OPTIMIZING FUEL TREATMENTS BASED ON RISK REDUCTION AND BUDGET CONSTRAINTS

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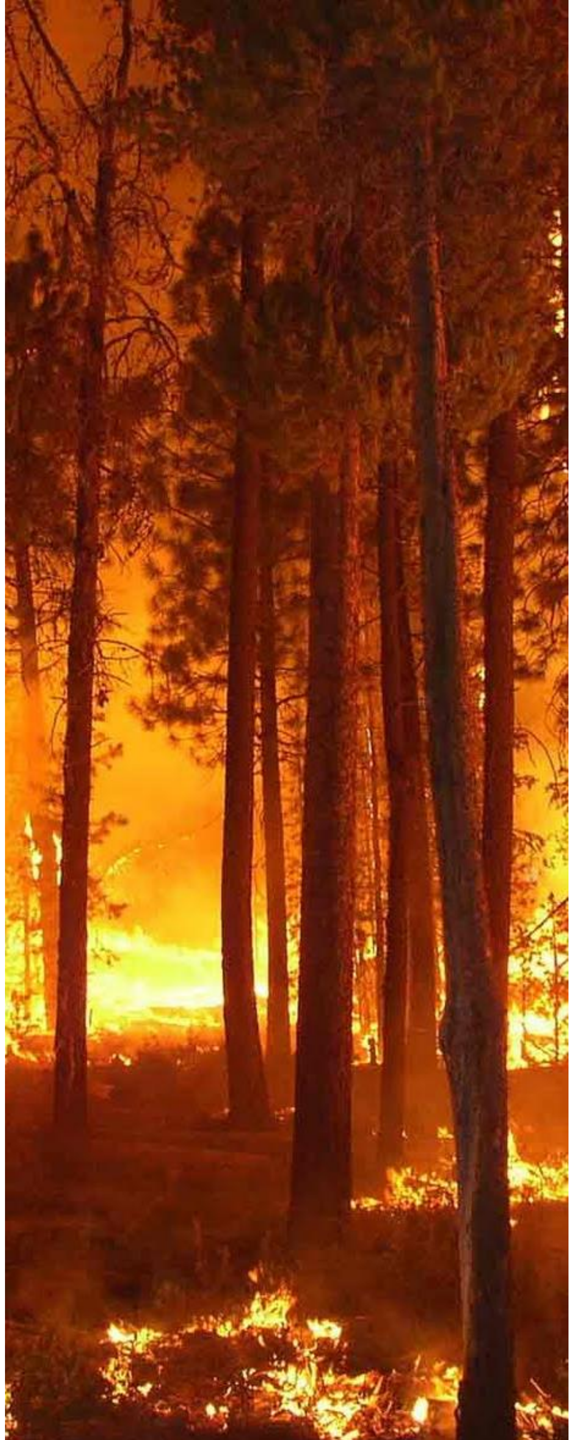
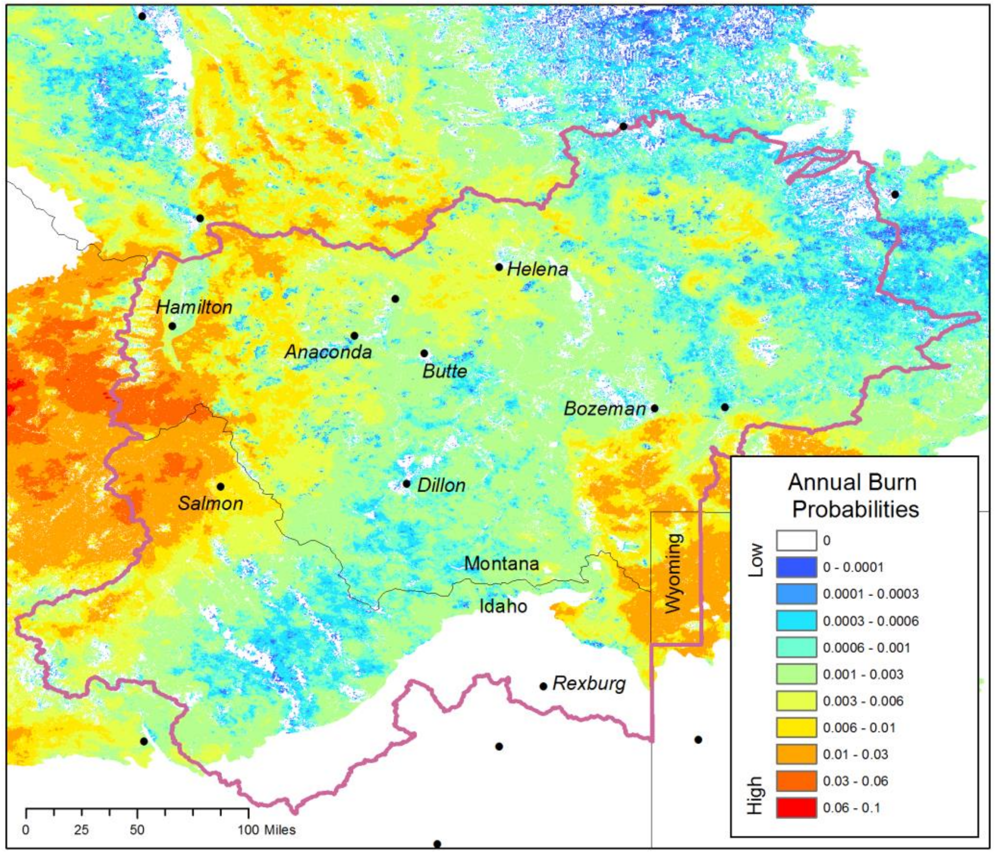
WHY USE FUEL TREATMENTS?

- Restoration of stands where timber harvest and fire exclusion have occurred
- Reduction of intensity and/or probability of future fires
- Safer areas for firefighters to work to control fires
- Etc.

- Can they be used:
  - To reduce risk to highly valued resources?
  - To produce savings in preparedness and suppression costs?



INVESTIGATING THESE QUESTIONS USING FIRE SIMULATION MODELING (FSIM)



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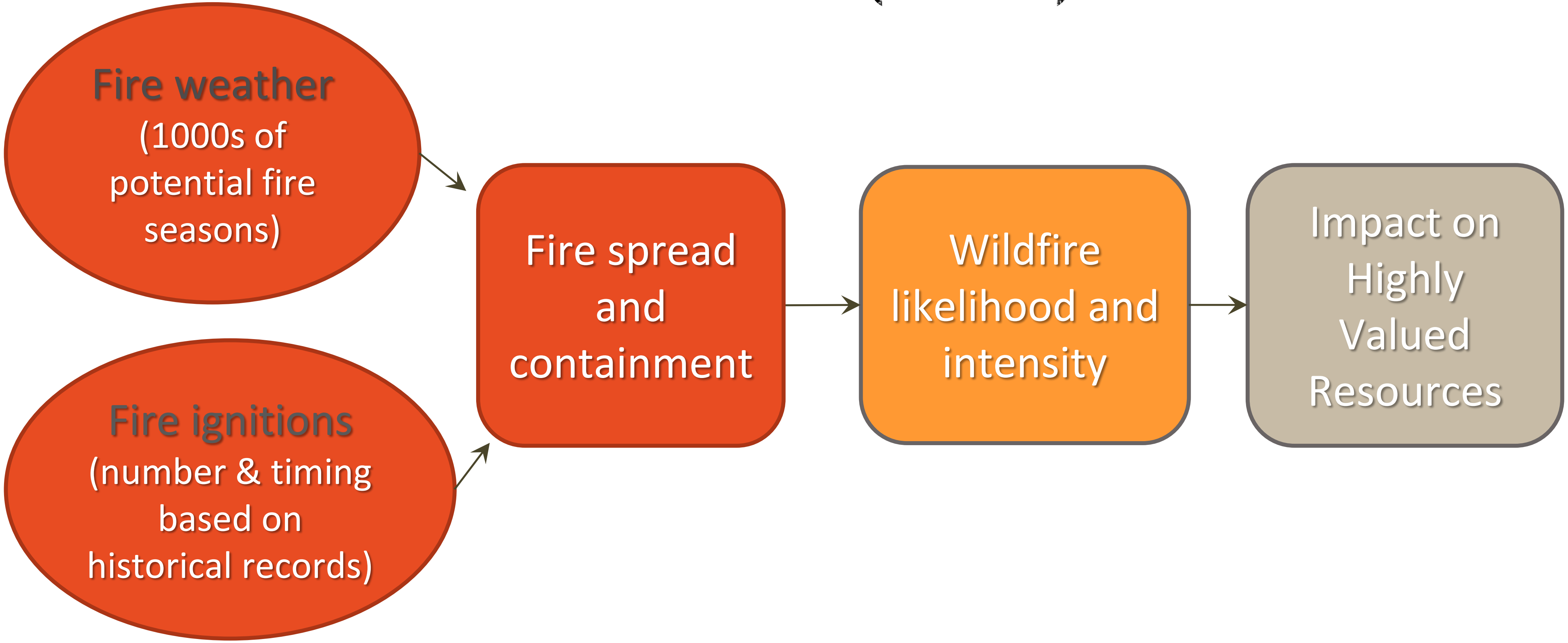
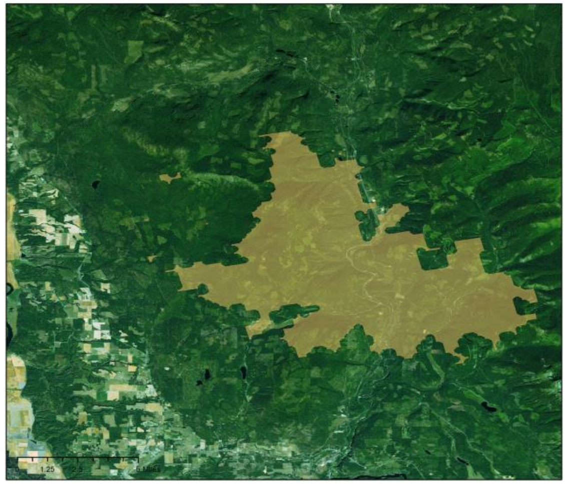


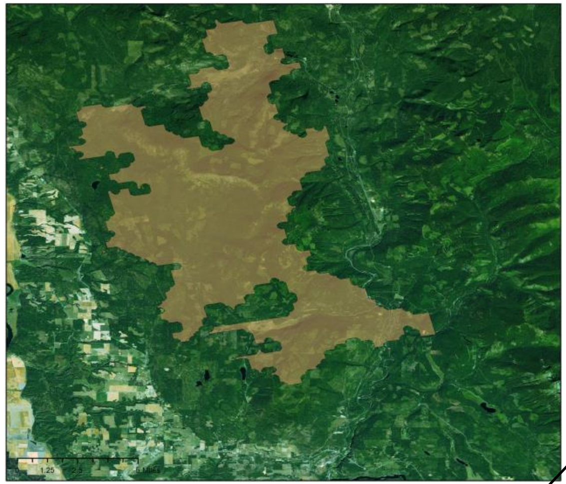
Finney, Mark A., Charles W. McHugh, Isaac C. Grenfell, Karin L. Riley, and Karen C. Short. 2011. A simulation of probabilistic wildfire risk components for the continental United States. Stochastic Environmental Research and Risk Assessment 25(7), 973-1000.

ANNUAL BURN PROBABILITY IN FSIM

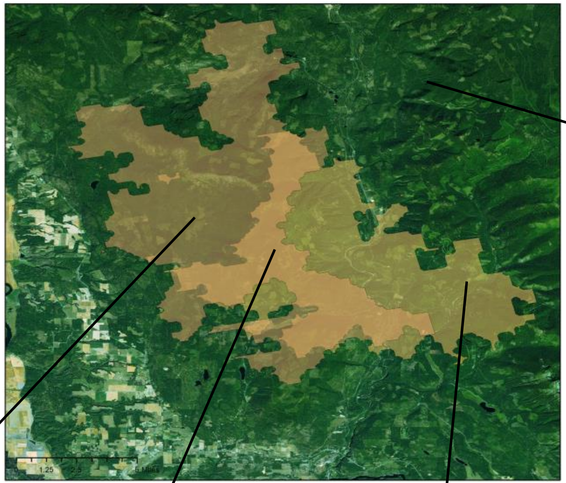
Year 1



Year 2



Year 1 & 2



0 out of 2 chance of burning = 0% = 0.0

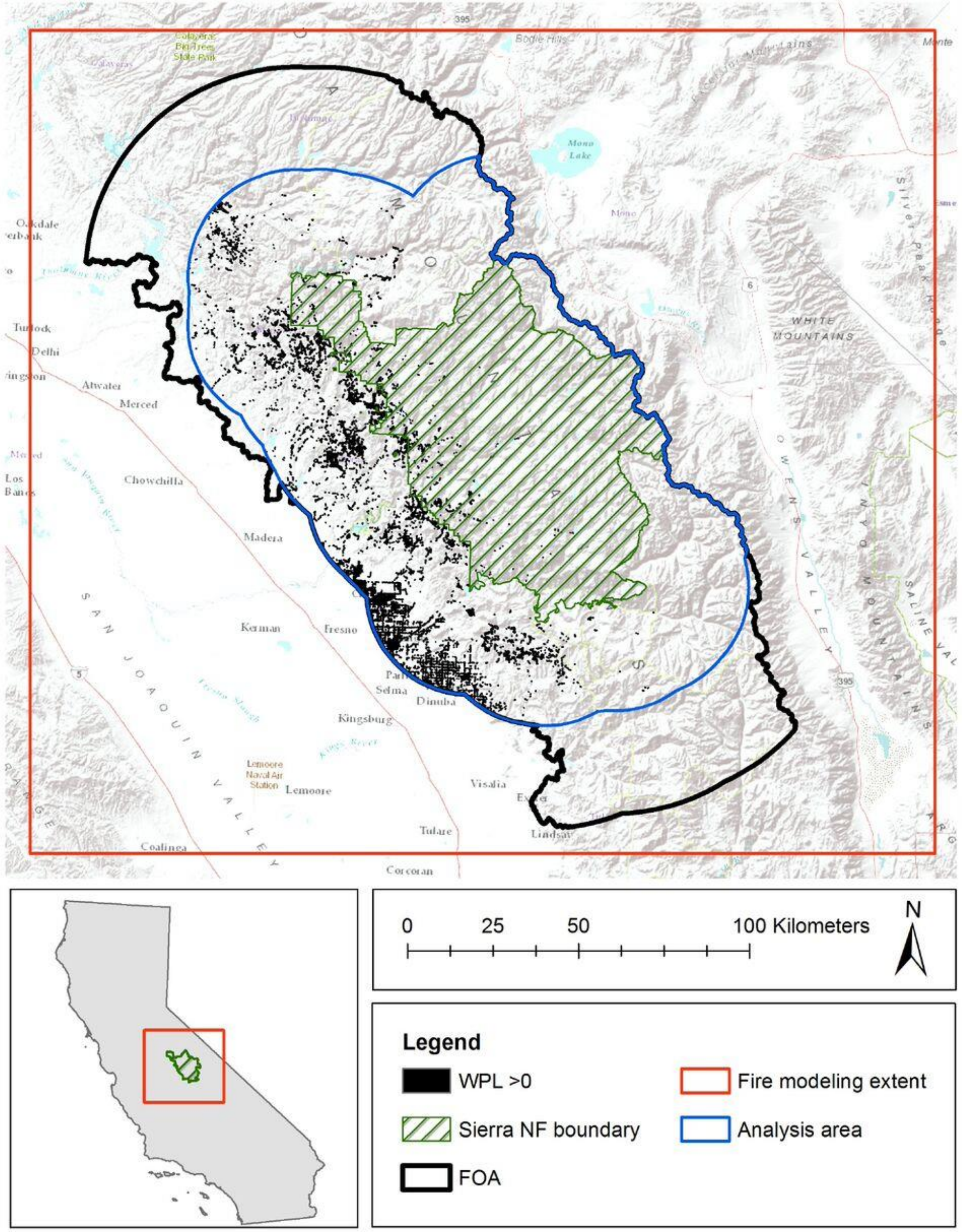
1 out of 2 chance of burning = 50% = 0.5

2 out of 2 chance of burning = 100% = 1.0

1 out of 2 chance of burning = 50% = 0.5

STUDY AREA: SIERRA NATIONAL FOREST

- Part of broader Southern Sierra Risk Assessment
- Well-studied area
  - fuel treatment opportunities and backlog (North et al)
  - fuel treatment opportunities (Scott et al.)
  - spatial response planning (Thompson et al.)



MECHANICAL FUEL TREATMENTS

Treatment = meant to simulate a combination of mechanical and Rx fire to reduce flame length and crown fire potential (after Scott et al 2016)

Canopy cover: only where greater than 35%, mild reductions of 5-20% proportional to cover

Canopy bulk density: reduced by 0.75

Canopy base height: raised to 1.5 times the current level, with a minimum of 2m

Fuel model: changed to reduce intensity and/or rate of spread (grass not treated as it can quickly regrow)

Scott, Joe H., Matthew P. Thompson, and Julie W. Gilbertson-Day. 2016. *Examining alternative fuel management strategies and the relative contribution of National Forest System land to wildfire risk to adjacent homes – A pilot assessment on the Sierra National Forest, California, USA*. Forest Ecology and Management 362: 29-37.

FUEL TREATMENT SCENARIOS

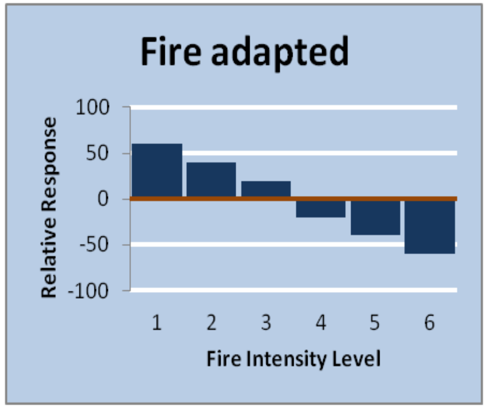
- treat all feasible pixels
- choose places to treat based on risk to highly valued resources at four different budget levels
  - $10 million
  - $20 million
  - $30 million
  - $40 million
- consider wildfire as a form of fuel treatment

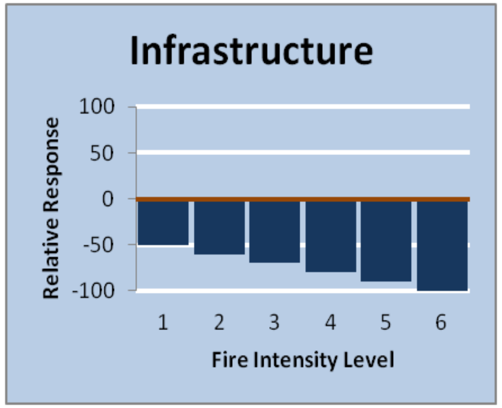
HIGHLY VALUED RESOURCES OF THE SIERRA N.F.

- Human habitation
- Inholdings (private timber companies and state land)
- Major infrastructure (e.g. transmission lines)
- Recreation-administration infrastructure
- Scenic byways
- Habitat (sage grouse, owl, fisher, goshawk)
- Timber
- Watershed
- Vegetation condition (is there enough or too little of a certain type of vegetation?)

GAUGING RISK TO HIGHLY VALUED RESOURCES

- Conditional Net Value Change = the change in Highly Valued Resources expected if the pixel burns

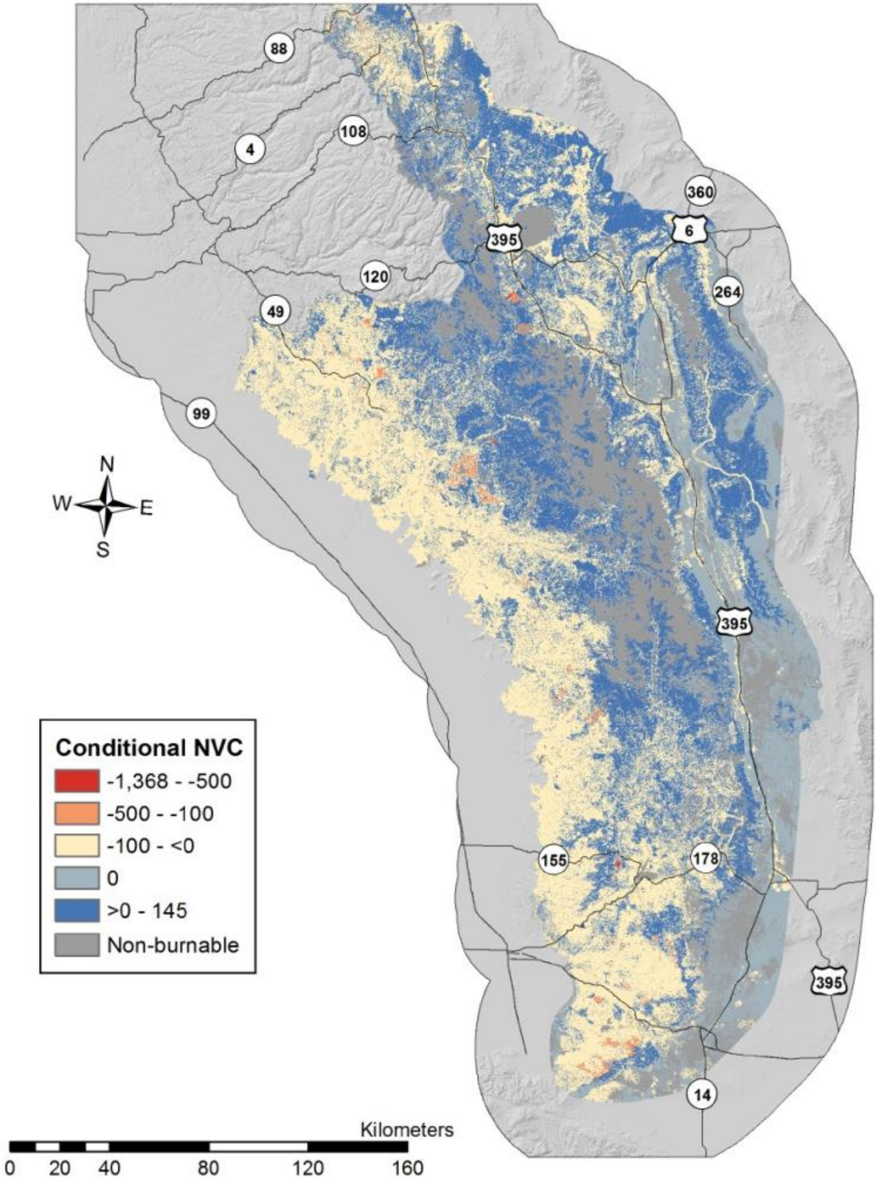




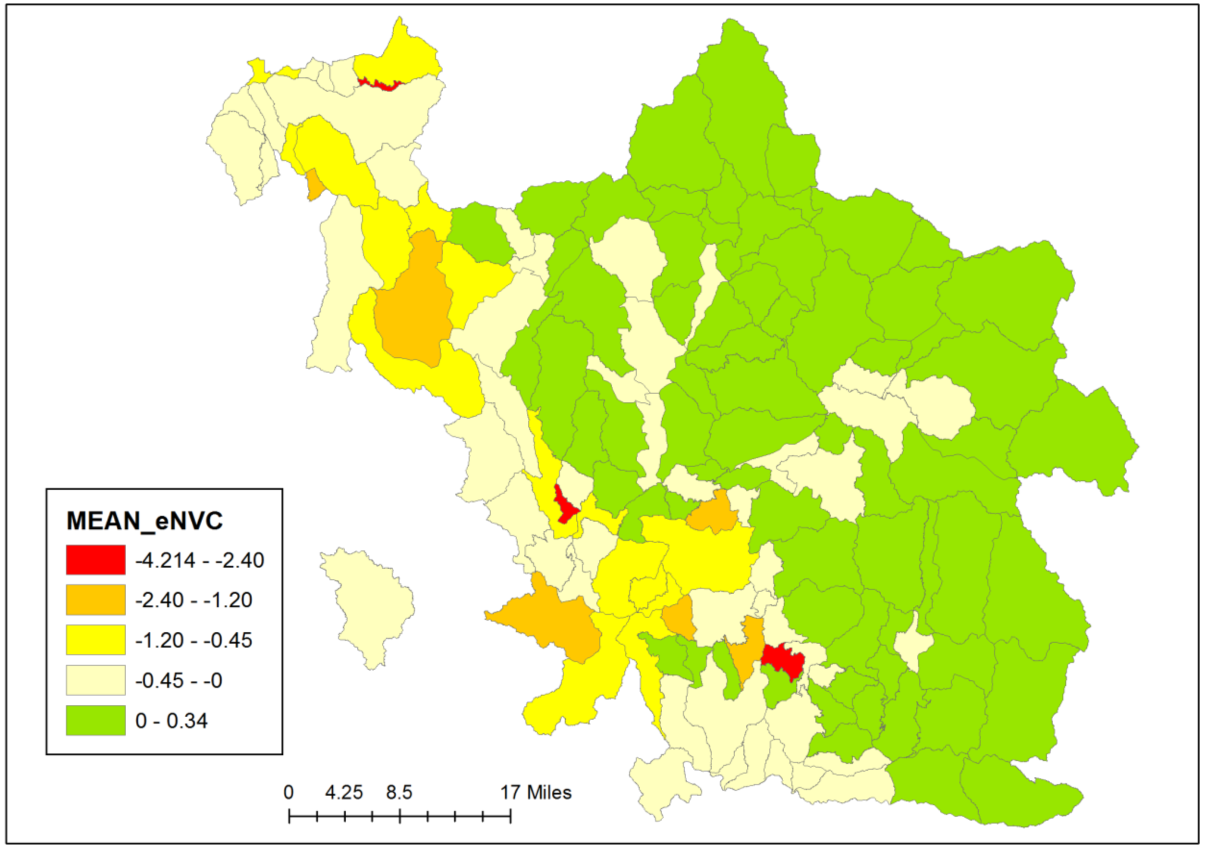
Description: Strong benefit at low fire intensity decreasing to a strong loss at very high fire intensity.

Description: Moderate to strong loss as fire intensity increases.

$$cNVC = \sum_{i}^{n} FLP_i * RF_i$$



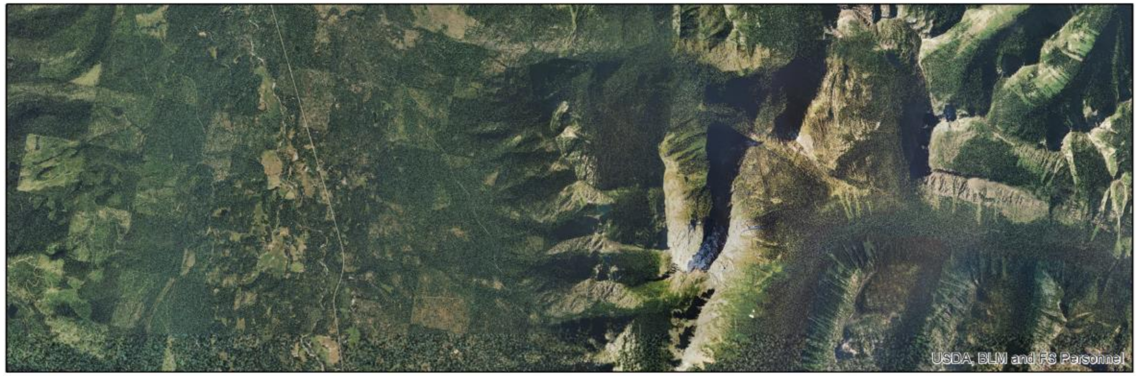
DECIDING WHERE TO TREAT

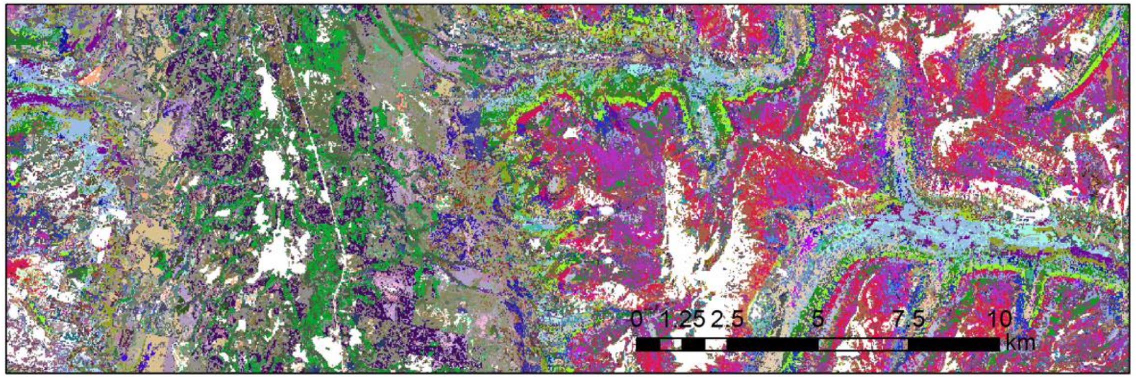


- Potential Operational Delineations (PODs) are areas within which a fire might be expected to be contained
- We calculated the mean Net Value Change for each POD
- Treatments were prioritized where resources were most negatively affected by fire

CALCULATING TREATMENT COSTS

- Number, size, and species of trees at each pixel taken from tree list for the western US
- Applied a thin-from-below in the Forest Vegetation Simulator (FVS) to determine which trees would be cut
- Treatment costs determined by the Fuel Reduction Cost Simulator (FRCS)

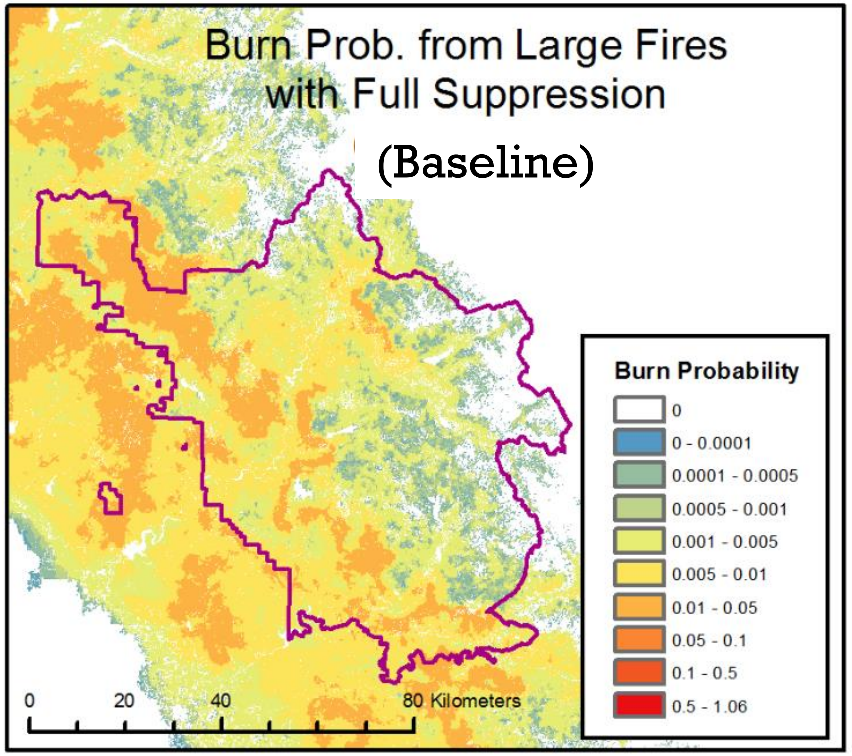




Riley, Karin L., Isaac C. Grenfell, and Mark A. Finney. 2016. Mapping forest vegetation for the western United States using modified random forests imputation of FIA forest plots. Ecosphere 7(10), 1-22.

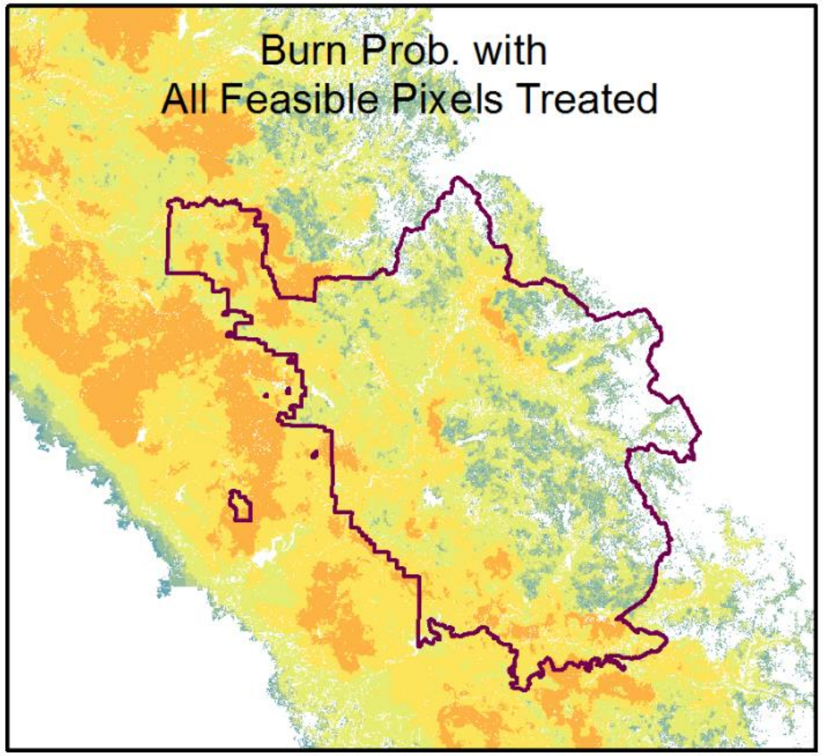
BURN PROBABILITY RESULTS

Mean=0.0048

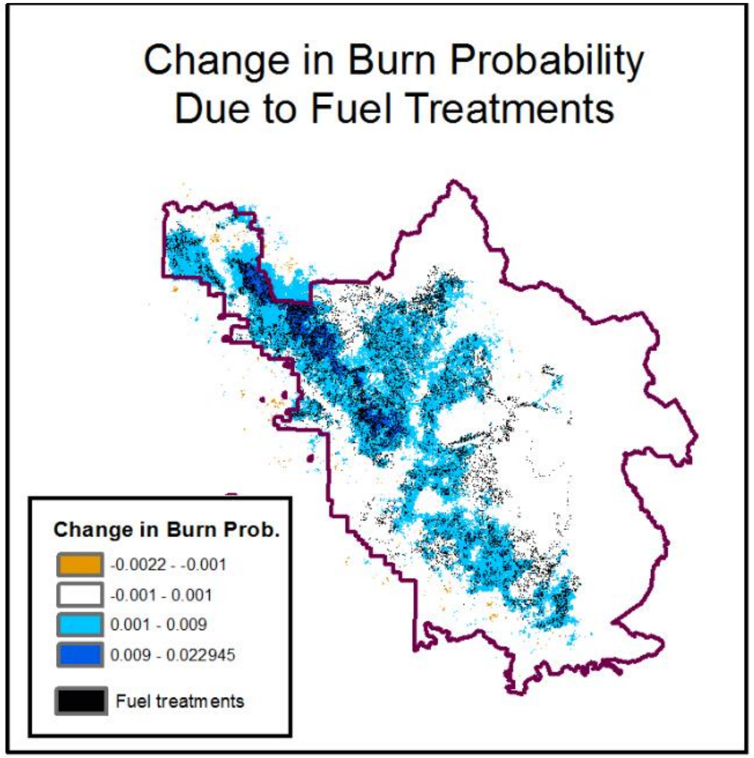


Median fire
size=992 acres

Mean=0.0036

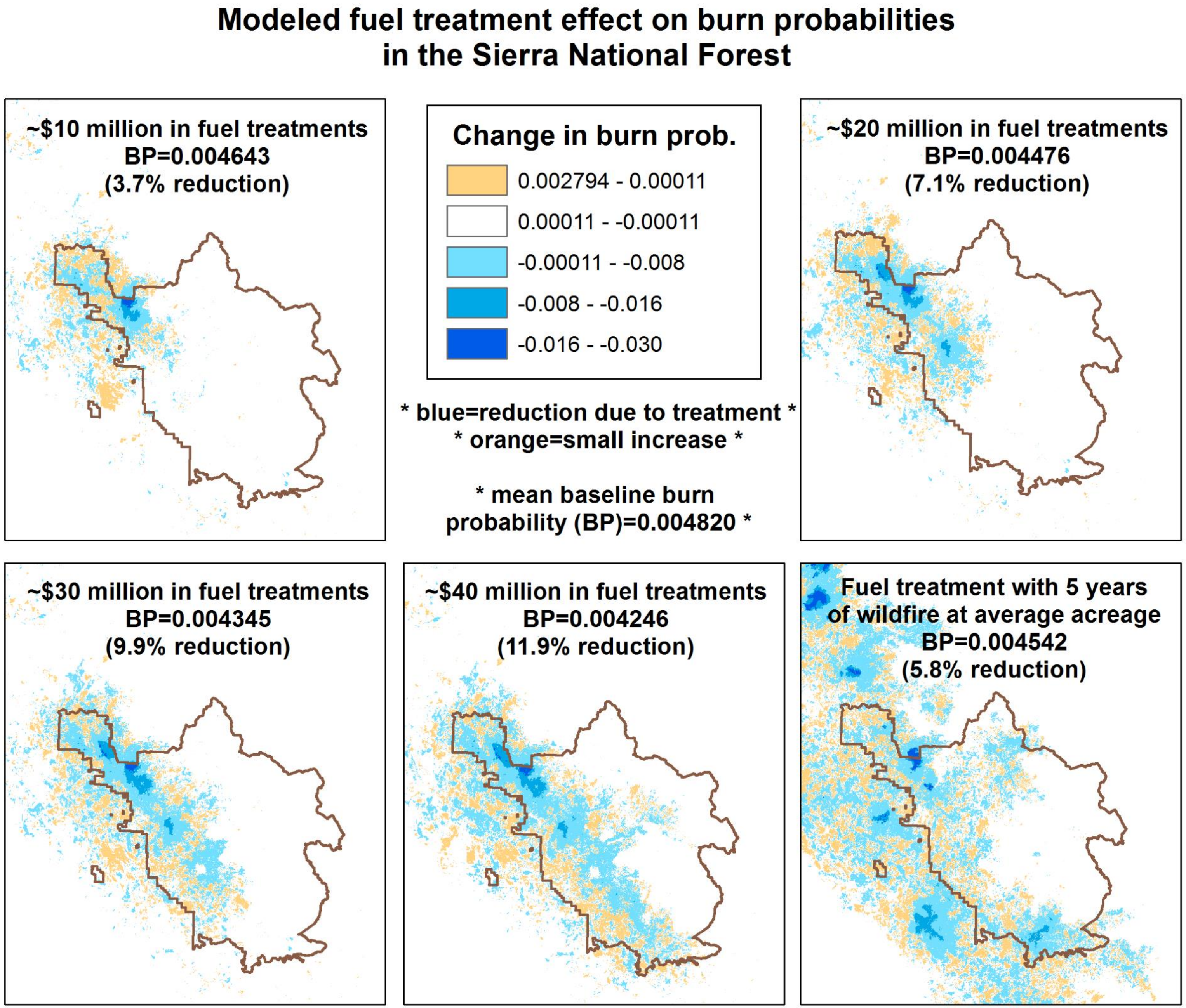


Median fire
size=880 acres



Reduction of:

- 25% in burn probability
- 11% in median fire size



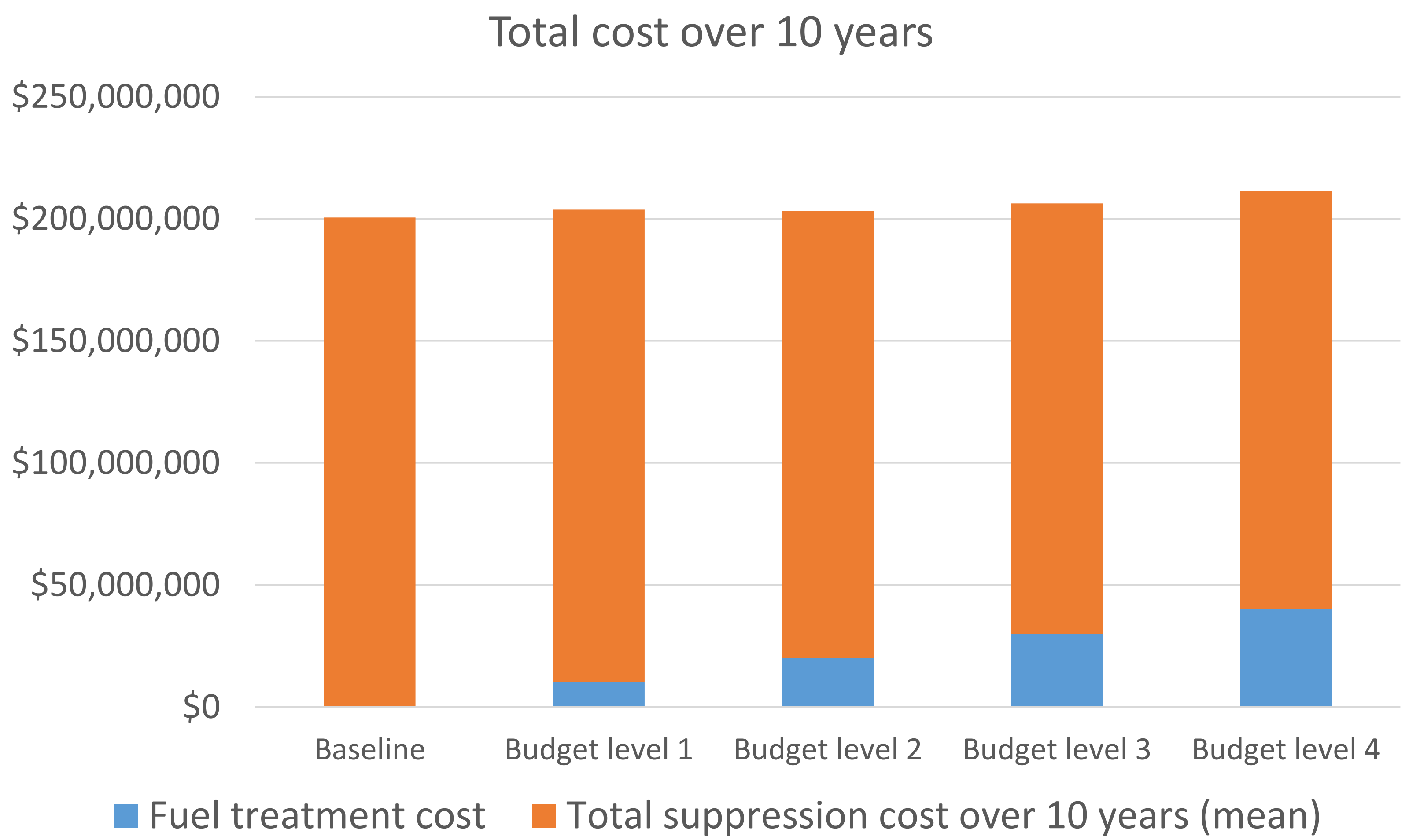
Fuel treatments can reduce risk from wildfire to highly valued resources

FUEL TREATMENTS CAN REDUCE THE SIZE OF FUTURE WILDFIRES AND PRODUCE SUPPRESSION COST SAVINGS

	Mean large fire size (ac)	Mean number of large fires/year	Mean acres burned/year	Mean suppression cost/fire	Total suppression cost/year (mean)	Suppression cost savings if fuel treatments effective for 10 years
Baseline	2619	2.42	6336	$8,290,000	$20,055,460	$0
$10 million in fuel treatments	2543	2.4	6091	$8,090,000	$19,378,085	$6,773,750
$20 million in fuel treatments	2455	2.38	5839	$7,704,000	$18,321,186	$17,342,740
$30 million in fuel treatments	2389	2.36	5644	$7,461,000	$17,630,438	$24,250,220
$40 million in fuel treatments	2338	2.35	5487	$7,304,000	$17,141,156	$29,143,040
Treatment with 5 years of wildfire at average number of acres burned	2529	2.36	5967	$8,061,000	$19,023,096	NA

Investment at $20 million in fuel treatments roughly equivalent to projected suppression cost savings

- The bulk of substantial investment in fuel treatments can likely be largely if not entirely offset by savings in suppression (shown below) and preparedness costs (not modeled in this analysis)



CONCLUSIONS

- The new methodology presented here allows treatment locations to be optimized based on their potential to reduce risk to highly valued resources, making efficient use of limited funding
- Strategically located treatments can reduce the probability that highly valued resources will burn
- There is potential for treatments to "pay for themselves" by reducing preparedness and suppression costs