

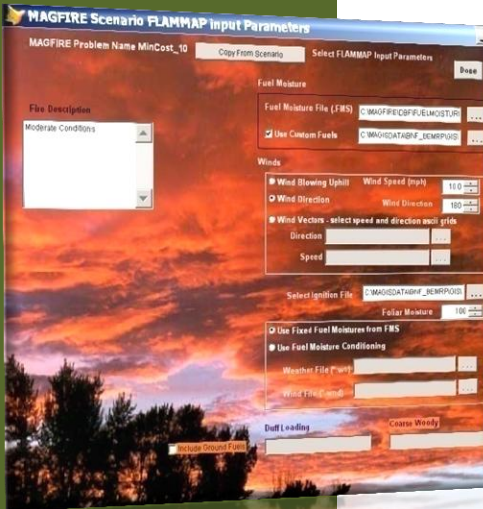
# OPTFUELS: ASSESSING FIRE RISK AND SCHEDULING FUEL TREATMENTS SPATIALLY OVER TIME TO MINIMIZE EXPECTED LOSS FROM FUTURE FIRE

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Woodam Chung, Edward Butler, *The University of Montana*  
Robb Lankston, *Collins, Inc.*



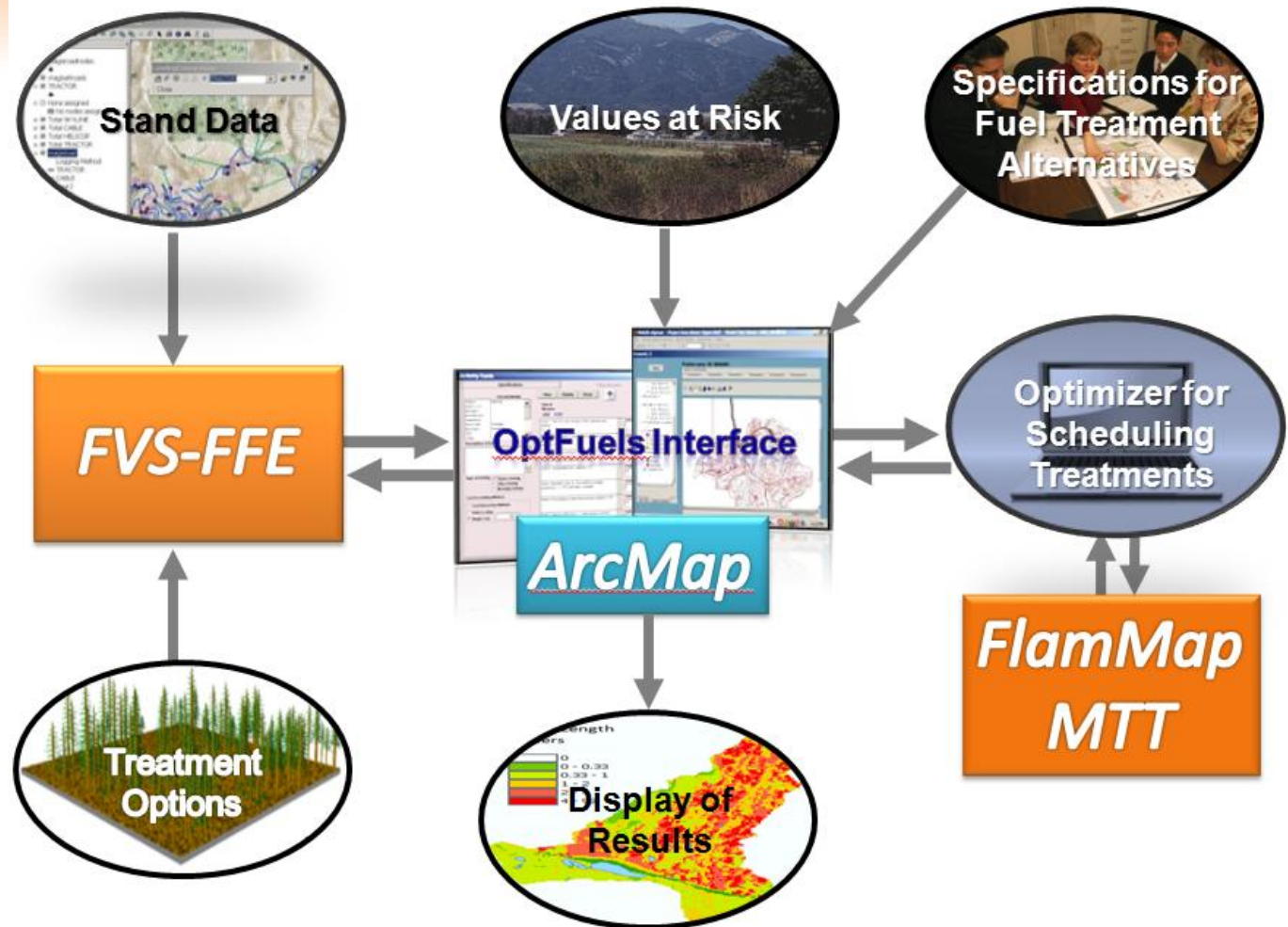
# OBJECTIVES FOR DEVELOPING OPTFUELS

- Integrate existing fire behavior (FlamMap), vegetation simulation (FVS-FFE), and land management planning (MAGIS) tools into one decision support system that supports long-term fuel management decisions in the Lake Tahoe Basin
- Optimize **spatial and temporal** location of fuel treatments to maximize landscape-level fuel treatment effects over time,
- Satisfy given budget and operational constraints,
- Meet water quality goals.

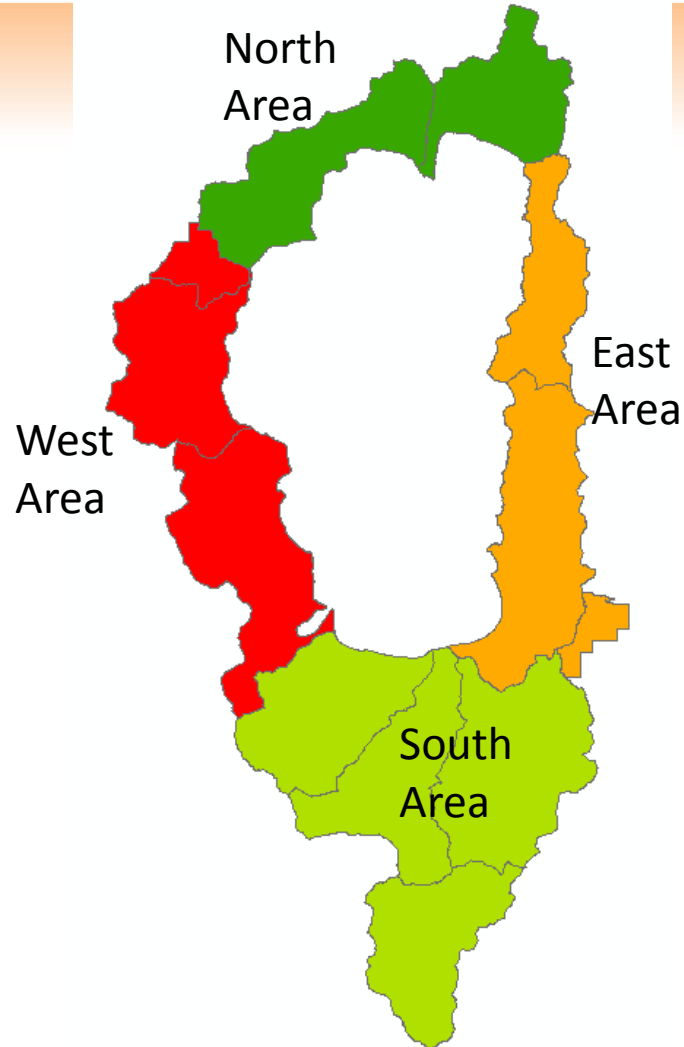


*OptFuels*

# OPTFUELS SYSTEM COMPONENTS



# FOUR DEFAULT OPTFUELS MODELS



# OPTFUELS OBJECTIVE FUNCTION

- Objective for driving placement and scheduling of fuel treatments
- Minimize expected loss from wildland fire over time:

$$\text{Minimize } \sum_t \sum_c P_{c,t} \times W_r \times \text{Loss}_{r,c,f,t}$$

where :

$t$ : Index of time period

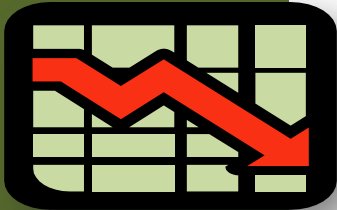
$c$ : Index of grid cells (pixels)

$r$ : Index for risk category

$P_{c,t}$ : Probability of cell  $c$  being burned in period  $t$

$W_r$ : Weight for risk category  $r$

$\text{Loss}_{r,c,f,t}$ : Expected loss for risk category  $r$  for grid cell  $c$  with flame length  $f$  in period  $t$ .



# OBJECTIVE FUNCTION WEIGHTS AND LOSS

$$\text{Minimize } \sum_t \sum_c P_{c,t} \times W_r \times \text{Loss}_{r,c,f,t}$$

Relative Loss Values <sup>1</sup>

Risk Category	Weights	Flame Length Categories (meters)				
		0 – 0.3	0.3 – 1.0	1.0 – 2.0	2.0 – 4.0	4.0+
Residential	8	5%	20%	40%	60%	100%
Defense Zone	8	5%	10%	25%	50%	80%
Extended WUI	3	0%	10%	20%	30%	40%
Other Lands	1	0%	10%	20%	30%	40%
Wilderness	1	0%	0%	0%	0%	0%

<sup>1</sup> Based on Calkin et al 2010. Wildfire Risk and Hazard: Procedures for the First Approximation. RMRS-GTR-235.

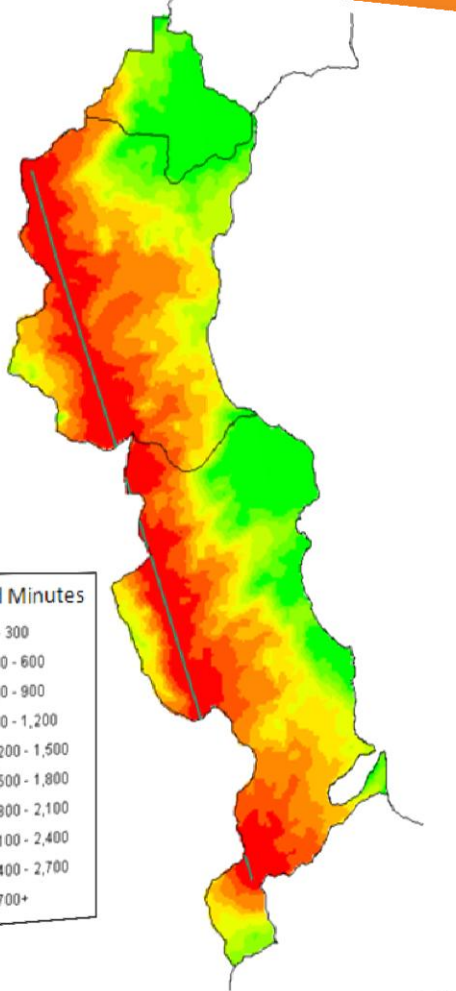
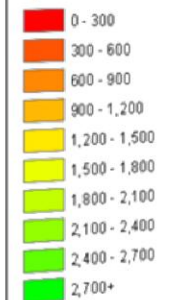
# OBJECTIVE FUNCTION BURN PROBABILITY

$$\text{Minimize } \sum_t \sum_c P_{c,t} \times W_r \times \text{Loss}_{r,c,f,t}$$

## Burn Probability

Time Step	Fire Duration (Spread Minutes)	Probability
1	300	0.91
2	600	0.83
3	900	0.74
4	1,200	0.67
5	1,500	0.60
6	1,800	0.53
7	2,100	0.46
8	2,400	0.40
9	2,700	0.35
10	3,100	0.31
11	3,500	0.27
12	3,900	0.23
13	4,300	0.21
14	4,700	0.19
:	:	:

### Spread Minutes

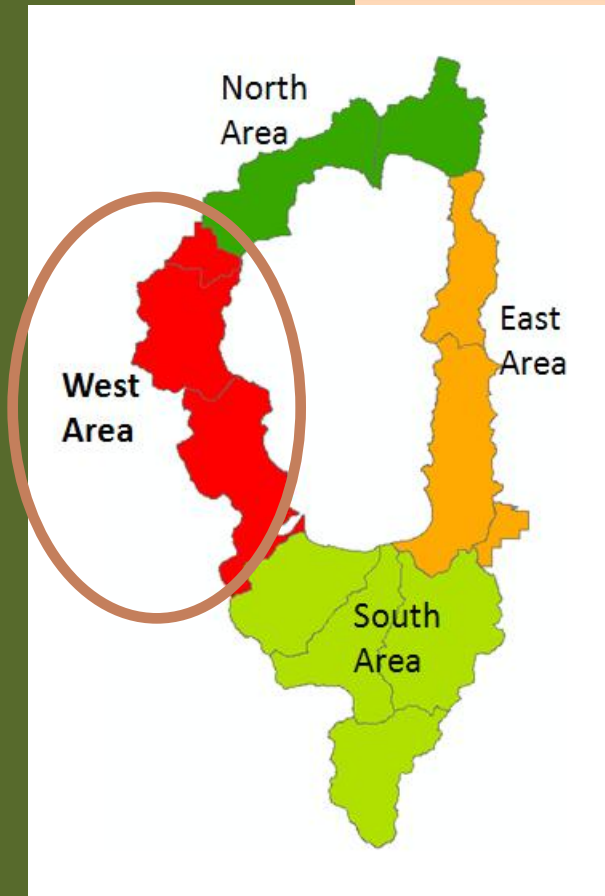




# SPECIFICATIONS FOR FUEL TREATMENT ALTERNATIVES

- ⊙ Fire scenarios (1 or more)
  - ⊙ Ignition line or points
  - ⊙ Wind speed & direction
  - ⊙ Fuel Moisture
- ⊙ Edit loss amounts for Risk Categories
- ⊙ Constraints (by planning period)
  - ⊙ Limit treatment acres
  - ⊙ Limit Budget
- ⊙ Pre-select Treatment Options

# APPLICATION



## Treatment Options

Hand thinning followed by broadcast burn

Mechanical thinning followed by mastication

## Time Periods

Three time periods with 5-year interval

## Cluster Size

50-acre target

## Treatment Alternatives

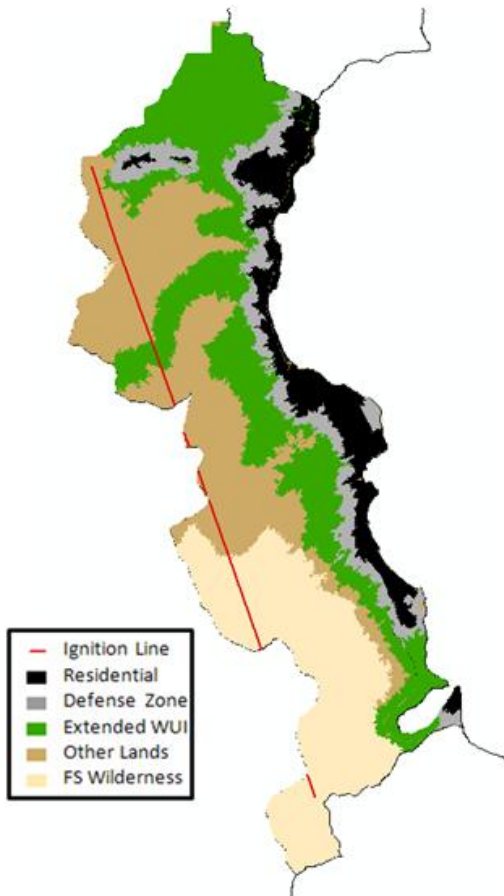
#1 No Action

#2 ~ 30% of total treatable area (1,940 acres/pd)

#3 ~ 50% of total treatable area (3,333 acres/pd)

# APPLICATION FIRE SCENARIO

## Ignition Line



## Wind

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Wind speed            22 MPH

Wind direction       222°

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## Fuel Moisture

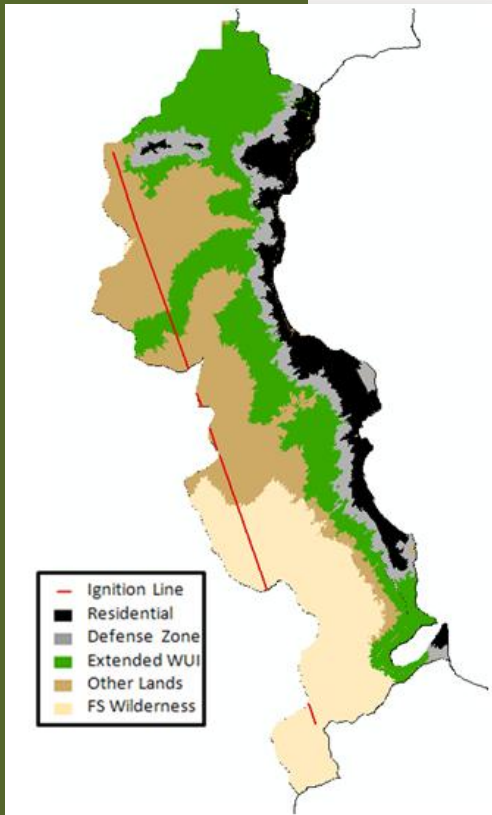
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Fuel Category	% Moisture
1 hr	4
10 hr	5
100 hr	7
Live herbaceous	50
Live woody	70
Foliar	90

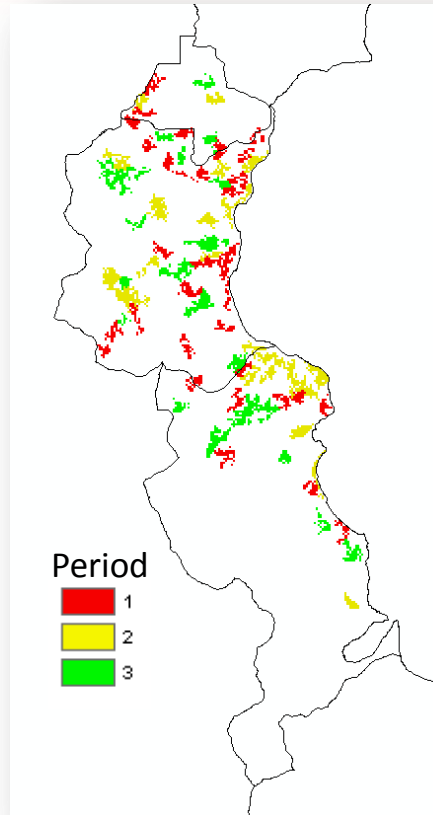
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# APPLICATION RESULTS

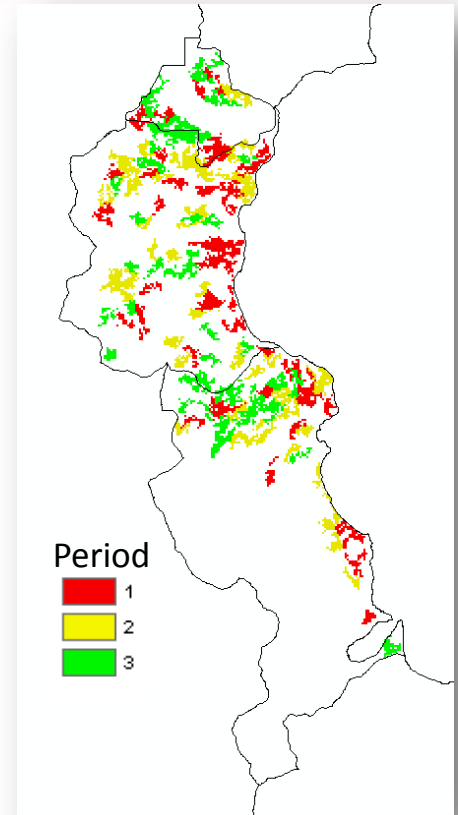
Risk Categories



Treatment Level #1 (30%)

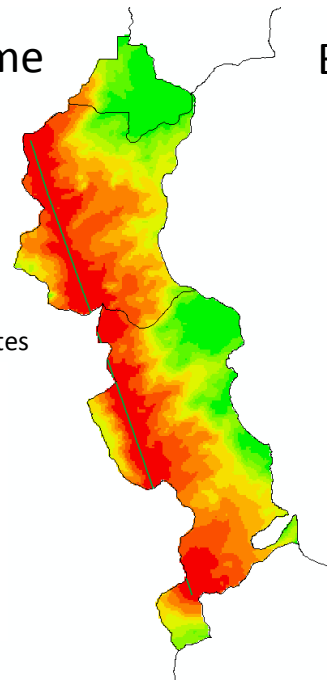


Treatment Level #2 (50%)

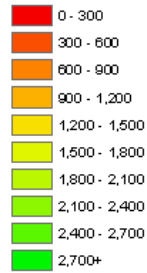


# NO ACTION (PERIOD 1)

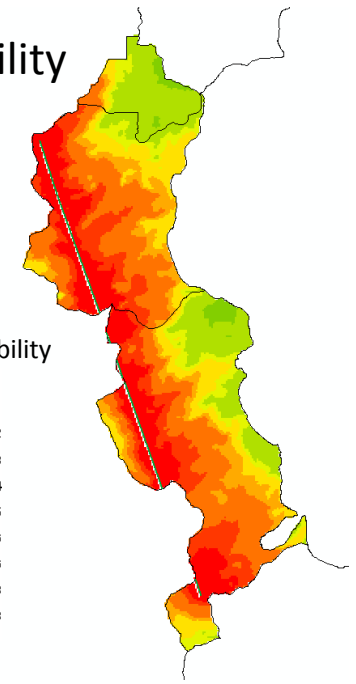
## Arrival Time



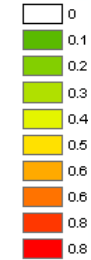
### Spread Minutes



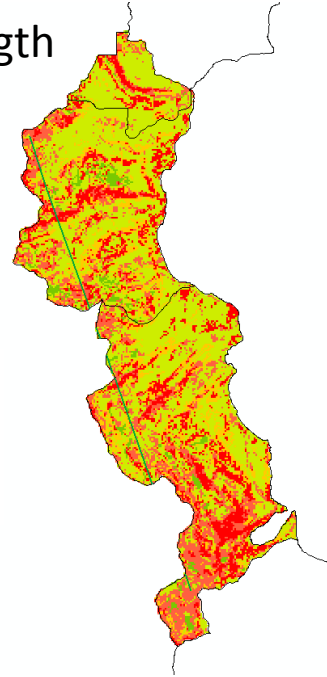
## Burn Probability



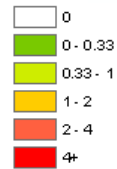
### Probability



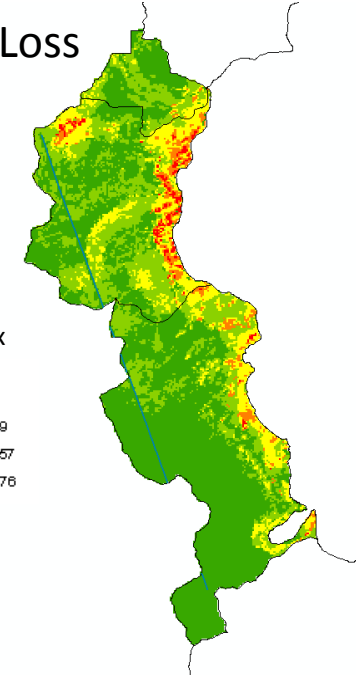
## Flame Length



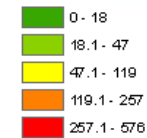
### Meters



## Expected Loss

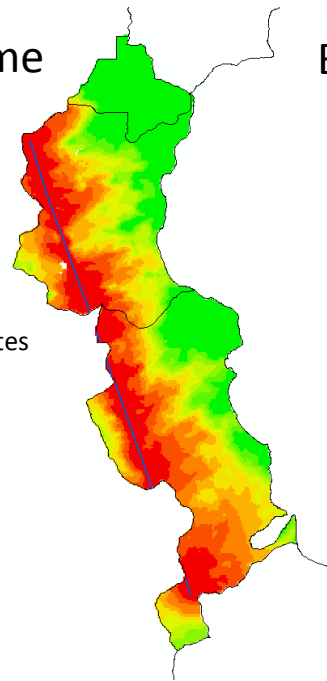


### Loss Index

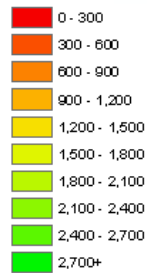


# TREAT 30% (PERIOD 3)

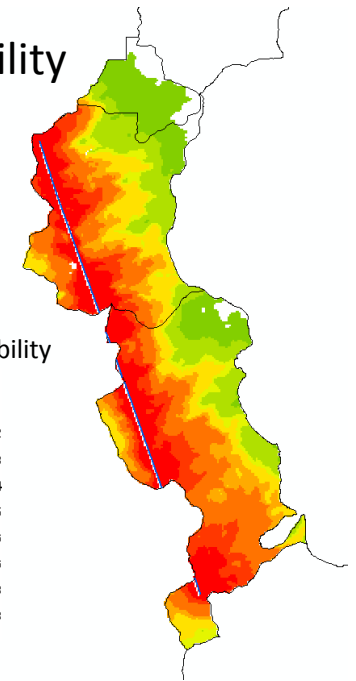
## Arrival Time



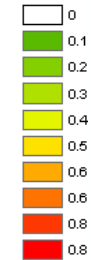
### Spread Minutes



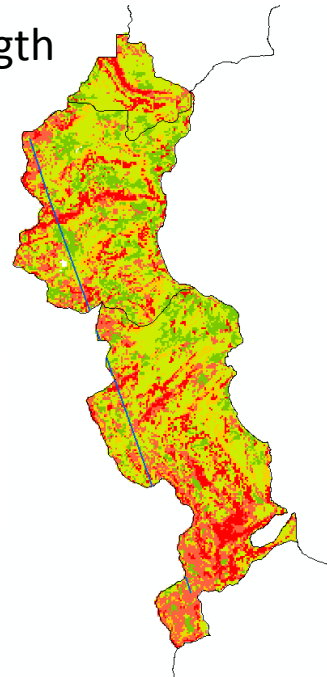
## Burn Probability



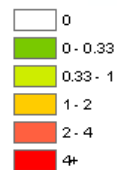
### Probability



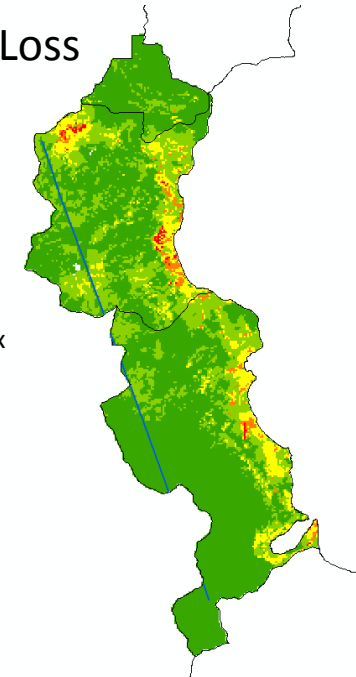
## Flame Length



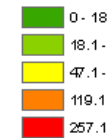
### Meters



## Expected Loss

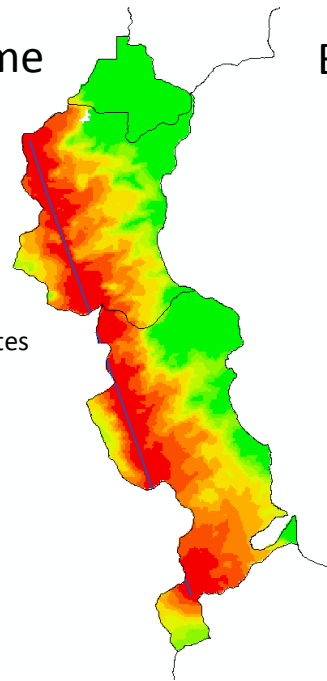


### Loss Index

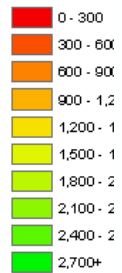


# TREAT 50% (PERIOD 3)

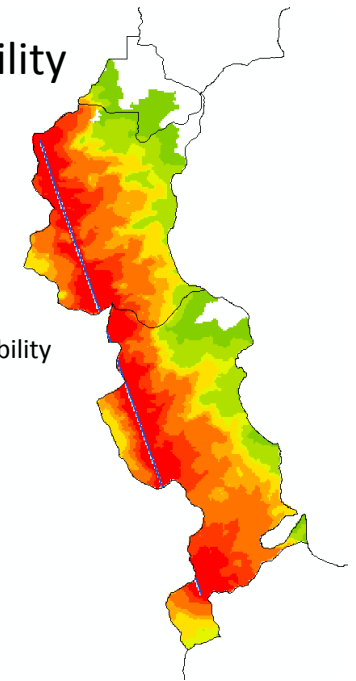
### Arrival Time



### Spread Minutes



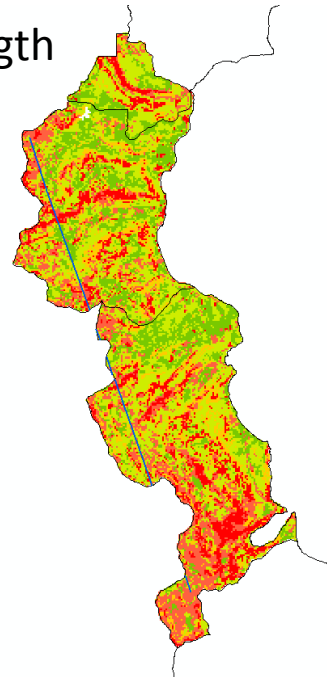
### Burn Probability



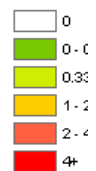
### Probability



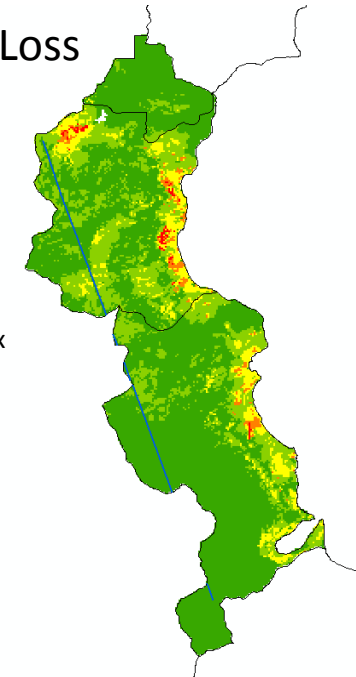
### Flame Length



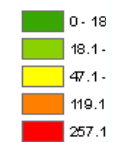
### Meters



### Expected Loss



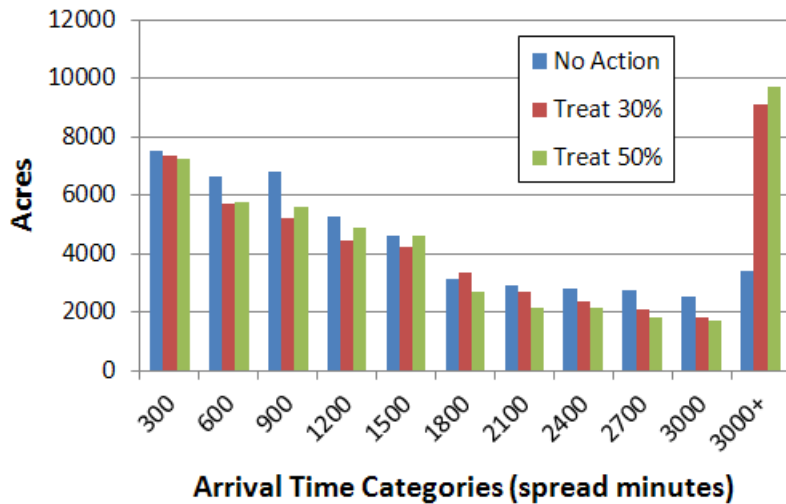
### Loss Index



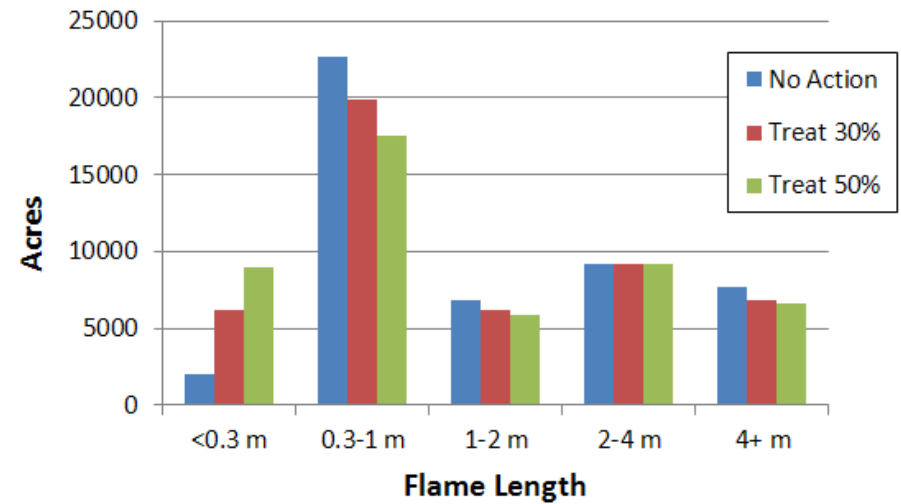
# APPLICATION RESULTS

## 3<sup>rd</sup> Period

### Fire Arrival Time - 3rd Period



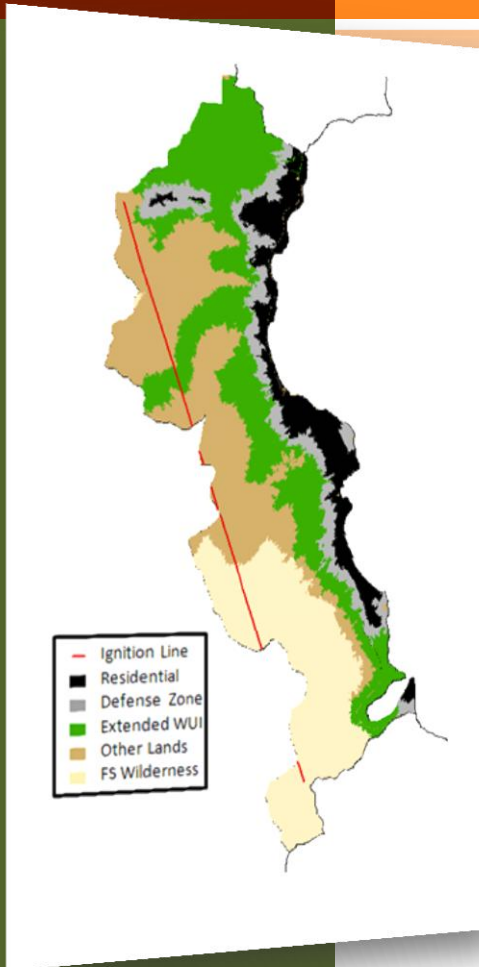
### Flame Length - 3rd Period



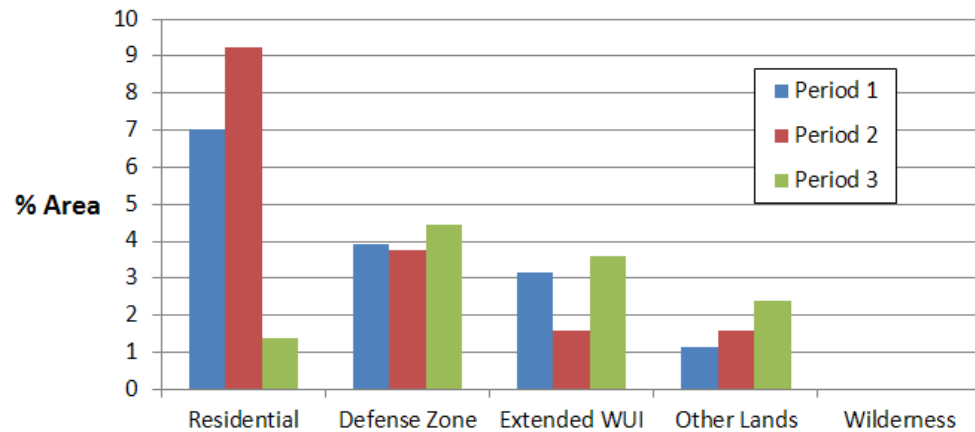


# APPLICATION RESULTS

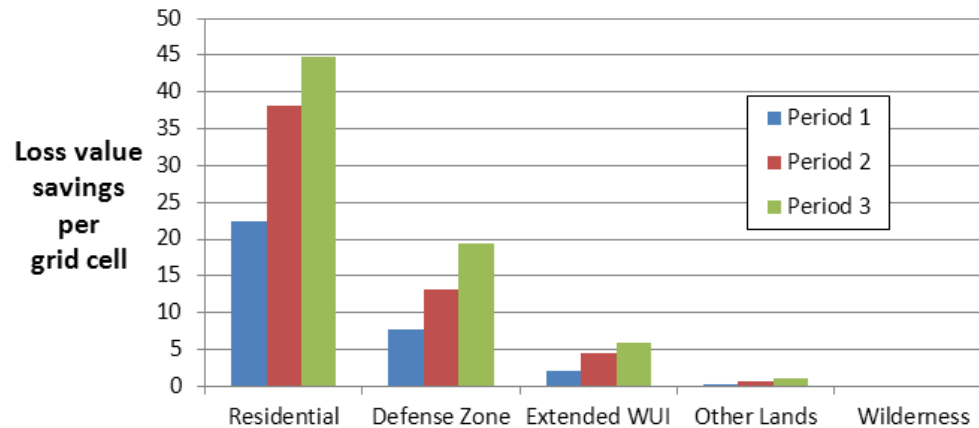
## Treat 30% Alternative



### Percent of area treated in each zone

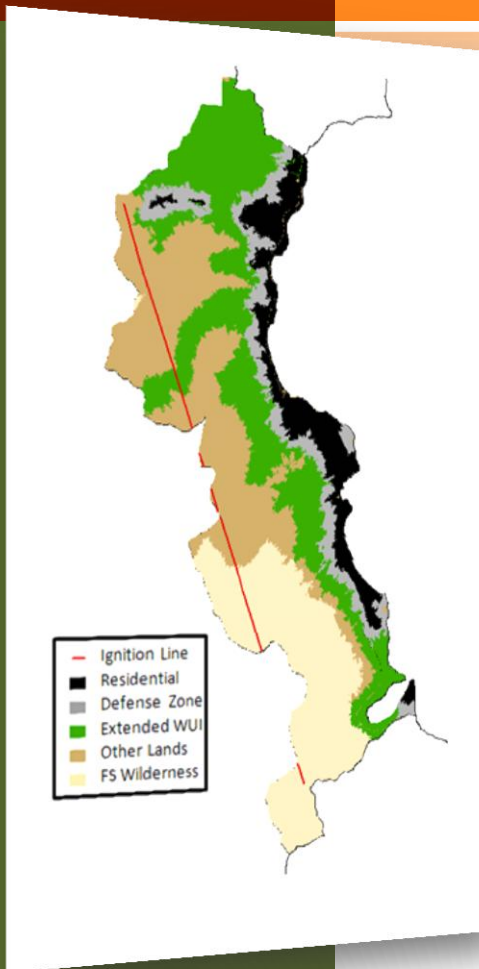


### Average reduction in loss value in each zone

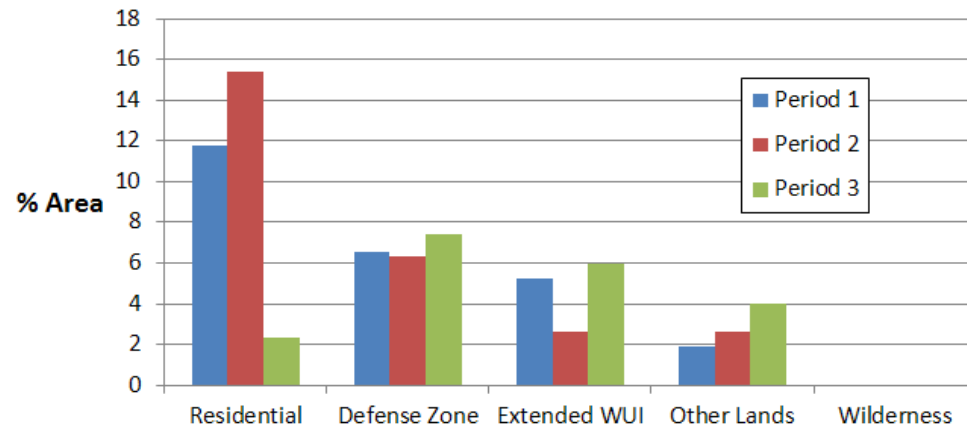


# APPLICATION RESULTS

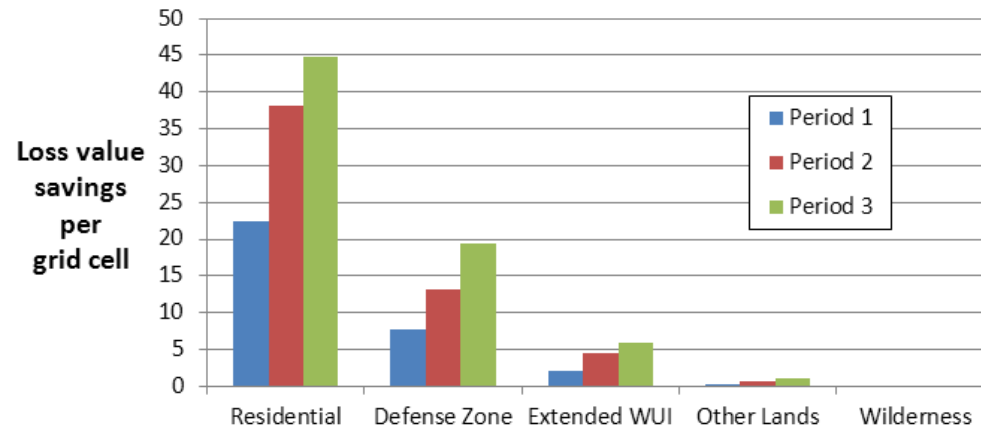
## Treat 30% Alternative



### Percent of Area Treated in Each Zone



### Average reduction in loss value in each zone





# WHAT IS NEXT?

- ⦿ Develop a streamlined process for clipping and building planning-area specific OptFuels Models.
- ⦿ Add functionality for entering treatment unit polygons with assigned treatments for analyzing alternatives at the project scale.
- ⦿ Enhance the fuel treatment information provided by OptFuels:
  - ⦿ Biomass volumes & costs
  - ⦿ Costs for treatment options that do not remove biomass
  - ⦿ Future stand structure & other stand data with and without treatments
- ⦿ Enhance the capability to estimate sediment delivery for various scenarios
- ⦿ Deliver OptFuels to end users.

# ACKNOWLEDGEMENTS

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- ⊙ Rocky Mountain Research Station

## ⊙ **Project Team**

- ⊙ Woodam Chung, PI, The University of Montana
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- ⊙ William Elliot, Co-PI, RMRS
- ⊙ Kurt Krueger, RMRS
- ⊙ John Hogland, RMRS
- ⊙ Robb Lankston, Collins, Inc.
- ⊙ Edward Butler, The University of Montana
- ⊙ David Schmidt, The University of Montana
- ⊙ Jody Bramel, Axiom IT Solutions, Inc

## ⊙ **Collaborators**

- ⊙ Mark Finney, RMRS
- ⊙ Elizabeth Reinhardt, USDA Forest Service
- ⊙ Carl Seielstad, The University of Montana
- ⊙ Janet Sullivan, formerly RMRS

(OptFuels Website: <http://www.fs.fed.us/rm/human-dimensions/optfuels>)



THANK YOU!

Questions?