CAN LANDSCAPE RESTORATION AND FIRE SUPPRESSION COST SAVINGS BE ACHIEVED VIA ECOLOGICAL FIRE RESPONSE?

PROOF-OF-CONCEPT AND PRELIMINARY RESULTS

Karin L. Riley [1], Matthew P. Thompson [1], Dan Loeffler [2], Joe Scott [3], and Jessica Haas [1]

[1] *Rocky Mountain Research Station, US Forest Service, Missoula, Montana*

[2] *University of Montana*

[3] *Pyrologix, LLC, Missoula, Montana*

WHAT IS ECOLOGICAL FIRE RESPONSE?

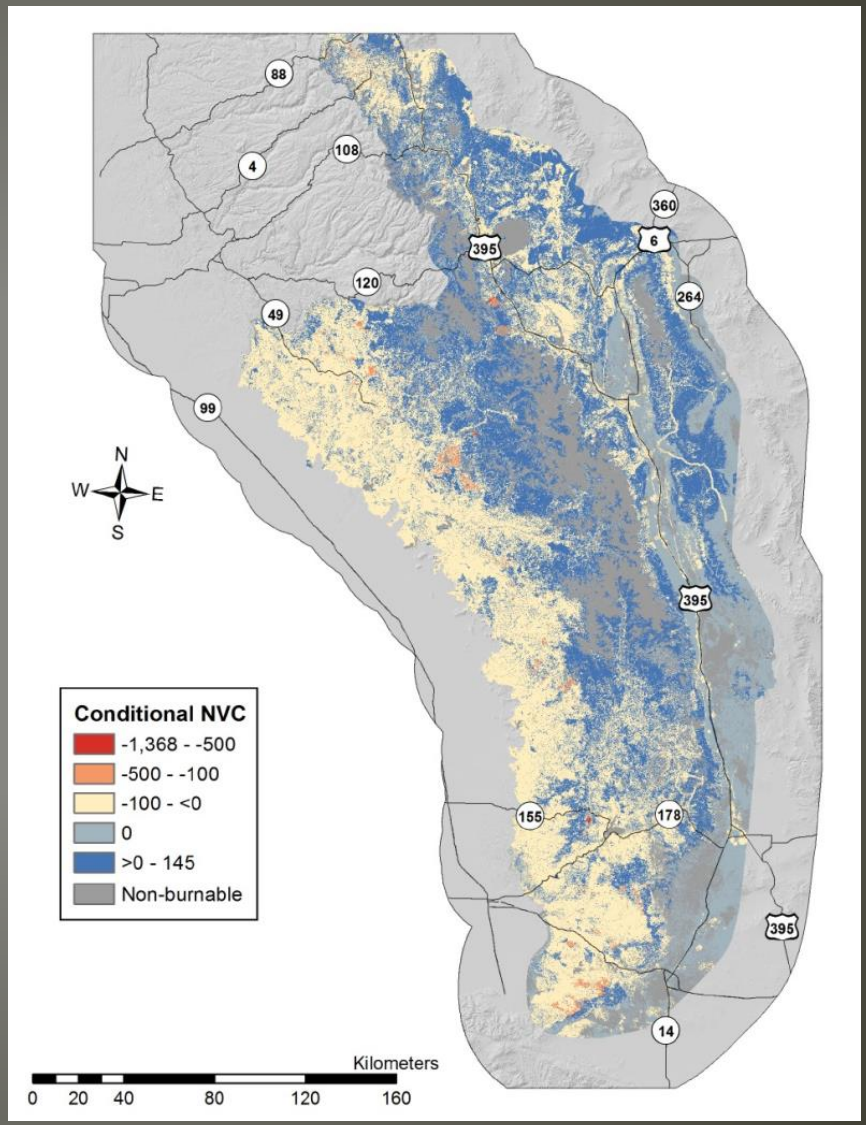
- During an incident:
  - ~~Tactics (e.g. Minimum Impact Suppression Tactics rather than bulldozers)~~
- Pre-fire planning:
  - Response strategy
    - More area burned in areas where it is ecologically beneficial
    - Continued suppression where fire ecologically harmful (or damaging to other highly valued resources)
  - Forest restoration via mechanical fuel treatment and Rx burning that means future fire is more likely to be beneficial

HOW TO EVALUATE THE POTENTIAL FOR ECOLOGICAL FIRE RESPONSE IN A PRE-FIRE CONTEXT?

- Fire simulation models and risk assessment methods
- Pre-fire planning allows time for research and increases decision space
- Results being integrated into spatial fire planning efforts on National Forests
  - Landscape assessment and planning efforts
  - Land and Resource Management Plans

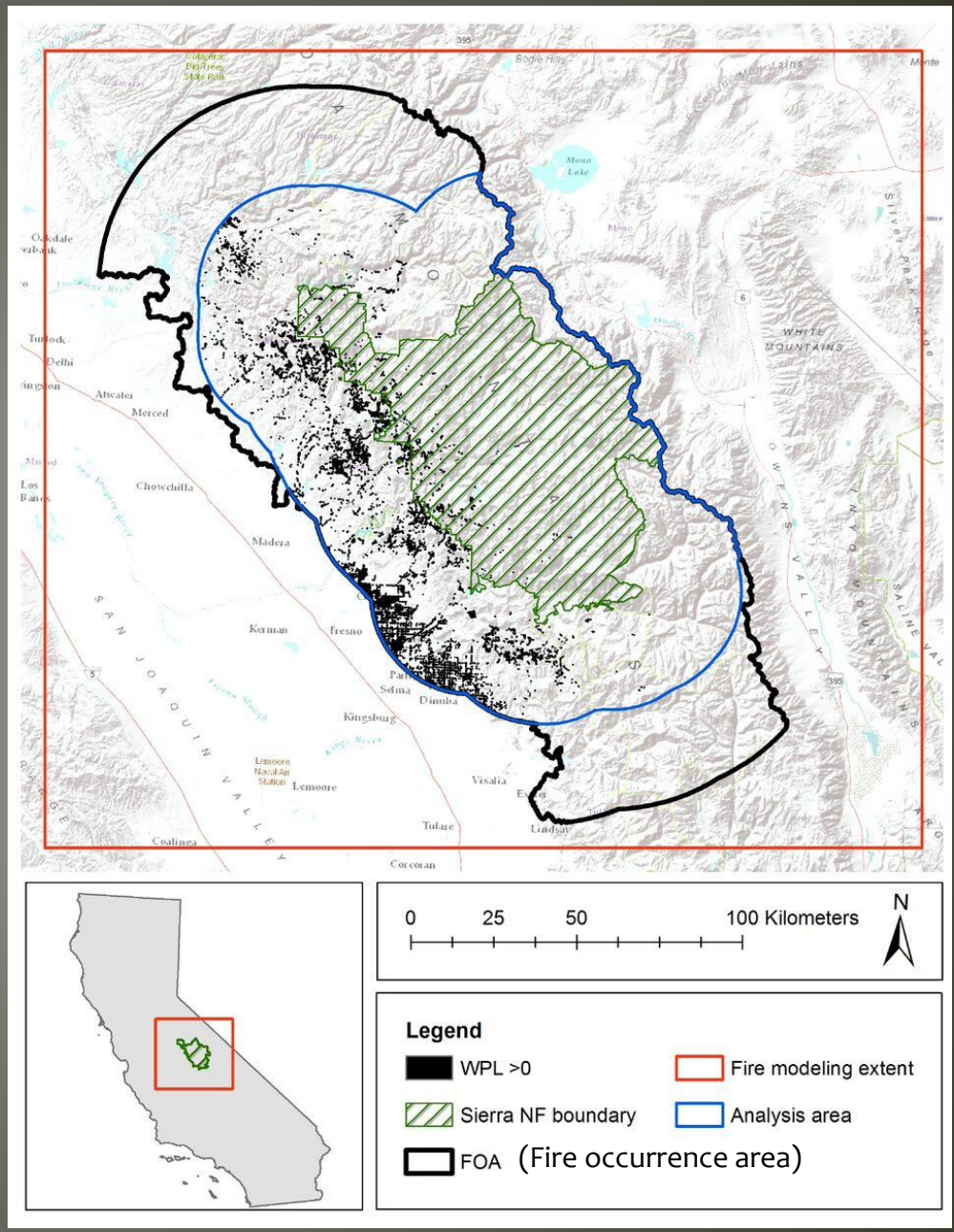
PRE-FIRE MODELING AND RISK ASSESSMENT IN ECOLOGICAL FIRE RESPONSE

- Objectives:
  - Estimate burn probabilities and fire sizes under different fuel treatment and fire response policies
    - Potential for loss v. benefit
  - Estimate feedbacks in area burned
  - Estimate fire costs where feasible
- Tools and concepts
  - The Large Fire Simulator (FSim)
  - Conditional Net Value Change
  - Spatial Stratified Cost Index



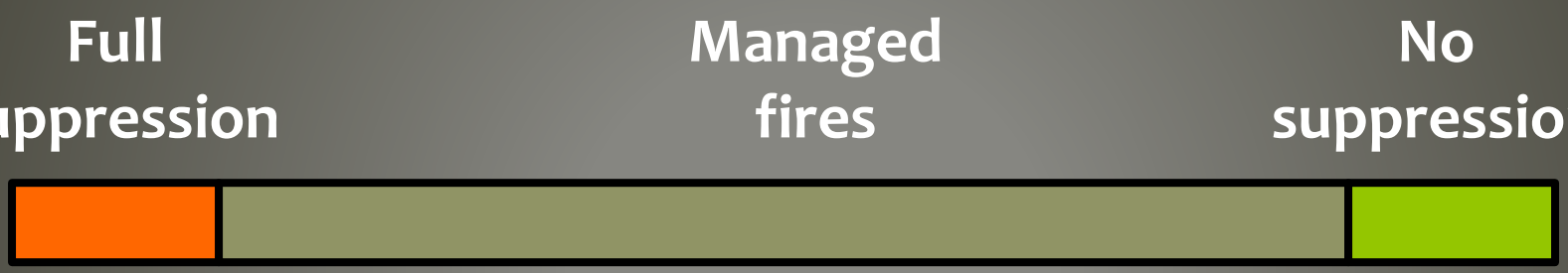
STUDY AREA

- Case study landscape: 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.)



OBJECTIVE 1:
ESTIMATE BURN PROBABILITIES AND FIRE SIZES UNDER DIFFERENT FUEL TREATMENT AND FIRE RESPONSE POLICIES

Fire Response Continuum



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ESTIMATE BURN PROBABILITIES AND FIRE SIZES UNDER DIFFERENT FUEL TREATMENT AND FIRE RESPONSE POLICIES

Fire Response Continuum

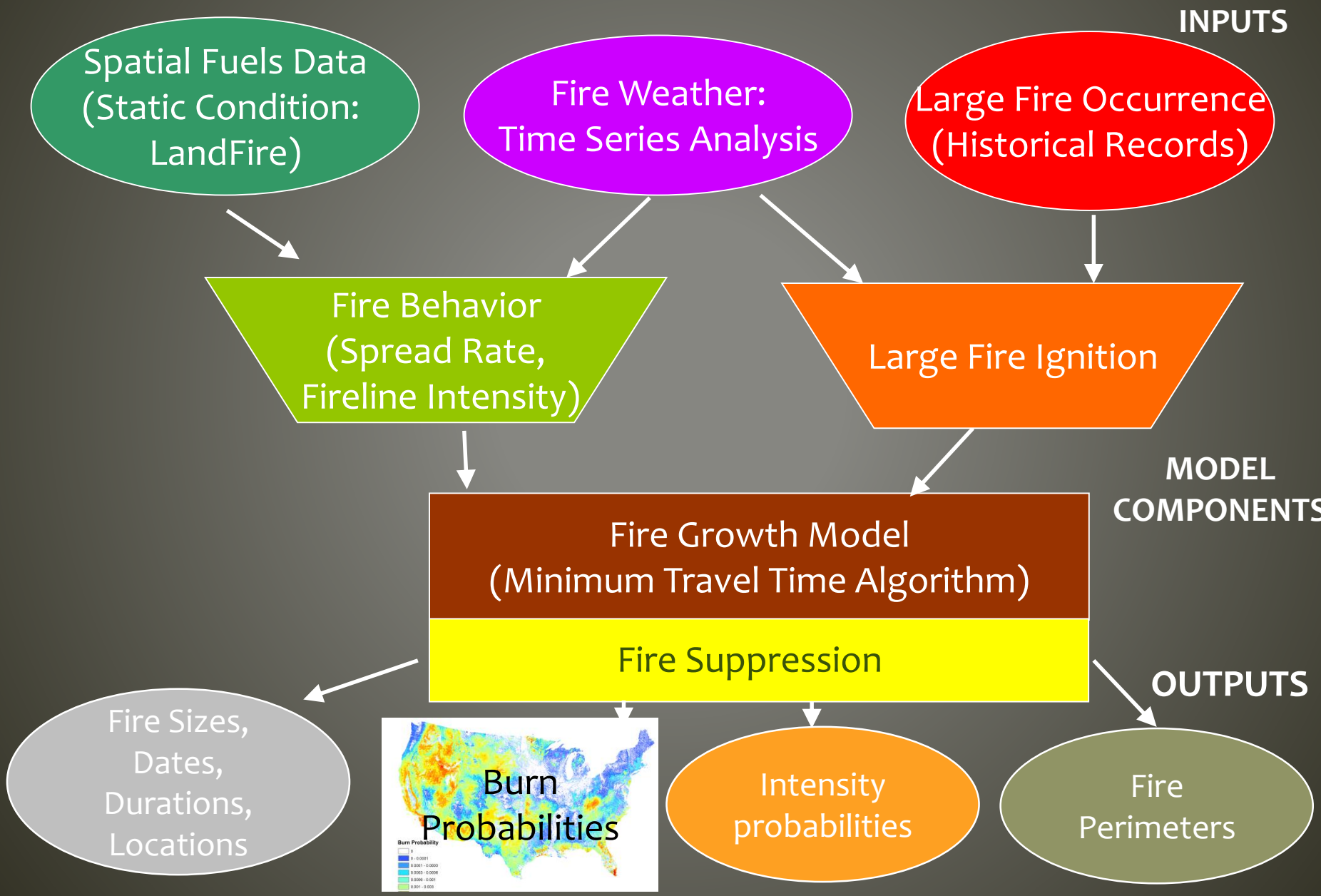
Scenario 1: Business as usual

Scenario 4: Business as usual, with fuel treatments

Scenario 3: Suppression on all fires, but less aggressive

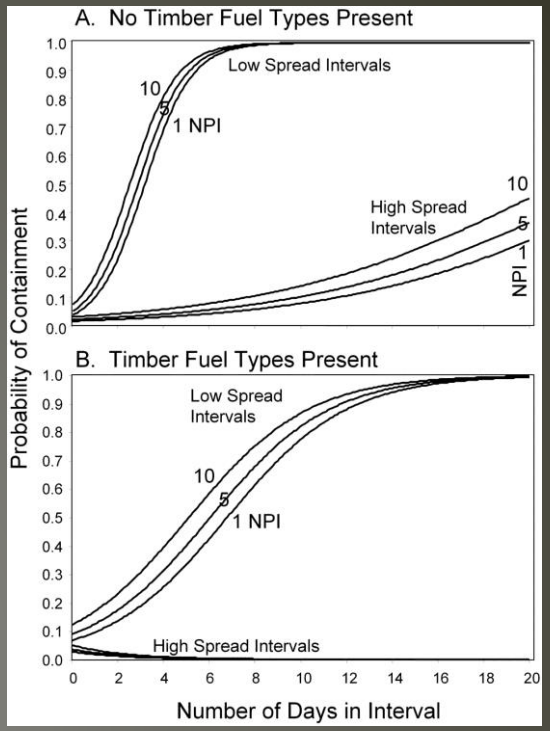
Scenario 2: Full suppression on human-caused fires, no suppression on lightning-caused fires

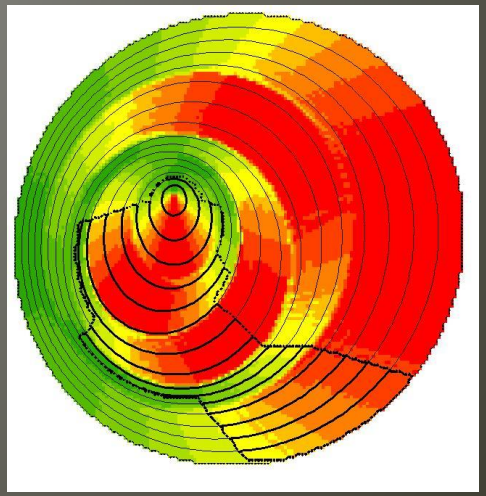
STUDY DESIGN: FIRE SIMULATION APPROACH = FSIM



FIRE SUPPRESSION IN FSIM

- *Three options:*
  - *Fire suppression on:*
    - *Determines fire duration based on probability of containment. Fire growth is unrestricted until containment.*
  - *Fire suppression plus perimeter trimming:*
    - *The fire's perimeter is successively contained, beginning with the area where fire intensity is lowest. While the suppression algorithm determines the duration, perimeter trimming restricts the spatial extent.*
    - *Trimming parameter can be adjusted to affect the rate of containment. (Alpha~2.4 in Western US)*
  - *No suppression:*
    - *Fires are extinguished by a period of wet or cool days (below 70th percentile ERC). Number of days is set by user; we chose 5.*





OBJECTIVE 1:
ESTIMATE BURN PROBABILITIES AND FIRE SIZES UNDER DIFFERENT FUEL TREATMENT AND FIRE RESPONSE POLICIES

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

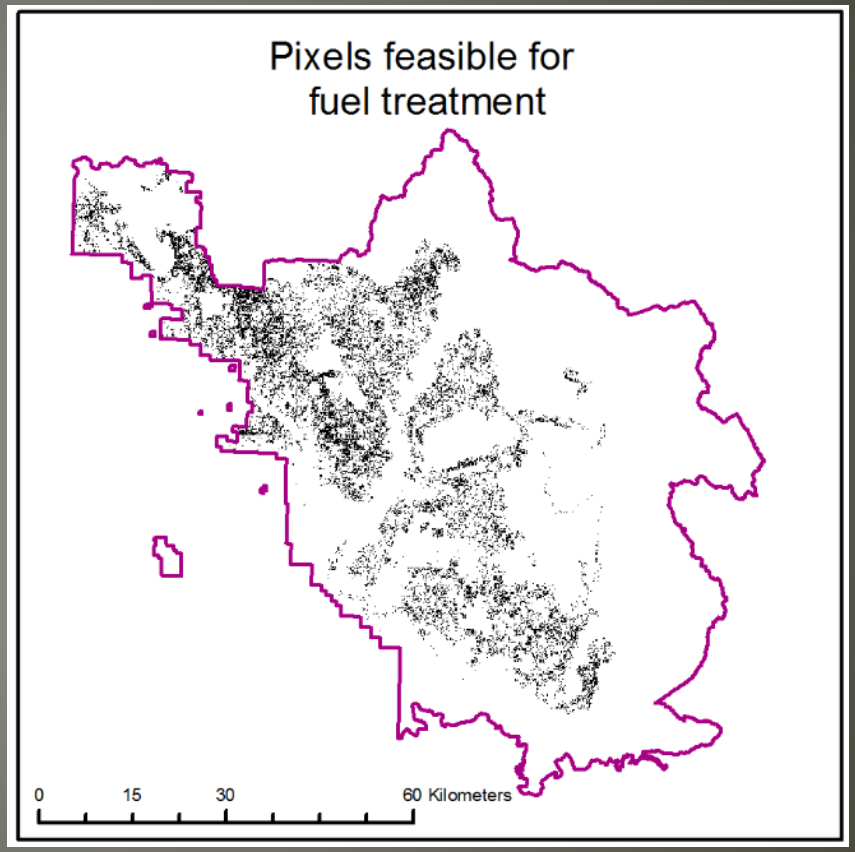
Fuel model: changed to reduce intensity and/or rate of spread (grass not treated as it can quickly regrow)

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.

OBJECTIVE 1: ESTIMATE BURN PROBABILITIES AND FIRE SIZES UNDER DIFFERENT FUEL TREATMENT AND FIRE RESPONSE POLICIES

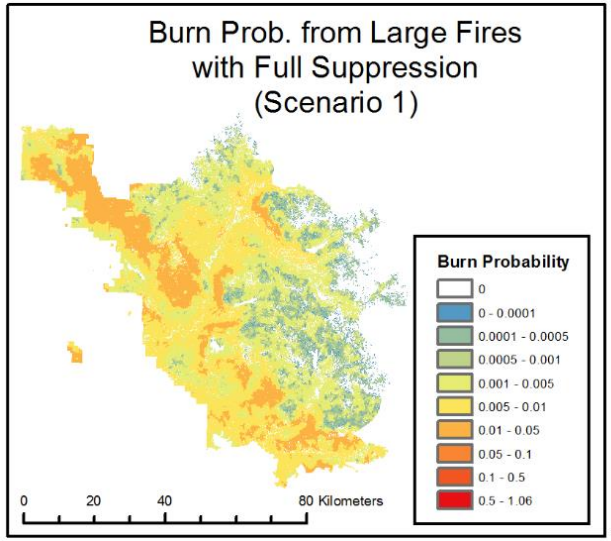
- *Fuel treatment placement was restricted by:*
  - *Distance to road, slope, and land designation (after North et al)*
  - *Treatment cost compared to ability to change forest structure (based on Riley et al tree list)*

- *Fuel treatment scenario #1: all feasible pixels treated*

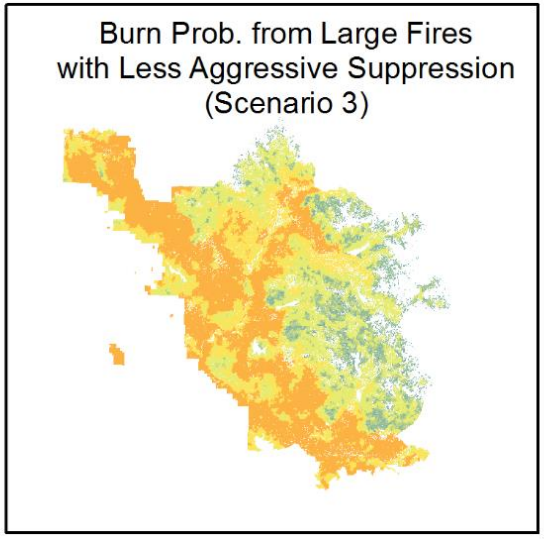


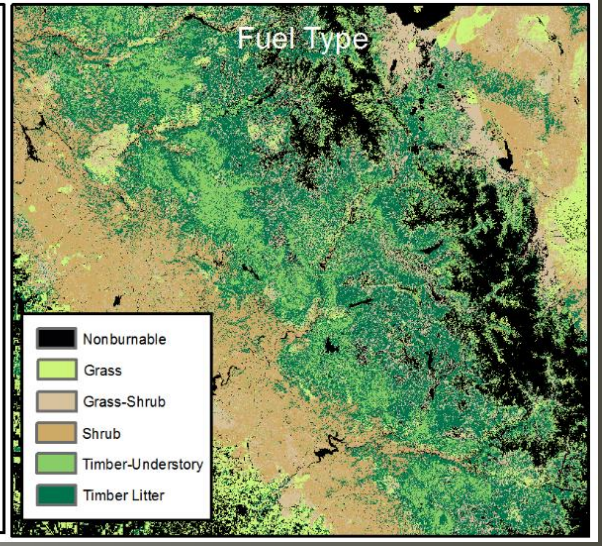
FSIM OUTPUTS FOR ALTERNATIVE SUPPRESSION AND FUEL TREATMENT SCENARIOS

Mean=0.0048

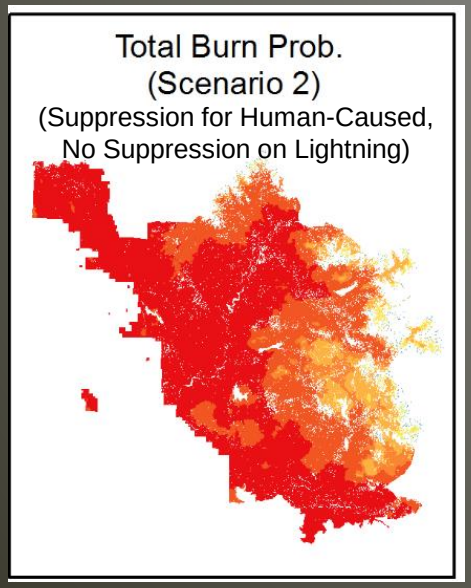


Mean=0.007

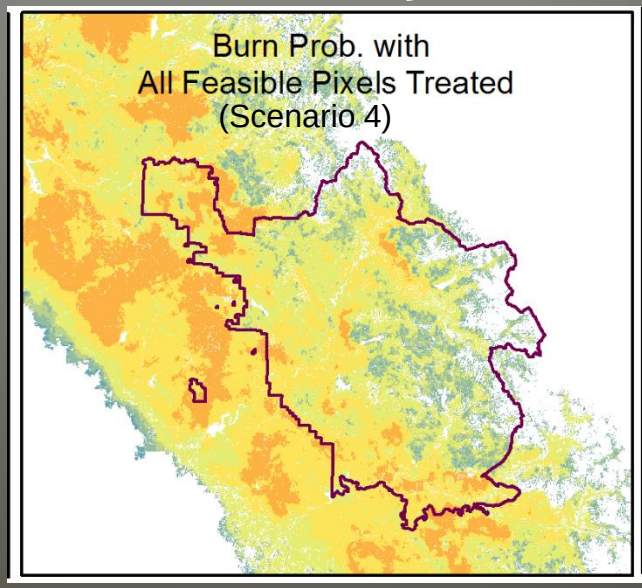


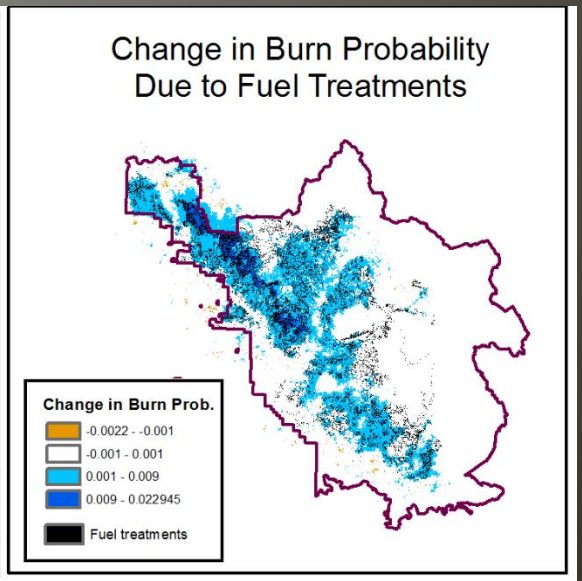


Mean=0.4247



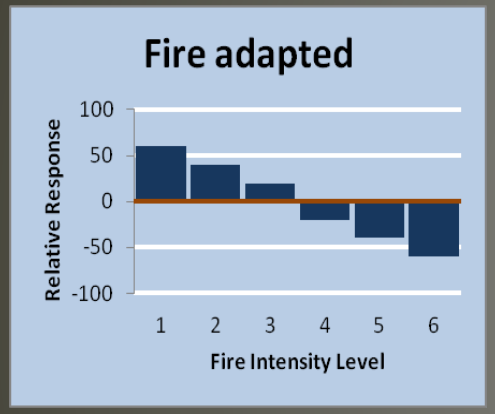
Mean=0.0036

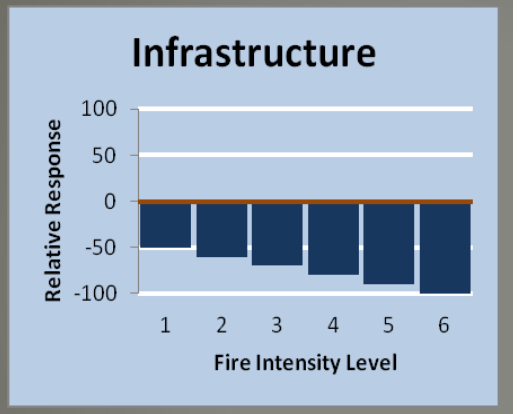




WHERE TO APPLY ALTERNATIVE FIRE SUPPRESSION AND FUEL TREATMENT POLICIES? WHERE FIRE IS A BENEFIT, OR LOSS

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

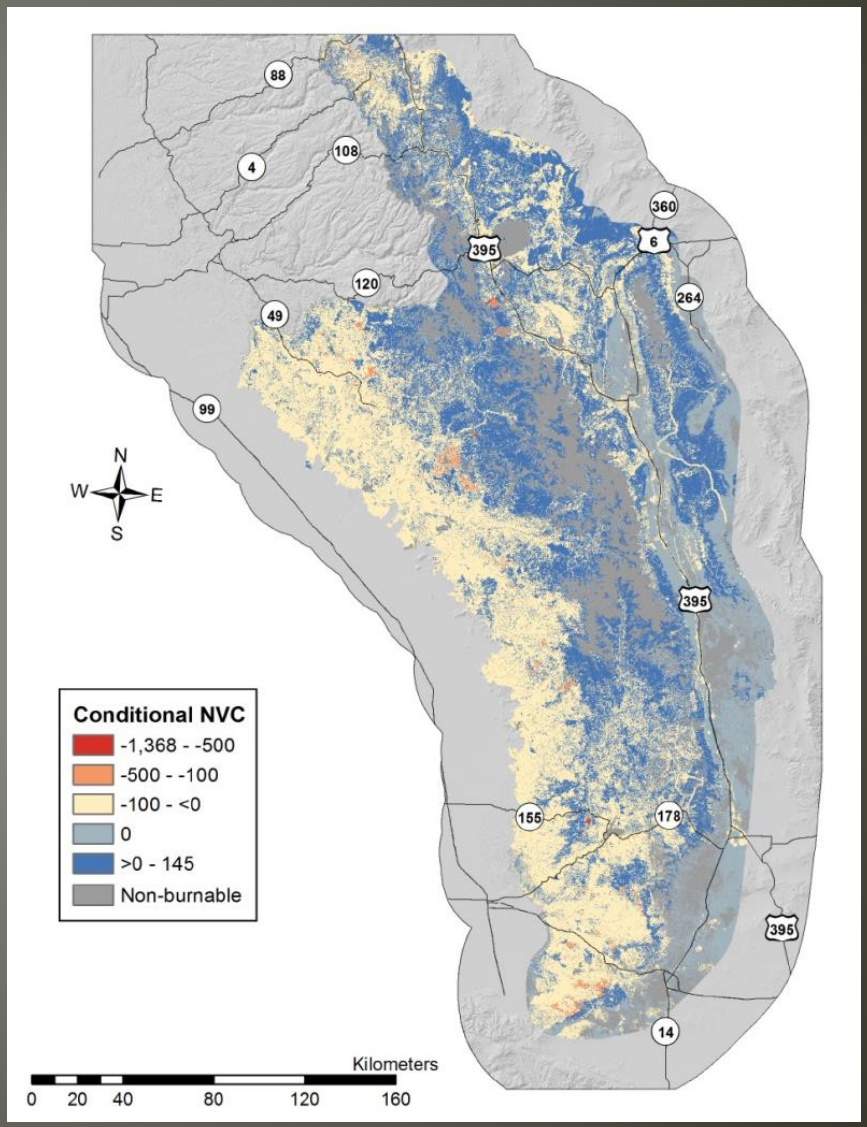




Description:
Strong benefit at low fire intensity decreasing to a strong loss at very high fire intensity.

Description:
Moderate to strong loss as fire intensity increases.

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

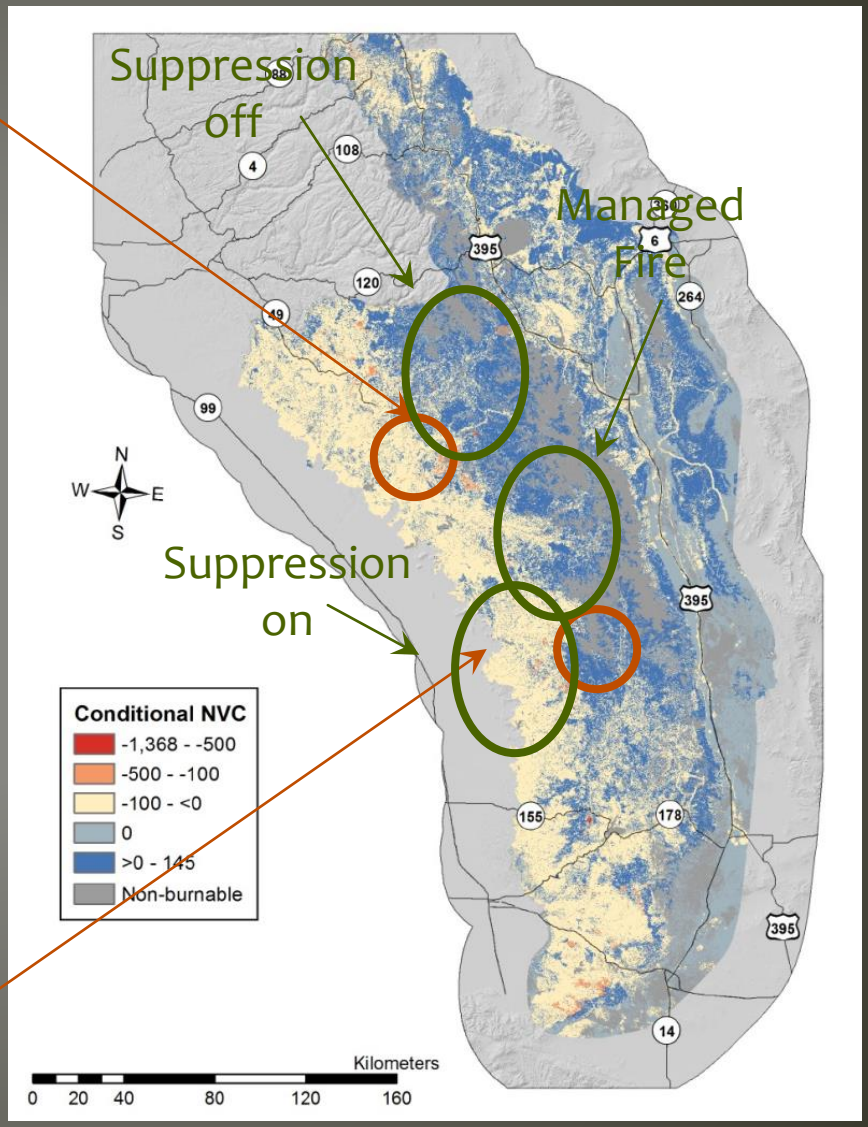


WHERE TO APPLY ALTERNATIVE FIRE SUPPRESSION AND FUEL TREATMENT POLICIES? WHERE FIRE IS A BENEFIT, OR LOSS

- *Fuel treatments*
  - *We will optimize placement based on:*
    - *Treatment cost/acre*
    - *Potential to reduce negative impacts to other highly valued resources*
- *Alternative suppression policies*
  - *Based on potential for benefit vs. loss*

High priority

Low priority



OBJECTIVE 3: ESTIMATE FIRE COSTS WHERE FEASIBLE

- *Stay tuned…*
  - *Current suppression policies*
    - *Cost Scenario 1 (full suppression) and Scenario 4 (fuel treatment) using the Spatial Stratified Cost Index (Hand et al 2016)*
  - *Ideas for costing alternative fire suppression policies?*

SOME PRELIMINARY CONCLUSIONS

- *Both fuel treatments and alternative fire suppression policies have the potential to impact burn probabilities and fire sizes*
- *Even given restrictions on feasible sites for fuel treatments, fuel treatments have the potential to substantially reduce burn probabilities and fire sizes, if implemented at a wide enough scale*
- *While implementing a no suppression policy on lightning fires is likely to increase burn probability by more than an order of magnitude in the short term, feedbacks would soon begin to act as a self-limitation in area burned*
- *Thus, there is an opportunity for managed fires to act as fuel treatments as well, in some locations, especially those where fire can produce benefit on the landscape*
- *Making use of managed fire and fuel treatments could thus reduce future firefighting expenditures*
- *….but more work is needed!*

QUESTIONS?

Karin Riley
kriley@fs.fed.us

Funding provided by:

Prescribed Fire, Banff Park