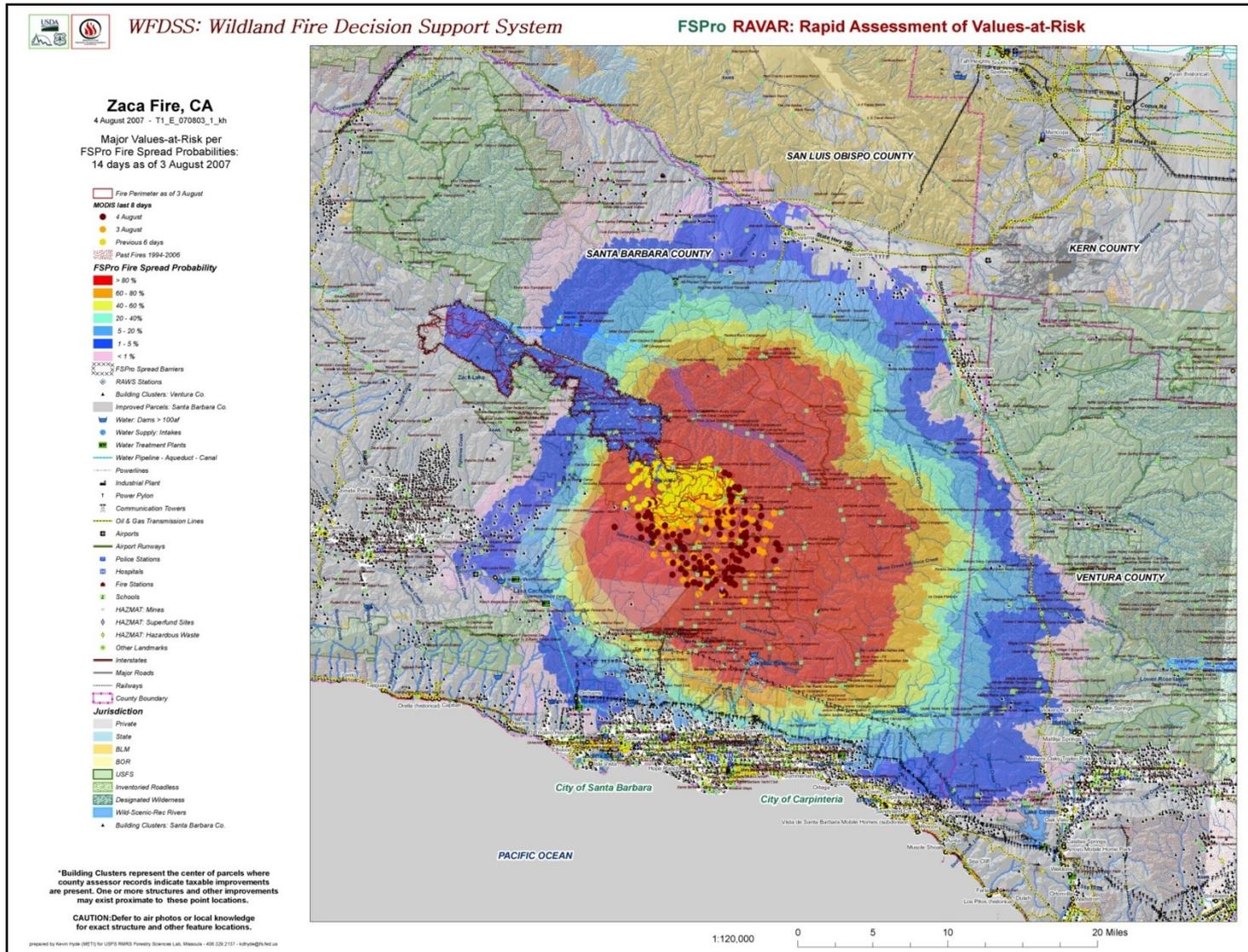
Probability X Consequence

- Manuscript preceded several new applications that improved our ability to estimate $p(F_i)$ across landscapes.
- These advances provided the foundation of many of the fire risk applications emerging from research.

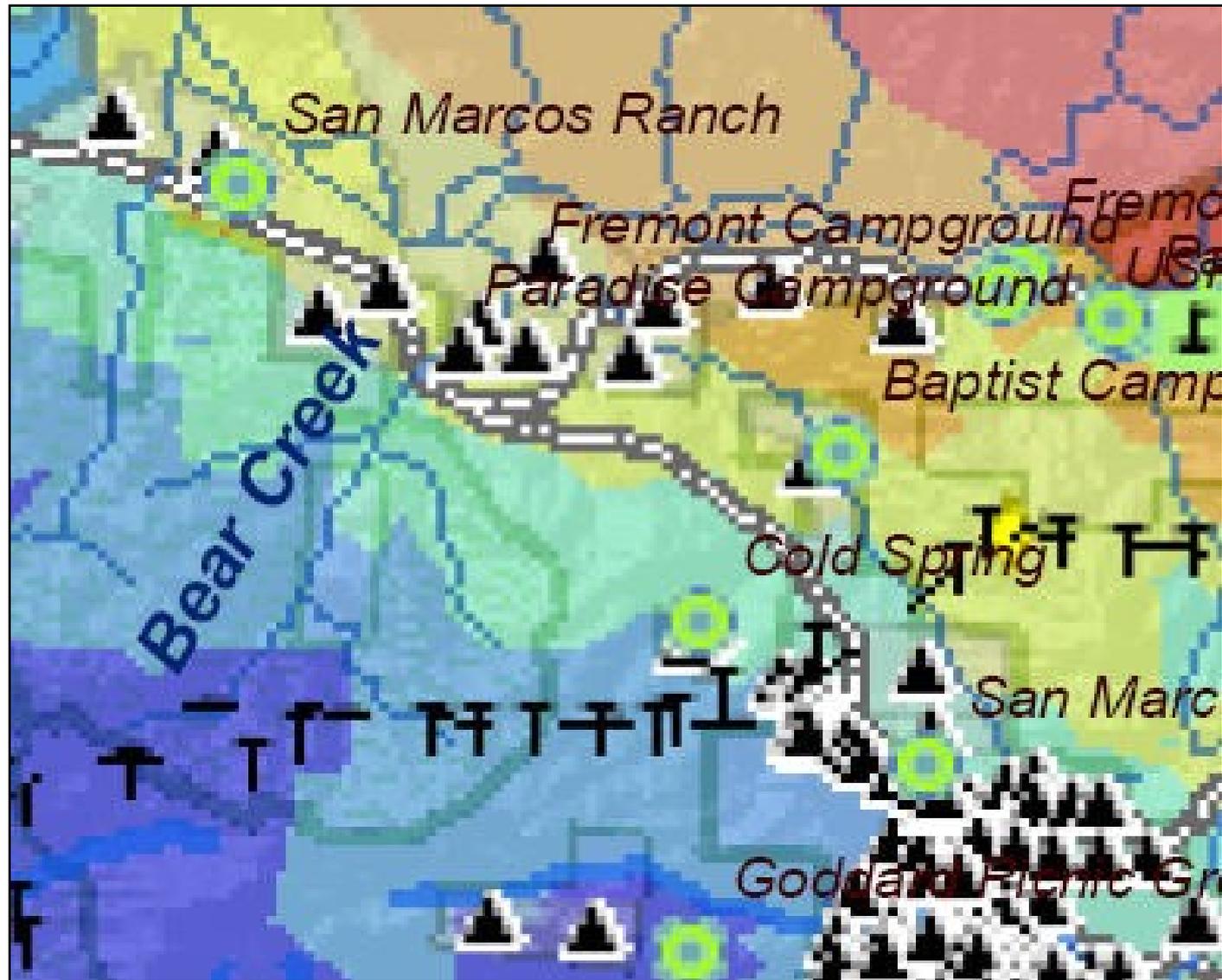
Risk Assessment

- Spatial interaction between fire likelihood and highly valued resources (HVR) is critical.
- Several challenges to evaluating the effects of wildfire on the suite of developed and natural resource values using a monetary framework.
 - Many affected resources do not have prices.
 - Spatial and temporal factors have a strong influence on physical impacts.
 - Limited benefit transfer opportunities.

RAVAR Map - Integrates FSPro with Critical Infrastructure Values at Risk

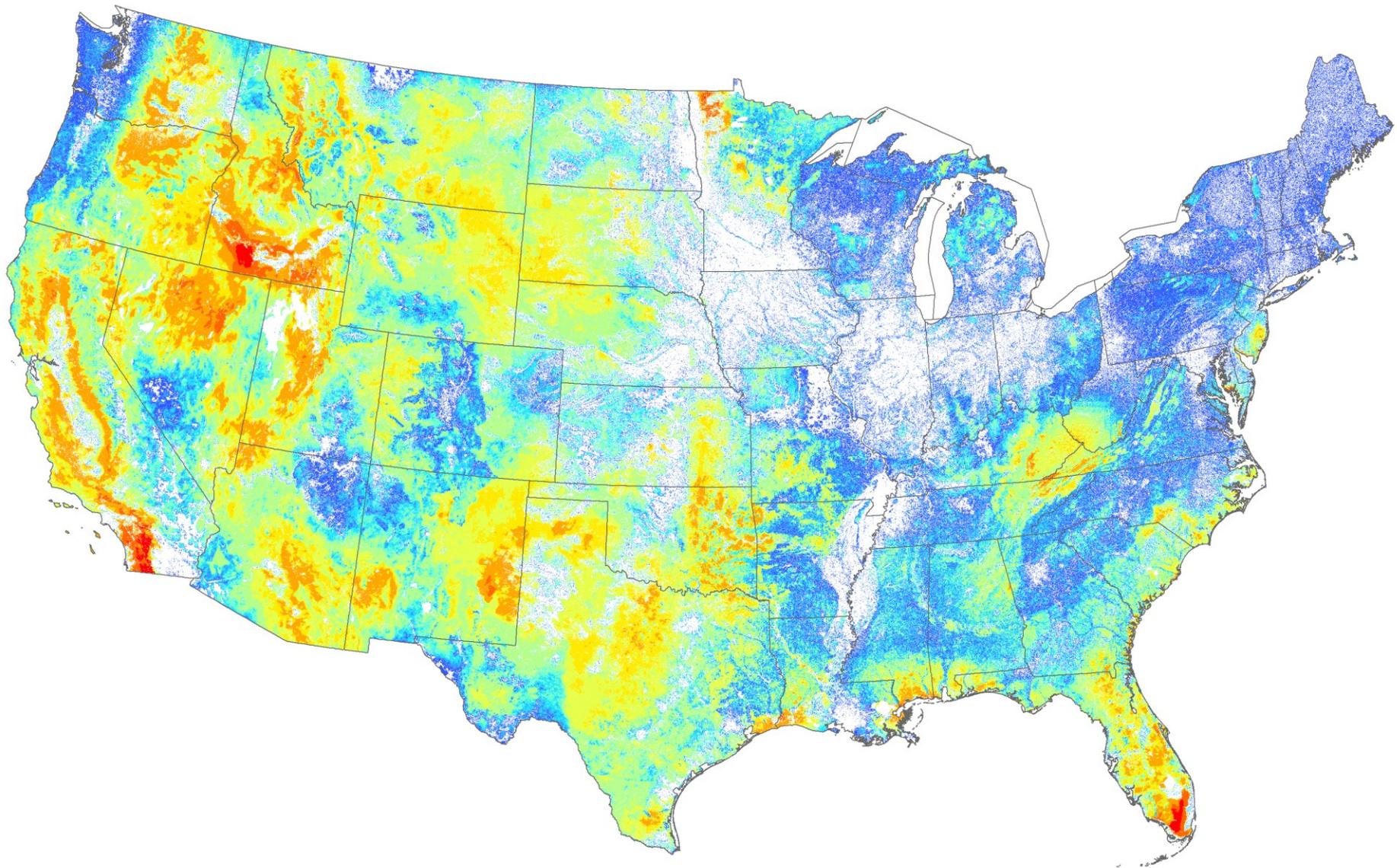


Values at Risk

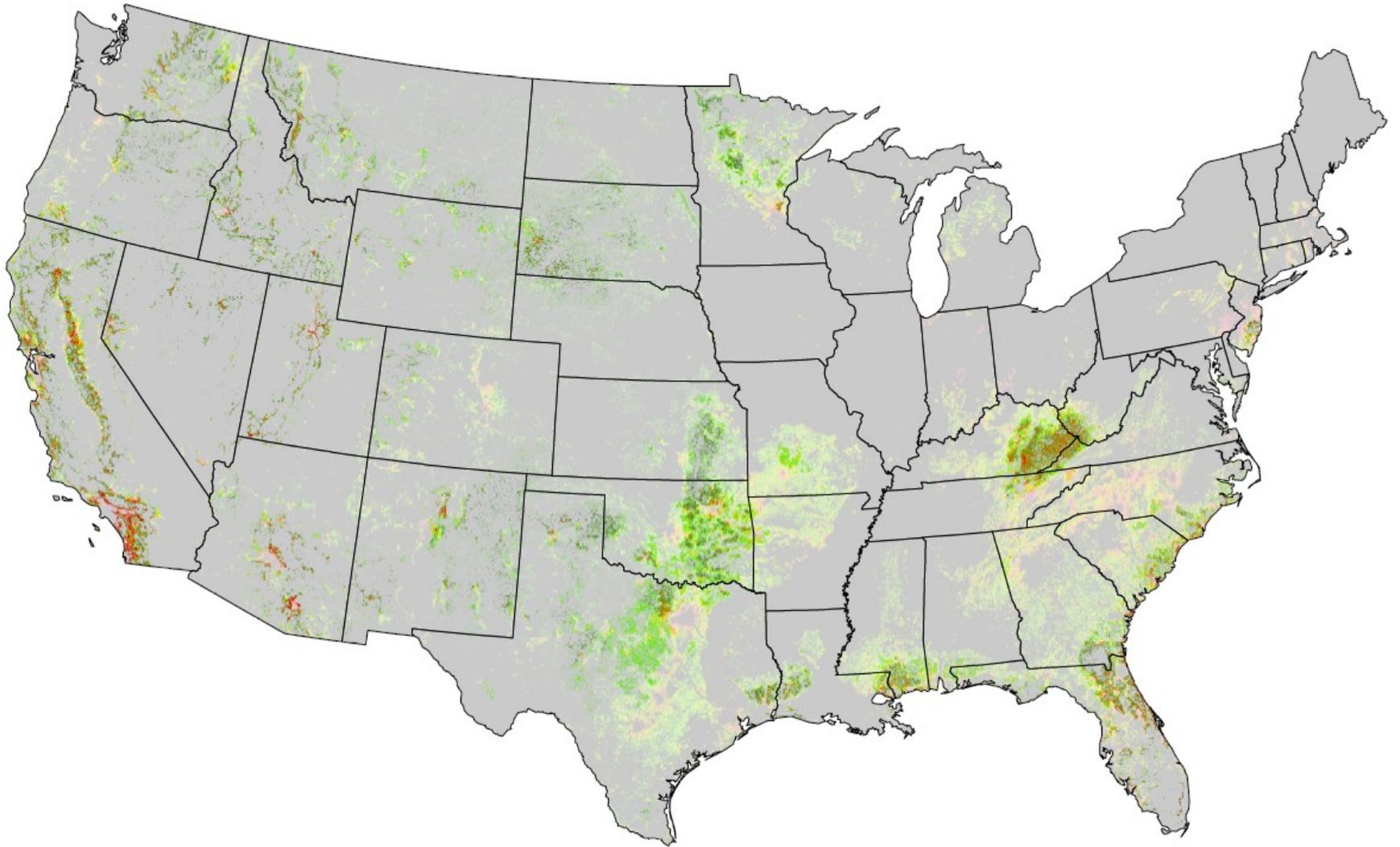


Estimating WUI exposure to future wildfires

- Previous national scale WUI maps based on intersection of homes and vegetation – no indication of fire potential
- Expanded WFDSS methodology by linking potential future fire likelihood with residential population at 270m resolution



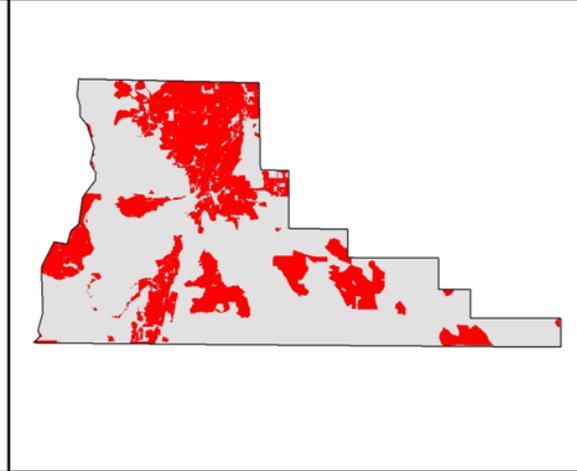
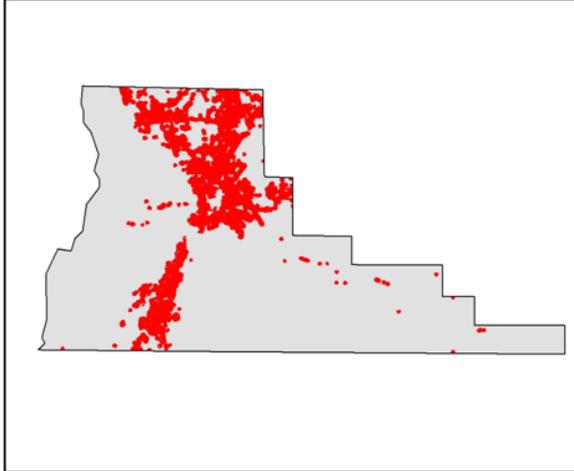
National Burn Probability from FSIM



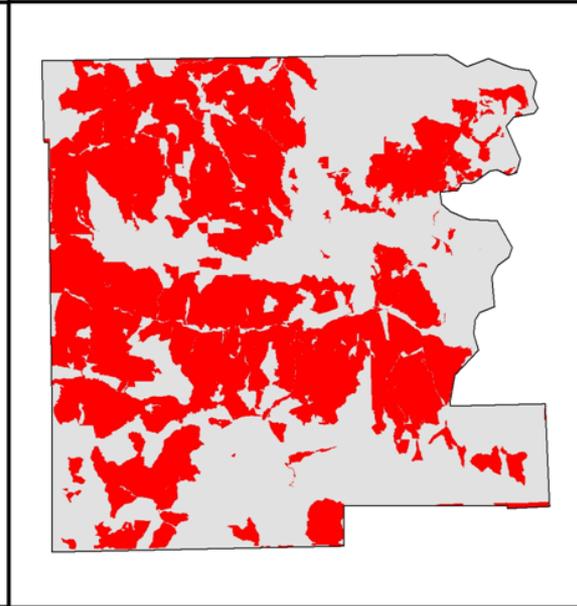
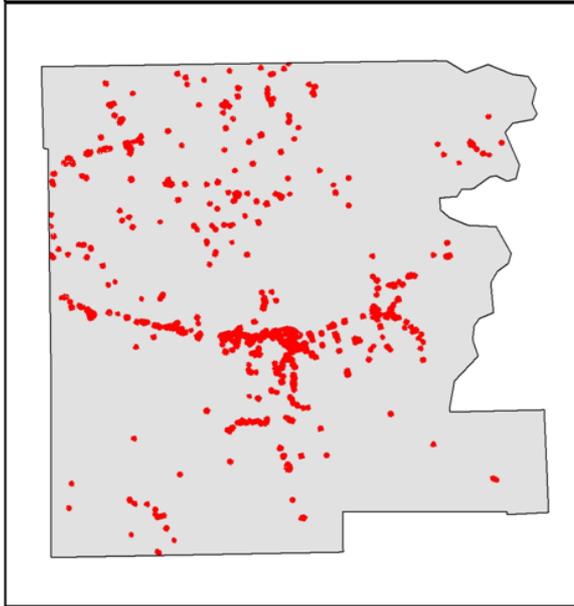
RDPA WUI

SILVIS WUI

Deschutes County, OR

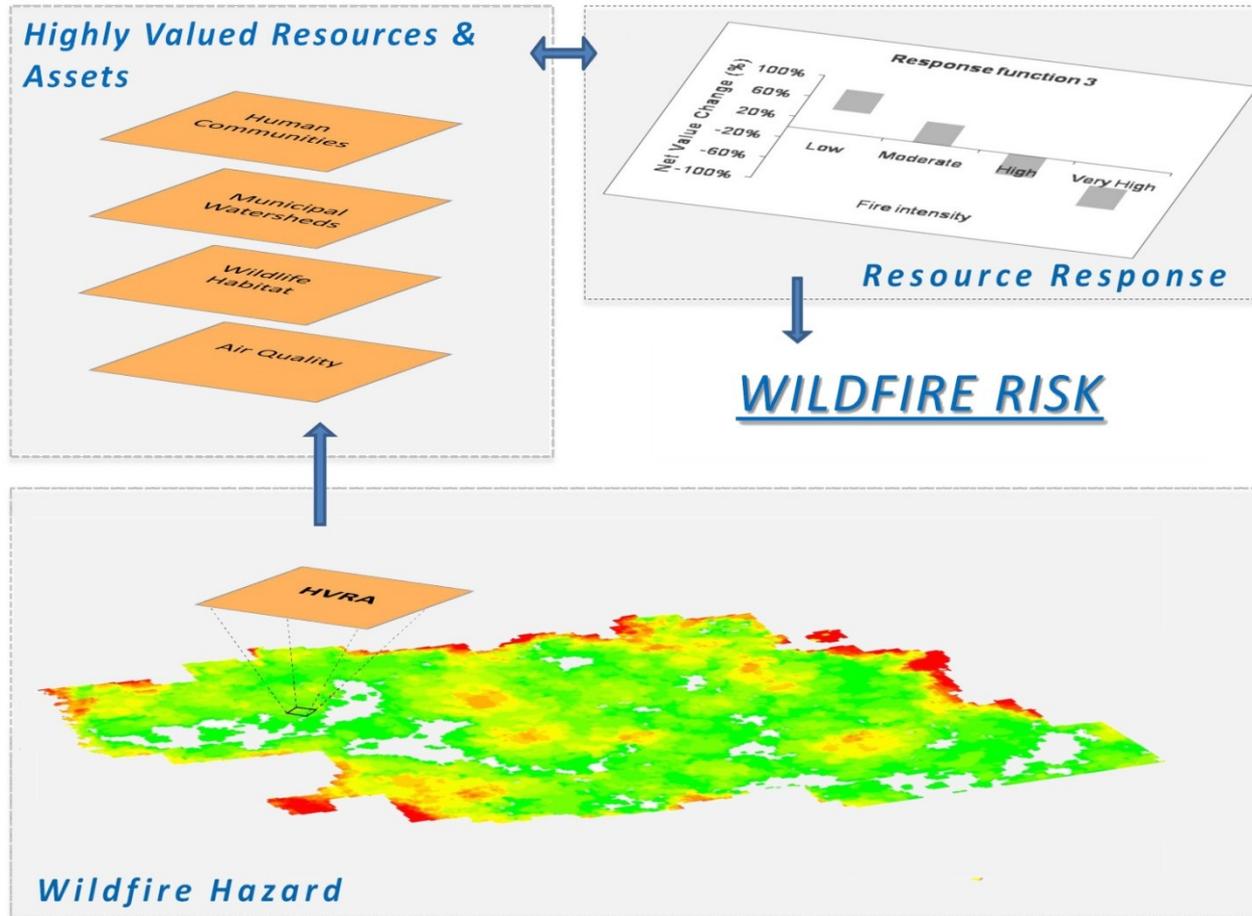


Grant County, OR

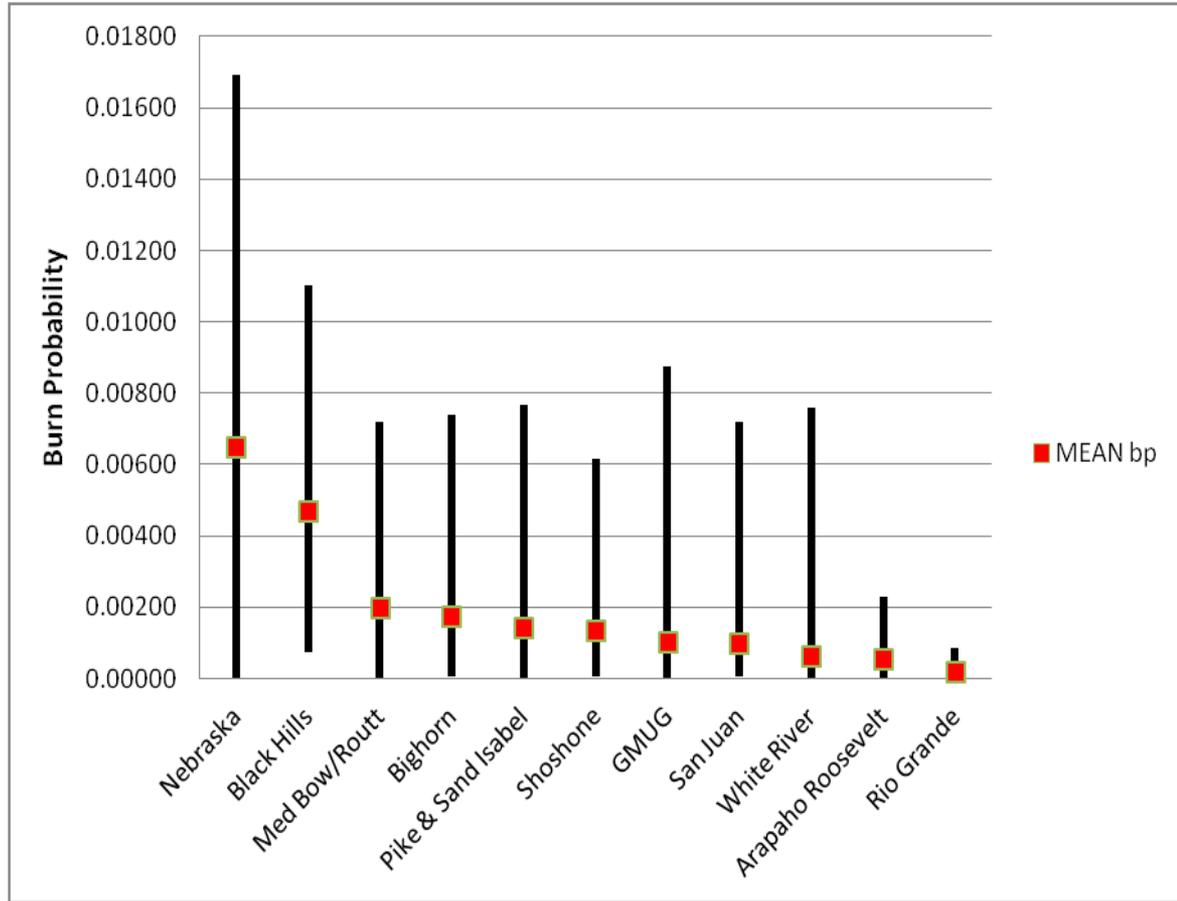
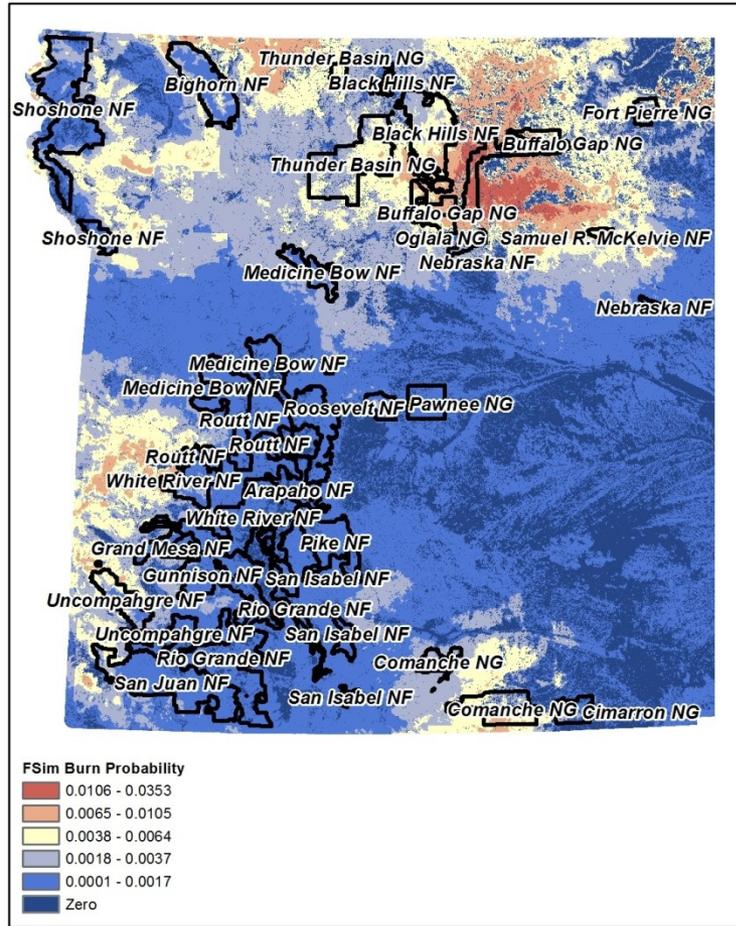


WUI FIRE RISK	COUNTY	Low Population Density	Medium Population Density	High Population Density
		Low BP	Cleveland, OK	24%
	Los Angeles, CA	5%	2%	5%
Medium BP	Cleveland, OK	0.3%	1%	0.3%
	Los Angeles, CA	3%	2%	5%
High BP	Cleveland, OK	0%	0%	0%
	Los Angeles, CA	6%	3%	4%
NO RISK	Cleveland, OK	24%		
	Los Angeles, CA	65%		

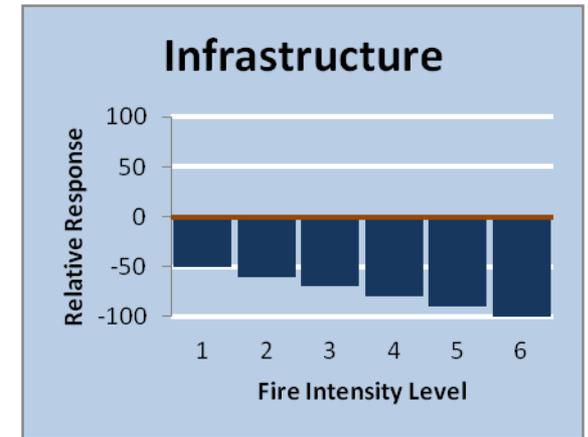
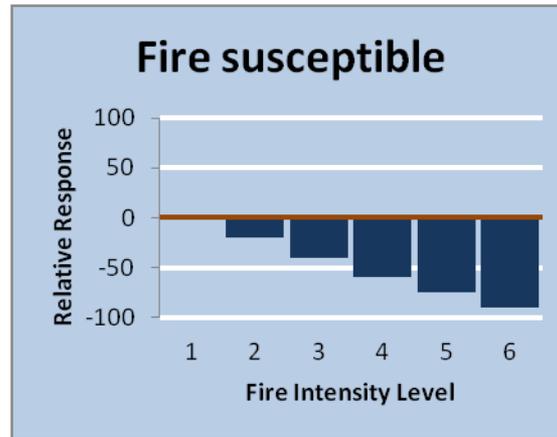
Integrated Risk Assessment



Burn Probability



Defining Response Functions (Resource Specialists)



Description:

Strong benefit at low fire intensity decreasing to a strong loss at very high fire intensity.

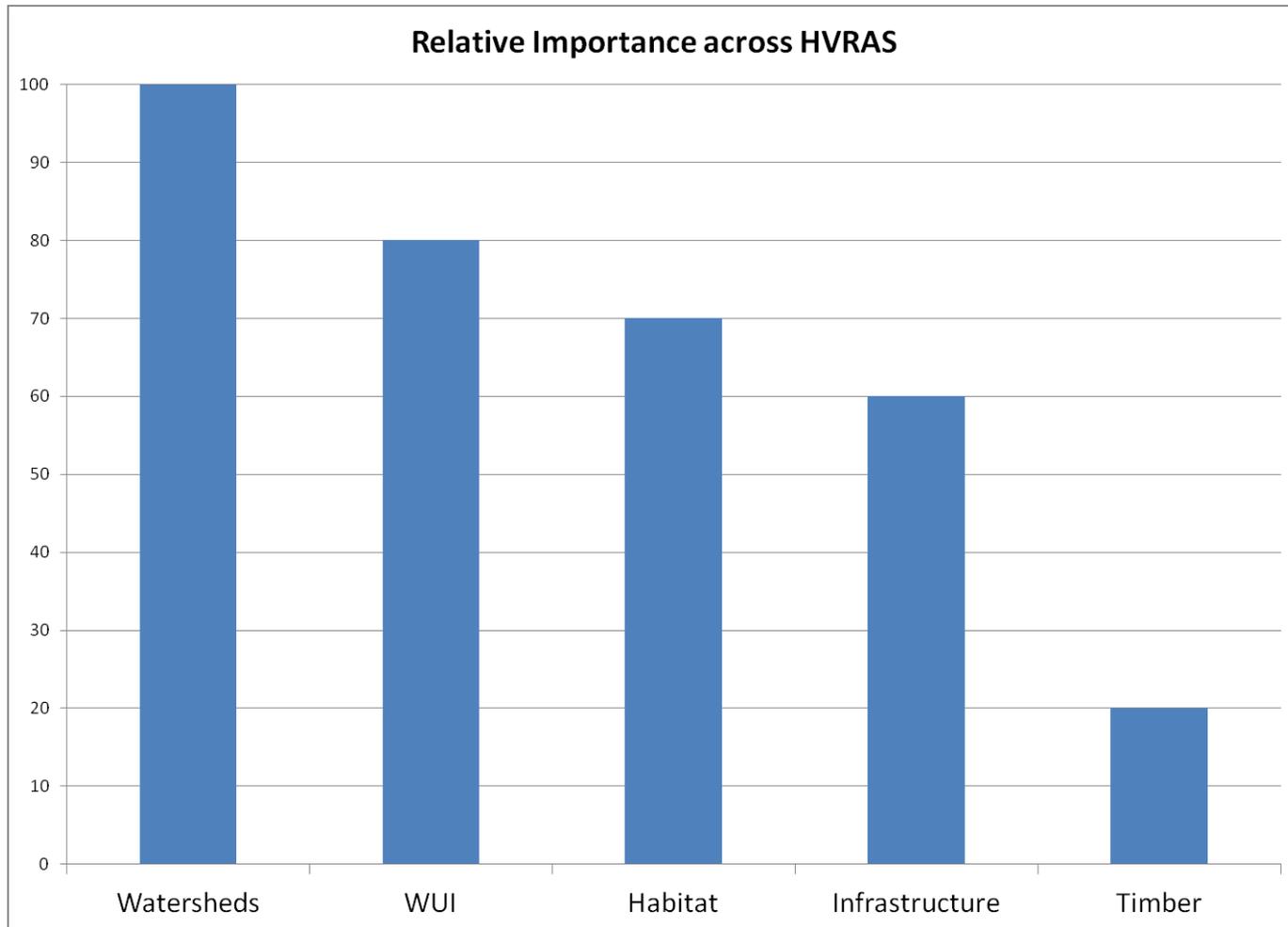
Description:

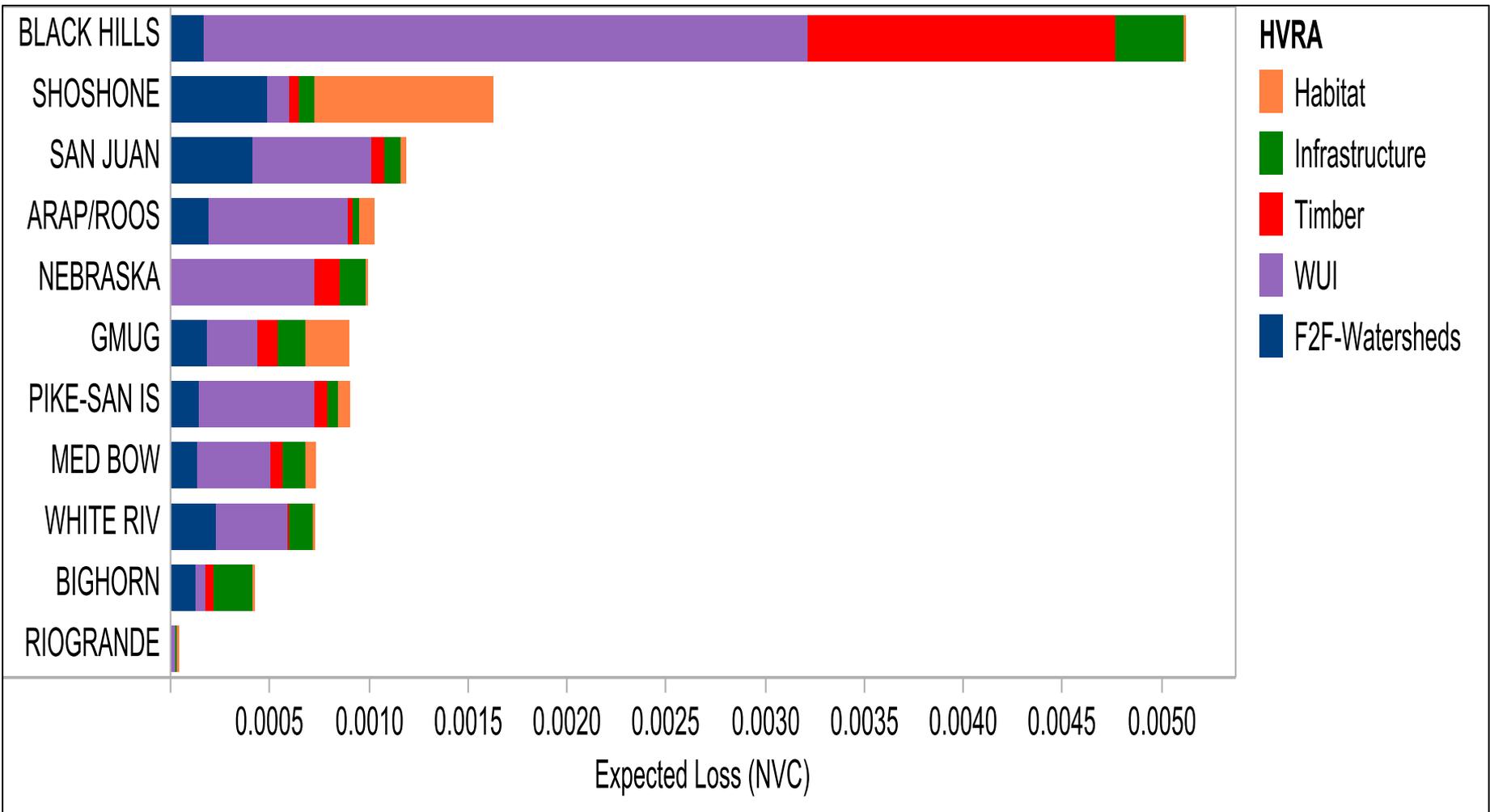
Loss increases from slight loss at low intensity to strong loss at very high intensity.

Description:

Moderate to strong loss as fire intensity increases.

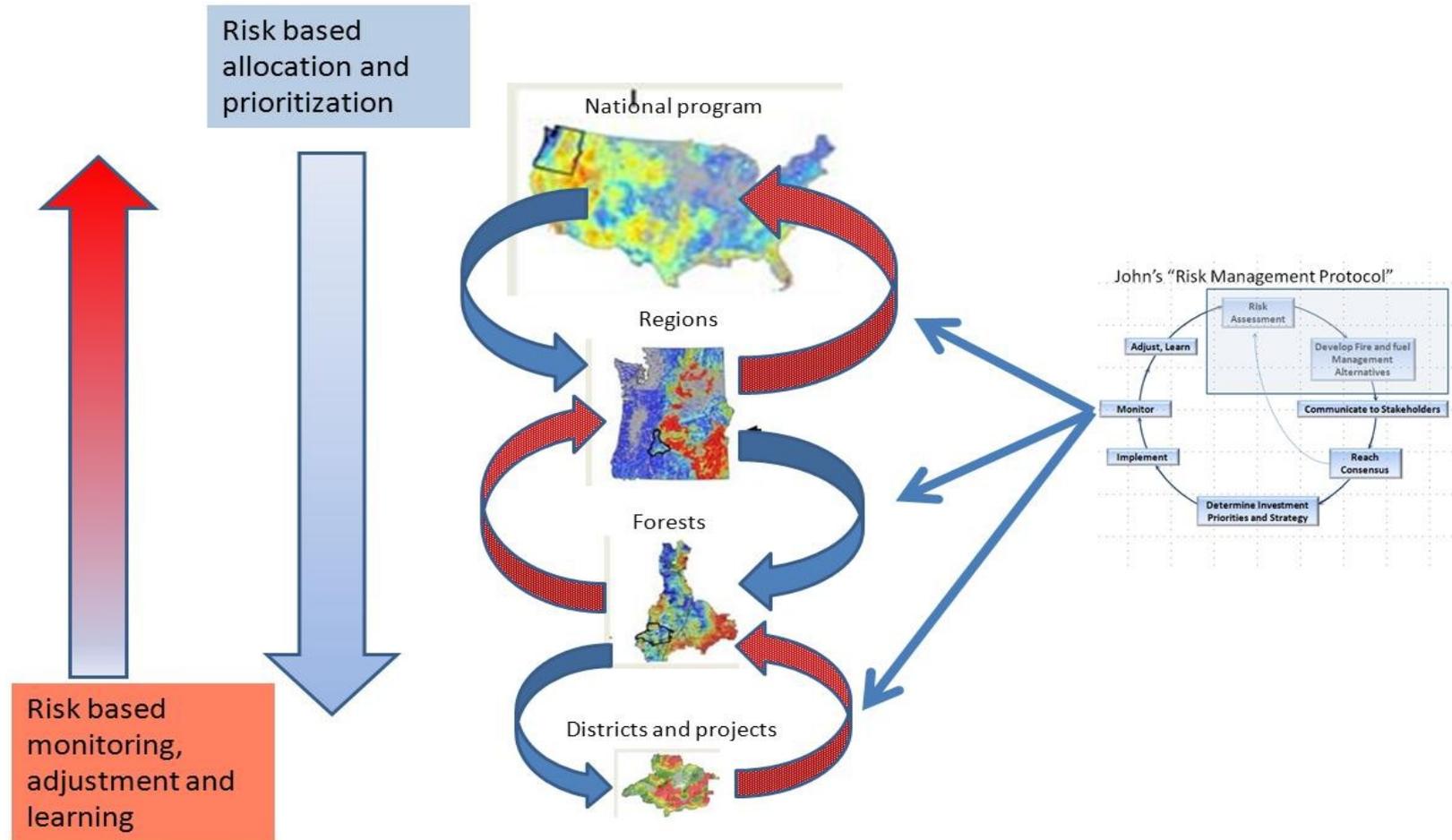
HVRA Relative Importance (RI) (Forest Leadership)





Adaptive Risk Management

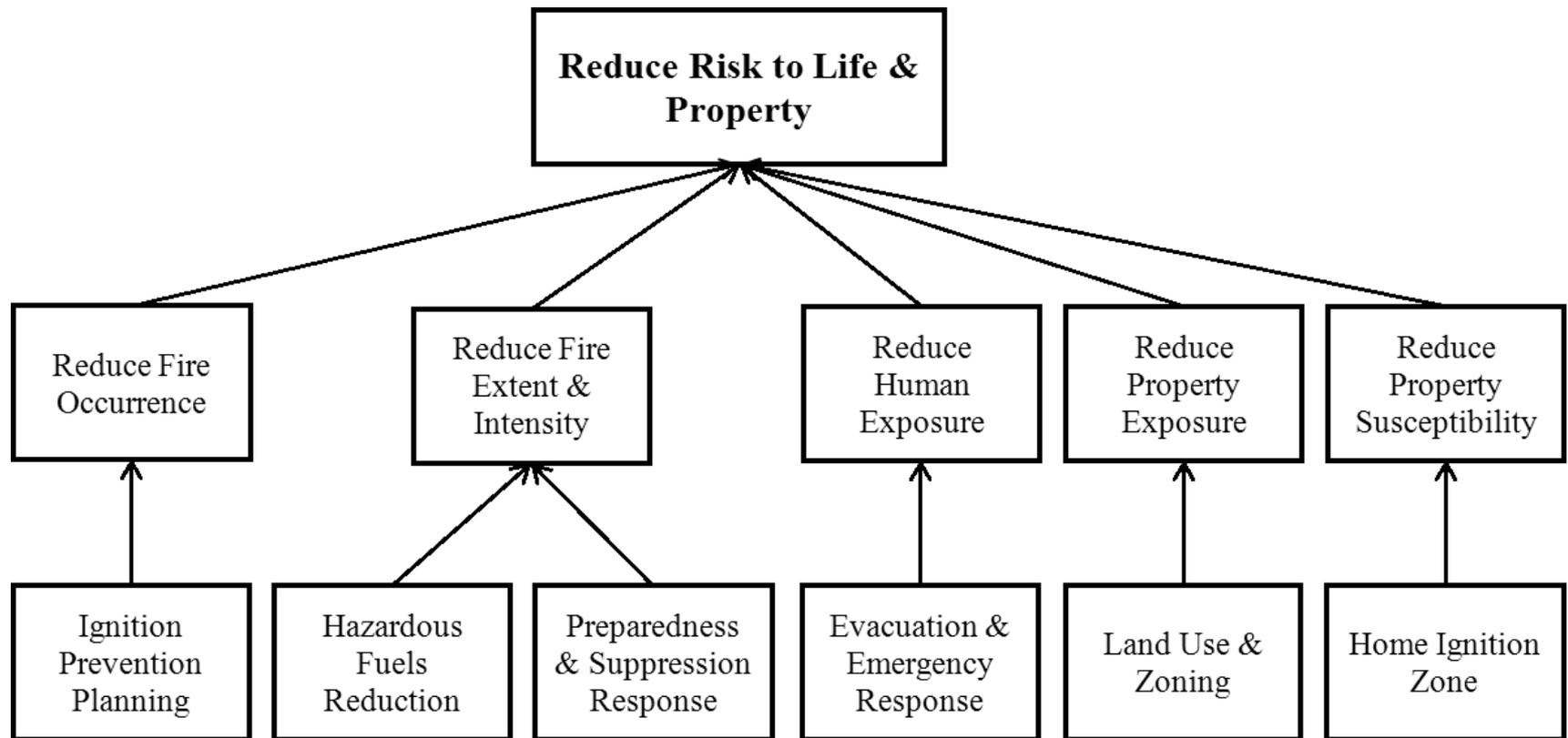
National Level Funding to Project Implementation



Wildfire Mitigation

- Wildfire management focuses on mitigating risk before, during and after wildfire events.
- Defining what risk factor a specific program or activity addresses is critical in appropriately framing the economic efficiency of risk reduction activities.
- Mitigation efforts need to alter fire outcomes under the reference conditions – the wildfire conditions where loss occurs.

Fire Adapted Communities



Fuel Treatment to reduce WUI Risk

- Strong political emphasis on fuels investments within the WUI.
- Unlikely that treatments in the Western US will be sufficiently funded to achieve significant reduction in large fire spread over broad landscapes.
- Treatments near WUI create many challenges – increased cost, smoke and aesthetic concerns, risk or Rx fire escape
- HIZ – is where WUI loss is defined yet is privately owned.





Risk sharing in the WUI

- Fire adapted communities is a primary goal of the Cohesive Strategy.
- Risk sharing is being recognized among partners as central to achieving this goal.
- Define the problem - who has control and responsibility for the risk component to be mitigated and what is the relative cost effectiveness of action?
- Risk transfer can significantly reduce mitigation opportunities.



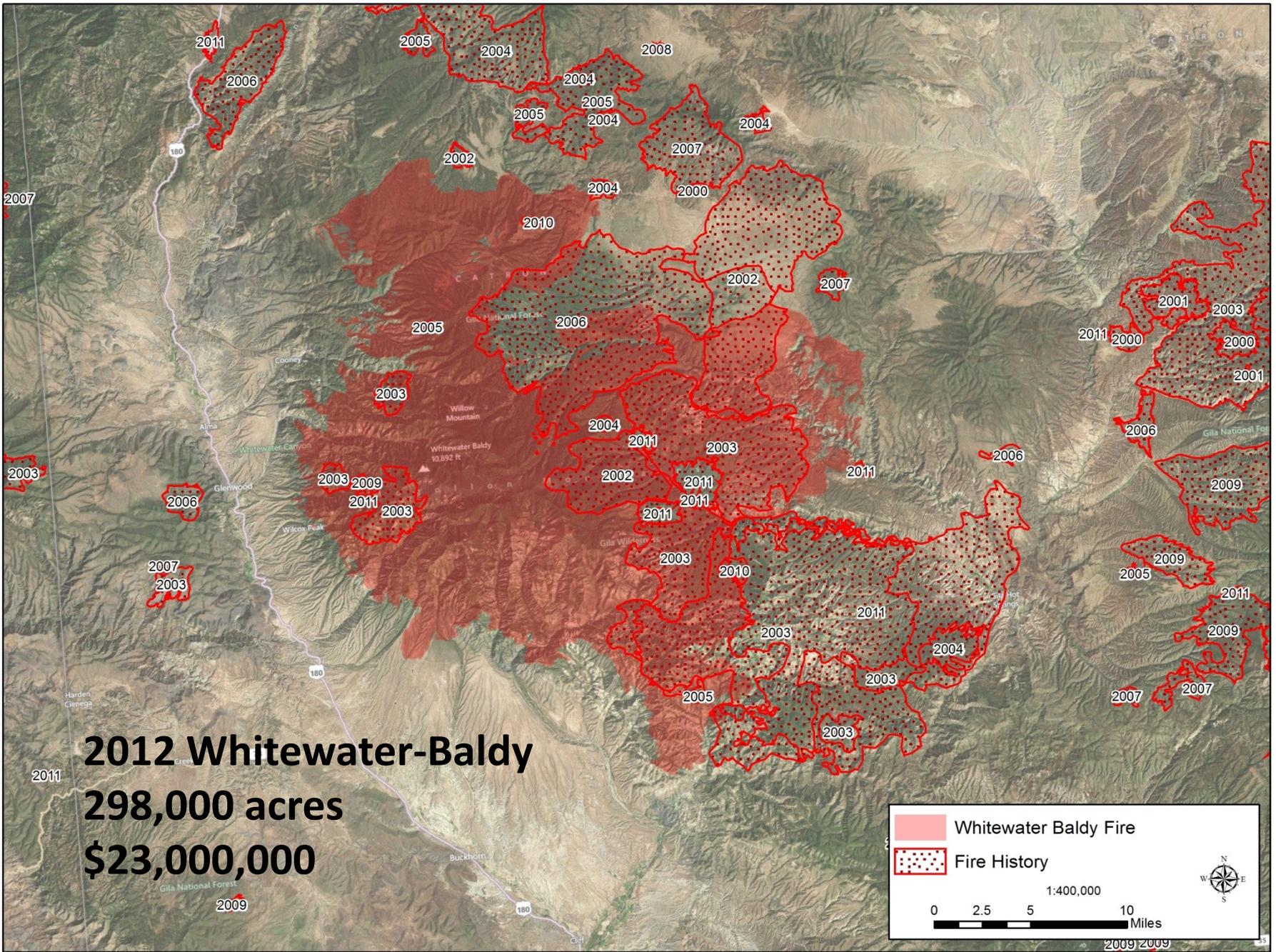


Community Engagement in Wildfire Risk Mitigation

- Improved understanding of community engagement and drivers of homeowner mitigation activities.
- However, the sufficiency of homeowner mitigation has not been well studied.
- Mitigation may not be economically efficient response in many cases.
- Is the focus on at risk communities in public land management investments appropriate?

The Value of Wildfire

- Beneficial impacts of fire have been difficult to quantify
 - Ecological benefit
 - And/or fuel treatment benefit
 - Challenging to consider spatial and temporal interactions given an uncertain future
- Scale of wildfires relative to most fuel prescriptions can greatly facilitate successful large fire management



2012 Whitewater-Baldy
298,000 acres
\$23,000,000

Whitewater Baldy Fire

Fire History

1:400,000

0 2.5 5 10 Miles

2009 2009

Fizzling Out

The Beaver Creek fire, which has been burning since Aug. 7, was heading toward the Sun Valley area of central Idaho. But the flames are starting to die out as they reach the area already burned by the Castle Rock fire in 2007.



Managerial Risk Tolerance

“Because adherence to standard operating procedures is hard to second guess, decision makers who expect to have their decisions scrutinized with hindsight are driven to bureaucratic solutions – and to extreme reluctance to take risk”

Thinking Fast and Slow (Kahneman, 2011)

Management Incentives

- Much of the variation in wildfire cost cannot be explained by characteristics of the physical fire environment.
- Zero opportunity cost associated with increased suppression expenditure.
- Partners concerns are foremost in framing line officer's wildfire risk problem –FS has done a poor job at articulating public land values.
- Response versus prevention - analogies to US health care.

Decision Biases

- Status Quo Bias – reluctance to beneficial fire use and aversion to new strategies
- Inter-temporal discounting – future impacts are largely ignored
- Risk aversion – over investment in suppression to avoid loss
- Framing – e.g. changing how firefighters risk is portrayed changes selected strategy

How can economists help extract ourselves from the wildfire paradox?

- How do we quantify consequences of alternative fire management programs to ecosystem services?
 - Baseline is not 0 fire.
- What are the long term costs and benefits of alternative mitigation strategies? Who pays, who gains?
- What are the consequences of current and alternative incentive systems for fire managers?
- Can behavioral economics be used to encourage better fire management? Better zoning policy and private property mitigation?

What is Truly at Risk

- USFS ability to address the public land mission is being compromised by fire management costs.
- Political solutions may address budgetary impacts but will not extract us from the wildfire paradox.
- Climate change could significantly complicate future fire management given changing ecological communities, altered fire regimes, and stressed ecosystems.
- Extracting ourselves from the wildfire paradox is essential to the health of our public lands.